

**Bangor University**

## **DOCTOR OF PHILOSOPHY**

### **Influence of a newly developed weight loss intervention based on diet commandments on physiological and psychological levels in obese females**

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U N I V E R S I T Y



**Influence of a newly developed weight loss intervention  
based on diet commandments on physiological and  
psychological levels in obese females**

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Degree of Doctor of Philosophy

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## Abstract

**Introduction:** Obesity has been described by the World Health Organisation as a global epidemic, and is recognised as a major health concern due to the associated medical, psychosocial, and economical problems. Treating obesity-related health conditions are a major burden for health systems but treatment towards weight loss are mostly unsuccessful in the long term. Most of the various treatment types are rather costly, like pharmaceutical or surgical interventions. Previous studies found that particular eating behaviours are associated with increased BMI; therefore, an approach of treatment is to influence the concerning eating behaviours towards behaviours with less risk of weight gain. Theories and models of behaviour are used to develop interventions to change eating behaviour. Often treatment schemes focussing on behavioural change are time consuming and costly based on the need of specialised therapists to conduct therapy. Thus, obese and overweight individuals urgently need an effective obesity-management intervention that is simple, inexpensive, and not too time-consuming, does not rely on major assistance of health professionals and can be performed at home for achieving changes in eating behaviour resulting in weight loss.

**Study aims:** The first aim of this current thesis was to develop a new weight loss intervention which focusses on eating behaviour with support of behavioural change theories and current knowledge about eating behaviours which carry obesity risks. The second aim was to investigate the effectiveness of the intervention on body weight and physiological and psychological parameters and to investigate whether particular targeted health behaviours would have a stronger impact on the measured parameters than others. The third aim was to investigate the influence of the various health behaviours on clinical blood parameters which are known to be risk factors for chronic diseases like insulin resistance, type 2 diabetes and cardiovascular disease being related to high BMI.

**Results:** A novel weight-loss intervention was developed, based on principles of Control Theory (CT) and Theory of Planned Behaviour (TPB), using reflective processes on 10 commandments (health behaviours) for the influence of eating behaviour. These 10 behavioural commandments were based on eating behaviours, extracted from literature, which are recognised of high importance for weight loss and health. The study design used three tools (laminated card, leaflet, compliance report). These tools were designed to be complementary to each other regarding their influence

on eating behaviour combining the nutritional information with selected behaviour change techniques.

Two longitudinal studies to test the effectiveness of the intervention were performed, in United Kingdom (UK) - Bangor area and Saudi Arabia (SA) – King Fahad Medical City. Both studies were performed for 3 and 6 months, as well as including a 3 months follow-up assessment with overweight/obese females. The first study was conducted in UK (3 months, n=35; 6 months, n=36; follow up, n=19) to investigate the effectiveness of the study intervention on body weight, attitudes towards food and food craving domains. The intervention was successful to achieve significant weight loss ( $5.5 \pm 3.7$  kg and  $7.8 \pm 5.3$  kg) in the first two phases of the study (after 3- and 6-months of the intervention), respectively. After the follow-up period, the intervention succeeded to maintain the achieved weight loss that was obtained at the end of the second phase (6 months) of the study. There were significant correlations between BMI change and commitment to seven of the eating commandments (B1, B2, B3, B6, B8, B9, B10), as well as after 6-months between commitment to (B1, B2, B3, B5, B7, B8, B9) and BMI change. In the follow-up period, there were significant correlations between BMI change and commitment to B1 and B10. The intervention induced significant improvement in explicit attitudes towards healthy food ( $3.9 \pm 4.5$  and  $5 \pm 7.4$ ) and unhealthy food ( $4.5 \pm 5$  and  $6.1 \pm 6.8$ ) after 3 and 6 months, respectively; outcomes in the follow-up period showed that participants maintained these improvements in explicit attitudes. However, no significant improvement in implicit attitude towards food was detected (IAT). Total of food cravings domains were significantly reduced after 3 months and 6 months of the intervention ( $33.3 \pm 34.3$  and  $36.8 \pm 47.5$ ). These achievements were maintained in the follow-up phase of the study. After 3-months of the intervention, there were significant correlations between weight loss and change of two craving dimensions (Ant+ and Emotions), while BMI change correlated with changes in Ant+ and Hunger. After 6-months, changes of two dimensions of FCQ-t (Ant+ and Hunger) were significantly correlated with weight loss and BMI change. After 3-months, changes in several FCQ-t dimensions were significantly correlated with commitment to some commandments. “Thoughts” dimension correlated with commitment to B1 and B10, and “Guilt” dimension correlated with commitment to B7, while “Intent”, “Cues” and “Hunger” dimensions were correlated with commitment to B1. After 6 months, change in “Thought” dimension was correlated with commitment to B1 and B10, “Intent” dimension correlated with commitment to B1 and B5, “Guilt”

correlated with commitment to B4, while “Ant+” and “Hunger” were correlated to commitment with B1. At the follow-up, the reduced level of FCQ-t dimensions remained.

The second study was conducted in Saudi Arabia (3 months, n=104; 6 months, n=26; follow up, n=11) at King Fahad Medical City (KFMC) investigating the effectiveness of the novel intervention on body weight loss and important metabolic blood parameters (glucose homeostasis, lipid profile, blood pressure, and resting heart rate) in overweight/obese females. The intervention was successful to achieve significant weight loss ( $7.3 \pm 3.5$  kg,  $15.1 \pm 8.5$  kg, and  $2.3 \pm 2.6$  kg) in the study phases after 3-, 6-months of the intervention, and follow-up, respectively. After 3-months, there was significant correlation between commitment to all commandments and achieved changes in body weight and BMI. However, changes in weight loss and BMI were correlated with commitment to all commandments except commitment to B4 and B6 after 6-months.

After 3 months of the intervention there was significant improvement in blood metabolic parameters in terms of glucose homeostasis parameters; significant improvement in fasting insulin, glucose, HGA1c, HOMA IR, and HOMA S. Improvement of various glucose homeostasis measures were significantly correlated with commitment to all commandments but B4 and B6. Lipid profile significantly improved (reduction in LDL, TC, and TG). Changes in LDL and TC were correlated with all commitment to all commandments but B1 and B10 which have been found to be significantly correlated with HDL change. Systolic blood pressure was found to be reduced after the 3 months of intervention.

In terms of attitude measures, explicit attitudes towards healthy and unhealthy food were significantly improved after the intervention; increased attitudes towards healthy food was correlated with commitment to all commandments except B4; decrease in attitude towards unhealthy food was correlated to commitment to all commandments.

After 6 months significant improvements in the glucose homeostasis parameters (insulin, glucose, and HGA1c) and in lipids profile (LDL, TC, and TG) were detected. In addition, there were improvements in explicit attitudes towards healthy foods and unhealthy foods. However, there was no significant change in the cardiovascular parameters (BP and RHR) after 6 months of the intervention.

**Conclusion:** The newly developed weight loss intervention was effective in inducing improvements in terms weight loss, food craving dimensions, explicit attitudes towards

food, and achieved significant reductions in blood based clinical health risk parameters. The outcomes support that achievements in weight loss, and the maintenance of weight loss can be achieved using interventional designs based on behavioural theories. As a novelty this has been achieved with an intervention which needs low time commitment from health professionals. The change in body weight via the applied cognitive techniques to alter negative eating behaviours might even be successful in the long-term.

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## Dedication

To my parents

Mohammed Alshubrami & Sa'ada Al-Jarallah

I made this thesis as a gift for both of you, to make your highest dream come true

This thesis is yours not mine; I certainly would never have made it to this point  
without your endless reserves of strength and couragement

قال الله تعالى {وَإخْفِضْ لَهُمَا جَنَاحَ الذُّلِّ مِنَ الرَّحْمَةِ وَقُلْ رَبِّ ارْحَمْهُمَا كَمَا رَبَّيْتَنِي صَغِيرًا}

The God says 'lower to them the wing of humbleness out of mercy and say: 'my lord,  
be merciful to them, as they raised me since i was little'

Making both of you happy and proud is the only aim I have for my life

Your son Mishal

## **Acknowledgments**

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## List of Abbreviations

AACC	American Association of Cereal Chemists
ACSM	American College of Sports Medicine
ADA	American Diabetes Association
AICR	American Institute for Cancer Research
BFM	Body Fat Mass
BIA	Bio-Impedance analyser
BMI	Body Mass Index
BP	Blood Pressure
BPD	Blood Pressure-Diastolic
BPS	Blood Pressure-Systolic
CBT	Cognitive Behavioural Therapy
CDC	Centres for Disease Control and Prevention
CHD	Coronary Heart Disease
CHO	Carbohydrate
COMA	Committee on Medical Aspects of Food and Nutrition Policy
CVD	Cardiovascular disease
DHHS	Department of Health and Human Services
DPP	Diabetes Prevention Program
EAQ	Explicit Attitudes Questionnaires
FAO	Food and Agriculture Organization
FCI	Food Craving Inventory
FCQ	Food Craving Questionnaires
FCQ-S	Food Craving Questionnaires-State
FCQ-T	Food Craving Questionnaires-Trait
FG	Fasting Glucose
FI	Fasting Insulin
FM	Fat Mass
FNB	Food and Nutrition Board
GI	Glycaemic Index
GP	General Practitioner
HFCS	High-Fructose Corn Syrup
HG.A1c	Glycosylated haemoglobin

Hip-c	Hip circumference
HOMA	The Homeostasis Model Assessment
HOMA-B	The Homeostasis Model Assessment beta cell function
HOMA-IR	The Homeostasis Model Assessment insulin resistance
HOMA-S	The Homeostasis Model Assessment insulin sensitivity
IAT	Implicit Associations Test
KFMC	king Fahad Medical City
LDL	High- Density Lipoprotein
LDL	Low-Density Lipoprotein
NHMRC	National Health and Medical Research Council
NHS	National Health System
NOO	National Obesity Observatory
NRC	National Research Council
RDAs	Recommended Dietary Allowances
REE	Resting Energy Expenditure
RHR	Resting Heart Rate
RMR	Resting Metabolic Rate
SACN	Scientific Advisory Committee on Nutrition
SD	Standard Deviation
SMM	Skeletal Muscle Mass
SPSS	Statistical Package for the Social Sciences
SSHE	School of sport, health, and exercise
TC	Total Cholesterol
TG	Triglycerides
UNU	United Nations University
USDA	United States Department of Agriculture
VLCD	Very Low Calorie Diet
Waist-c	Waist circumference
WCRF	World Cancer Research Fund
WHO	World Health Organization
WHR	Waist-Hip Ratio
WHtR	Waist to Height Ratio

## **Chapter One**

### **General Introduction and literature review**

#### **1.1 Introduction:**

Obesity is recognized as the most widespread metabolic disease in most parts of the world. It affects children, adolescents and adults and has reached epidemic proportions in developed and developing countries (Tsigos et al., 2008). Obesity is often defined simply as the abnormal or excessive accumulation of fat in adipose tissue that can impair health (Garrow, 1988). It arises as a result of an imbalance between energy intake and energy expenditure (energy balance dysregulation) (Gibney et al., 2009). Body mass index (BMI) is a simple indicator that is the most widely used method for measuring obesity in adults. BMI is a person's weight in kilograms divided by the square of the person's height in meters ( $\text{kg}/\text{m}^2$ ). In 1995, the World Health Organisation (WHO) accepted BMI as an adequate method for evaluating the severity of obesity and being overweight (WHO, 1995). It defines being overweight as having a BMI of 25–29.9  $\text{kg}/\text{m}^2$  and obesity as having a BMI of  $\geq 30 \text{ kg}/\text{m}^2$ . In recent years, worldwide the number of adults who are overweight has grown to more than 1.6 billion, and about 400 million of these adults are clinically obese (WHO, 2011). In the UK, prevalence of obesity has reached epidemic proportions and is considered a contributory factor in several medical conditions, such as heart disease, back and joint pain, certain cancers, hypertension and diabetes as well as psychosocial problems (Bajekal et al., 2003; Gortmaker et al., 1993; Must et al., 1999).

The increased prevalence of obesity is related to increased incidences of type 2 diabetes. Bender et al. (2006) suggested this trend has occurred in both sexes. Central obesity is characterized by a high accumulation of fat in the abdominal region and has been shown to be associated with insulin resistance (Frayn, 2001; Frayn, 2009; Despres, 2006; Després & Lemieux 2006; McFarlane et al., 2001; Ritchie & Connell, 2007; Vitale et al., 2006). In addition, the degree of insulin resistance explains a significant portion of changes in levels of triglyceride (TG), low-density lipoprotein (LDL) and high-density lipoprotein (HDL) (Steinberger et al., 1995). Resistance to the action of insulin on lipoprotein lipase in peripheral tissues might also contribute to elevated TG and LDL cholesterol levels (Pykalisto et al., 1975, Sadur et al., 1984). It has been proposed that insulin resistance might account for decreased levels of HDL cholesterol in type 2 diabetes patients (Steinberger & Daniels, 2003).

With diabetes, two defects arise: (a) insulin resistance, or a decreased biological effect of insulin on the target tissue, and (b) a reduced ability of the pancreas's beta cells to secrete insulin in response to glucose (Bril & Ktorza, 2006). Consequently, increased blood glucose results in more insulin secretion, and finally, excessive glucose leads to death of beta cells. The American Diabetes Association (ADA) published revised recommendations to use haemoglobin A1c (A1C) to diagnose diabetes and to identify participants at risk for developing diabetes (ADA, 2010). Glycosylated haemoglobin (A1C %) is an important long-term glycaemic marker commonly used in clinical practise (Shantha et al., 2012). Martins et al. (2012) suggested that women have higher HbA1c than men.

Blood lipids profiles (total cholesterol [TC], Low-density lipoprotein [LDL], High-density lipoprotein [HDL], triglycerides [TG]) are widely used as markers to estimate cardiovascular disease risk. High adipose tissue increases cardiovascular risk. Commonly, it has been correlated with the increases in the levels of TC, LDL and TG and decreases in HDL levels (Frayn, 2003; Marsh, 2003). BMI has been demonstrated to have a positive correlation with LDL and an inverse correlation with HDL (Bray, 2004). The relationship between BMI and HDL is highly significant as low HDL levels reflect a higher risk of cardiovascular disease than high TG (Bray, 2004).

Cardiovascular parameters for blood pressure (BP) and resting heart rate (RHR) are connected to health risks and obesity. Blood pressure is predominantly elevated in overweight and obese individuals (Doll et al., 2002; Rocchini, 2004; WHO, 2000). Sjostrom et al. (1997) estimated that a 1 mm HG reduction in diastolic blood pressure reduces the risk of myocardial infraction by 2%–3%. Additionally, resting heart rate (RHR) is an important cardiovascular parameter and has been shown to be correlated with obesity. Palatini and Julius (2004) reported that RHR is easy to evaluate and a beneficial marker for cardiovascular health. Some studies have connected elevation of RHR to increased incidences of cardiovascular mortality (Fox et al., 2007; Lang et al., 2010).

Obesity leads to very high rates of morbidity, mortality, disability and impairment of quality of life (Adams et al., 2006; Banegas et al., 2003; Flegal et al., 2007; Linde et al., 2004; Renehan et al., 2008; Roberts et al., 2003; Stevens et al., 2002; Tsigos et al., 2008). It is not surprising that individuals who are overweight or obese are looking for an effective treatment to control their weight. There are several methods

of tackling obesity, namely diet, physical activity, medication, behaviour modification, and surgery. However, despite progress in non-medical treatments, the rapid increase in the prevalence of obesity continues. Numerous meta-analyses, systemic reviews, and individual studies have illustrated that weight loss programs are not effective in the long term (Anderson et al., 2001; Brownell & Jefery, 1987; Curioni & Lourenco, 2005; Douketis et al., 2005; Kramer et al., 1989; Latner et al., 2000; Wadden, 1993). For example, one meta-analysis concluded that exercise only, diet only, diet plus exercise, and medication resulted in weight loss over six months as follows: -2.4 kg, -4.9 kg, -7.9 kg, and -7.8 kg, respectively (Franz et al., 2007). However, all of these treatments resulted in a rebound in weight after six months. In terms of surgery for obesity, several studies and meta-analyses have claimed that bariatric surgery is more effective than non-surgical options (O'Keefe et al., 2010; Picot et al., 2009; Varela et al., 2006). For instance, Buchwald et al.'s (2004) systematic review and meta-analysis of studies using Bariatric surgery found that weight loss for all bariatric procedures combined was 61%. Despite this apparent success of surgical option, there are many barriers to this option. Firstly, surgery is not appropriate for all overweight or obese individuals. It is appropriate only for more severe cases of morbid obesity ( $BMI > 40 \text{ kg/m}^2$ ) and for individuals having a BMI greater than  $35 \text{ kg/m}^2$  (Brethauer et al., 2006). Secondly, surgery generally is associated with many complications and side effects (NOO, 2010), such as bleeding, wound infection, thromboembolism, bowel obstruction, and nutritional deficiencies (Brethauer et al., 2006).

For overweight and obese individuals, one question remains without a clear answer: What is an effective treatment or that they people could follow to reduce their weight? To design an effective weight loss intervention, we must return to the fundamental principle of energy balance (change in energy store = energy intake – energy expenditure). According to this energy balance equation, body weight can increase due to a positive energy balance, i.e. energy intake being greater than energy expenditure. It has been suggested that in the last few decades, the level of energy expenditure in the population has declined because of increased dependency on technological advances, such as computers, remote controls, and cars (Gortmaker et al., 1996). Physical activity is a very important component of energy expenditure (Saris, 1989). Cross-sectional studies have found an inverse relationship between physical activity and body weight (French et al., 1994; Miller et al., 1990). Evidence from many meta-analyses has revealed that weight loss interventions relying on exercise only are

not effective (Ballor & Keeseey, 1991; Franz et al., 2007). For instance, over 16 weeks, weight loss from exercise only has been found to be between 0.3 and 1.3 kg (Macfarlane & Thomas, 2009). However, some reviews have reported that modest weight loss was achieved by exercise only (Wing, 1999) but that it was not sustainable (Anderson et al., 2001; Brownell & Jeffery, 1987). Also, it is estimated that it could take up to two years for an obese individual to overcome his or her condition through exercise alone (Bouchard et al., 1993). Thus, the traditional activity recommendation advanced by the American College of Sports Medicine (ACSM), 150 min/week of moderate exercise, seems to produce only a slight effect on body weight (Donnelly et al., 2009). Additionally, it would be wrong to blame a reduction in physical activity for weight gain. An important study performed by Li et al. (2010) to systematically examine patterns and time trends in US adolescents' physical activity (PA) found that over the previous 17 years, the data do not clearly show reduced physical activity among adolescents. They concluded that reduced PA is not likely to be the primary explanation for the recent increase in obesity among US adolescents. In any case, the influence of the reduction in physical activity is still a matter of debate. However, several reviews have confirmed that physical activity plays an important role in the prevention of weight gain (Jeffery et al., 2000; Ravussin & Gautier, 1999; Saris, 1998; Wing, 1999).

The second part of the energy balance equation is energy intake. Swinburn et al. (2009) found that increased body weight is a consequence of the overconsumption of foods rich in sugar, fat, and salt rather than a reduction in physical activity. Several studies connecting the rapid increase in obesity to dietary excess are supported by empirical evidence revealing that food intake and obesity rates increase in parallel (Cutler et al., 2003; Ello-Martin et al., 2005; Malik et al., 2006). Data derived from many reliable sources suggest that the increase in body weight over the current generation has been a consequence of high levels of food intake and low levels of physical activity (Davis et al., 2004a). Studies have reported that the increased intake of high-energy-density foods was linked to the increased prevalence of obesity (Drewnowski & Specter, 2004; Mendoza et al., 2007; Rolls et al., 2005b). In the U.S., a significant percentage of this increase can be attributed to the increased intake of sweetened beverages, which now constitute about 25% of the daily calorie intake of young adults (Rajeshwari et al., 2005; Striegel-Moore et al., 2006). However, many studies and reviews of the scientific literature on dieting have revealed that dietary intervention is successful in the short-term but not effective in the long term because

most participants regain their lost weight after they have stopped the diet program (Jeffery et al., 2000; Wadden et al., 1989; Wadden & Frey, 1997).

In conclusion, exercise interventions alone have a small effect on weight loss, whereas dietary interventions can be very successful in short-term weight reduction. However, it is clear that dietary interventions do not lead to sustained weight loss.

## **1.2 Behavioural Therapies:**

Behaviour therapy is a broad term referring to psychotherapy, behavior, or a combination of the two therapies. Behavioral treatment has several specific characteristics (Wadden & Foster, 2000). First, it is goal directed; Setting up clear goals that can be easily measured. Second, treatment is process oriented; process orientation helps individuals in identifying how to change habits rather than deciding what to change. Third, the behavioral approach focusing on small rather than large changes; to achieve distant targets gradual steps are taken. Behavioural therapy does not involve one specific method but it has a wide range of techniques that can be used to treat a person's problems. Behavioural treatment usually is not based on one specific technique. Moreover, behavioural therapy has evolved into cognitive-behaviour therapy, which is widely used today. It analyzes and aims to change both the person's thought processes and his or her behaviour. It generally uses principles such as: goal setting, self-monitoring, rate control, setting rewards for achieving one's goals, functional analysis of eating situations, learning alternative coping skills.

According to the American Gastroenterological Association (2002), behaviour modification is among the five "principles of obesity therapy." The other four principles include dietary intervention, pharmacotherapy, physical activity, and bariatric surgery (Levy et al., 2007). Stuart (1967) was the first study to demonstrate the merits of integrating behavioural weight-loss interventions with other interventions that are solely psycho-educational. According to Wadden and Foster (2000), behavioural treatment's core objective is to help obese patients recognize and change their detrimental behavioural habits (such as overeating) and cognitive habits that cause their weight problem. As a corollary, the goal of behavioural therapy is to facilitate the development of skills that will help obese individuals to regulate their weight to make sure that they remain at the lowest possible, although they may still be overweight after the treatment. This is achieved by adopting behaviours such as following: a low-fat diet,

and a high-activity lifestyle, as well as developing a cognitive style that is rational and forgiving (Wadden & Foster, 2000).

Several studies have asserted that the assumption upon which behavioural therapy is founded is that maladaptive behaviours are learned and can also be modified by using particular learning principles, such as classical and operant conditioning (Fabricatore 2007; Foster et al 2005; Tsigos et al. 2008). Foster et al. (2005) stated that classical conditioning is a process that involves creating association between a previously neutral stimuli and naturally existing stimulus. Based on classical conditioning principle, eating is often prompted by antecedent events (i.e. cues) that become strongly linked to food intake. The more frequently they are paired, the stronger the association between them until eventually, the presence of one event automatically triggers the other. Behavioural therapy seeks to disconnect cues associated with unwanted eating and activity habits. While operant conditioning is a form of learning which utilising reinforcement and punishment to create association between behaviours and their consequences. The principle of operant conditioning is used to promote behaviour change by manipulating the consequences of eating and activity choices (Brownell, 2000; Wadden et al., 2005). Behaviours that are rewarded (i.e. reinforced) are more likely to be repeated. On the other hand, behaviours that are punished (or followed by negative consequences) are less likely to be repeated (Brownell, 2000).

Behaviours are elicited by antecedent or simultaneous events, and they can become strongly learned through constant pairing of events (Brownell, 2000; Wing, 2002). Through evaluation of their behaviourally habits, behavioural treatments endeavour to recognize the factors that prompt and sustain individuals' maladaptive behaviours. After identifying the maladaptive behaviours, specific behavioural goals are agreed upon, to help the patient develop and maintain a set of skills that are needed to prevent and manage the maladaptive behaviours (Master, 1987; Wadden & Foster, 2000). Implementation of a comprehensive behavioural treatment for 20-26 weeks can enable patients to lose an average of 8.0-10.0 kg, which is approximately 9% of their initial weight (Foreyt & Goodrick, 1993; Wadden & Foster, 2000; Wing, 2002). Wadden and Foster (2000) found that around 80% of patients who embarked on treatment, completed it. Behavioural therapy has been found to have favourable results, as indicated in the above statistics and has been endorsed by several organizations such as the WHO (WHO, 1998), the Dietary Guidelines for Americans (Agricultural



Research Service, 1995), and the Institute of Medicine of the National Academy of Sciences (Institute of Medicine, 1995).

### **1.2.a Structure and key components of a behavioural treatment**

A behavioural treatment for obesity is normally administered to individuals in a closed group format comprising 10–15 people. All members of the group begin the treatment program together and each therapy session lasts for 60–90 minutes (Foster et al., 2005). The treatment is administered in a group format because the group provides the participants with valuable social support, where they can help each other to recognize and develop skills for dealing with their maladaptive behaviour (Akabas et al., 2012). Butryn et al. (2011) found that patients who engage in a group treatment lose more weight than those who engage in individual treatment. Renjilian et al. (2001) conducted a randomized controlled trial and established that group treatment is more efficient than individual treatment, even for patients who prefer the former. During the weight loss phase of the group, sessions are held weekly for 16–26 weeks, then followed by biweekly sessions in the weight loss maintenance phase.

A behaviour therapy is a multifaceted treatment that takes into account the myriad of elements that facilitates patients' better eating and activity habits, such as self-regulation/monitoring, stimulus management, problem-solving, cognitive reconstruction, relapse deterrence, reinforcement, and social support (Brownell 2000; Butryn et al., 2011; Diabetes Prevention Program 1996)

### **1.3 All wales obesity pathway**

The All Wales Obesity Pathway (2010) is a Welsh Government initiative that categorizes obesity services into four levels. The four-tier scheme for obesity services described in the pathway is comprehensively discussed below:

**Level 1:** Community based prevention and early intervention (also referred to as the self-care level): This level's objective is to ensure accessibility and awareness of a variety of opportunities to help every individual, regardless of their age, to achieve and maintain a healthy body weight, thus eliminating the need to seek health services.

**Level 2:** Community and primary weight care management services: This level's objective is to ensure accessibility to and awareness of a variety of opportunities to help people who are identified to be at risk of developing obesity to lose weight.

Individuals who express willingness to change are ready to change, if they are given support by a trained individual.

**Level 3:** Specialist weight management services: This level’s objective is to ensure accessibility of services to individuals, who are identified as having one or more co-morbidities and have attempted several strategies but with no success, or individuals who have complex emotional relationships with food. Specialist services such as dietary, physical activity and behavioural interventions are provided more intensely at this level than previous ones, and can be administered both via primary and secondary care. At this level, drug therapy can be introduced where it is integrated with other several behavioural, dietary and physical activity interventions, if they have proved futile when used alone.

**Level 4:** Specialist medical and surgical services: This level’s objective is to offer specialist medical and surgical (bariatric surgery) interventions for individuals who are unsuccessful in achieving or maintaining adequate weight loss after trying out interventions in other levels of the pathway. Unlike the previous three levels, some of the interventions in this level, such as bariatric surgery, cannot be performed on individuals below the age of 18.

According to the All Wales Obesity Pathway, it is important to know the individual’s BMI, waist circumference and presence of co-morbidities in order to determine the level of intervention that suits them best.

Table 1.1: obesity classification and pathway levels

BMI classification	Waist circumference			Comorbidities present
	Low Men < 94 cm Women < 80cm	High Men 94-102cm Women 80-88cm	Very high Men >102cm Women >88cm	
Healthy Weight (18.5-24.9)				
Overweight (25-29.9)				
Obesity I (30-34.9)				
Obesity II (35-39.9)				
Obesity III (40 or more)				

White box: General advice on healthy weight and lifestyle Pathway level 1, light grey box: Diet and physical activity Pathway level 2; dark grey box: Diet and physical activity; consider drugs Pathway targeted level 2 and level 3, black box: Diet and physical activity; consider drugs; consider surgery Pathway targeted level 3 and level 4

#### **1.4 Barriers to obesity treatment in primary care**

According to Williams et al. (1991), obesity has become a recurrent medical condition in primary care. According to the literature, overweight or obese patients in primary care show great interest in getting weight control instructions from their practitioner (Levy BT, Williamson 1988; Potter MB, Vu 2001). However, most studies have found that obesity is usually under-diagnosed and overlooked in primary care sessions (Simkin-Silverman et al., 2008). Despite the availability and accessibility of evidence-based guidelines for the evaluation and management of obesity (NHLBI Obesity Education Initiative 2000), weight control counselling in primary care is still subject to several impediments. Based on the findings of several studies, only 33% to 50% of patients with obesity receive weight loss advice (Friedman et al., 1994; Galuska et al., 1999; Nawaz et al., 1999). Wardle and Johnson (2002) conducted a study among British adults. They established that although, the majority of obese adults accurately regarded themselves as overweight, only a small number had taken part in a weight control programme and not many had obtained weight loss advice from health professionals. There is a general interest among obese individuals in getting information regarding how their weight affects particular medical conditions and an interest in getting precise recommendations from specialists on how to lose weight instead of just general statements regarding the importance of losing weight (Blixen et al., 2006; Brown et al., 2006; Ward et al 2009). Ward et al. (2009) added that patients prefer being given weight loss counselling by their clinicians during their treatment session, instead of receiving it as an afterthought at the end of the session. The treatment of obesity in primary care, according to Bray and Ryan (2007), continues to be encumbered by numerous challenges, such as low insurance reimbursement, as well as the immense patient motivation and determination required to adopt and maintain a healthy lifestyle. Some other impediments that have been identified in other studies include under-diagnosis of obesity, inadequate nutrition and education about obesity, deficiency of resources needed in patient counselling, negative mind-sets about counselling among obese patients, perceptions that patients are not interested in or prepared for treatment, and perceptions that obesity is the patient's responsibility, and not practitioners' (Forman-Hoffman et al., 2006; Simkin-Silverman et al., 2008). According to Rao et al. (2011), obesity counselling is encumbered by its complex nature and the time needed for its completion. Gunther et al. (2012) conducted a pilot study in Leicester, UK and found that health professionals usually felt a sense of helplessness

in terms of obesity counselling, and this served as a potential barrier. Flodgren et al. (2010) reviewed the strategies used to encourage and support weight loss among obese patients and found that the interventions needed to be improved and better developed, so as to enable health care professionals to give effective weight loss advice.

## **1.5 Eating behaviour**

One of the most prevalent causes of death in developing and developed countries is unhealthy behaviours, such as smoking, alcohol consumption, low physical activity, and poor dietary habits (Danaei et al., 2009; Davies et al., 2014; Solomon and Kington, 2002). Behavioural change, regardless of its magnitude, can lead to a significant health impact on an individual (Ezzati et al., 2002; Mokdad et al., 2004; Solomon & Kington, 2002; Swann, 2009). To devise effective evidence-based health interventions for maladaptive behaviours, it is imperative to be well acquainted with these behaviours, as well as the contexts in which they take place (House of Lords, 2011; Office of Behavioural and Social Sciences Research, 2006). Consequently, it is necessary to investigate the causes of poor eating behaviour, as well as the impact of psychological factors on the former, before prescribing a particular intervention aimed at changing a patient's eating behaviour (Davies et al., 2014).

### **1.5.1 Why we eat**

Historically, food was scarce, and the desire to survive seems to have been the main drive behind consuming large amounts of food when it was available and choosing food that was highly dense (Brown & Konner, 1987). Obviously, the main reason for this behaviour was to maintain one's energy balance and prevent starvation (Brownell & Horgen, 2004) through complicated physiological mechanisms (Murphy & Bloom, 2006; Schwartz et al., 2000). In many countries, the environment nowadays is rich in palatable food, and most food intake does not happen as a result of energy deprivation (Brownell & Horgen, 2004). Access to palatable food is deemed to be a major environmental risk factor for obesity (Volkow & Wise, 2005), and the overconsumption of enjoyable, high-calorie food is assumed to be a major factor in increased obesity rates (Swinburn et al., 2009; Finkelstein et al., 2005). Sweet, high-calorie foods are the most preferred foods that are over-consumed (Drewnowski, 1995). It is well-recognized that the increased food intake often seen in cases of obesity is driven by pleasure related to the consumption and reward system, as well as delusive craving for food in the

absence of an energy deficit (Epstein & Leddy, 2006; Lowe & Butryn, 2007; Mela, 2006; Yeomans et al., 2004), not by the homeostatic regulation of energy intake (Epstein et al., 2007). It has been suggested that over-eating, like gambling or substance abuse disorders, reflects a reward deficiency syndrome, the consequences of which include increased motivation to obtain the reward, which is food in this case (Comings & Blum, 2000).

The general view about the regulation of energy intake suggests that it involves an interaction between of two systems, the homeostatic and hedonic systems, both of which play a role in eating (Berthoud & Morrison, 2008; Figlewicz & Sipols, 2010; Davis et al., 2011; Lutter & Nestler, 2009). The homeostatic system involves bodily signals arising from the hormonal regulators of hunger, satiety, and adipose level, such as leptin, ghrelin, and insulin. It operates via hypothalamic and brainstem circuits that trigger or suppress food intake and thus maintain one's energy balance. A malfunction in homeostatic control may lead to a continuously positive energy balance, which will stimulate eating and thus result in obesity (Campfield et al., 1995; Halaas et al., 1995; Gao & Horvath, 2007; Pelleymounter et al., 1995). The hedonic system includes the brain's reward system, which can be engaged by the pleasurable nature of readily available, palatable food (Lutter & Nestler, 2009; Mela, 2006; Saper et al., 2002). It is essential to observe that in spite of the interaction between the two systems, there is a difference between the neurophysiological bases of the motivations underlying hedonic eating and homeostatic control (Berthoud, 2007).

In light of previous research, there is no doubt that body weight and food intake are regulated by homeostatic control via hormones and neural signals (Woods et al., 2000), but the question remains as to whether or not homeostatic control is fundamentally important in increased obesity levels (Lowe & Levine, 2005; Pinel et al., 2000). Lowe and Butryn (2007) attributed increased weight to the impact of hedonic hunger rather than homeostatic hunger on food consumption. Based on the incentive salience theory of rewards, there are two important components in food reward and overconsumption: liking and wanting (Berridge, 1996; Berridge & Robinson, 1998). Liking is the hedonic component that reflects the immediate experience or anticipation of pleasure (Mela, 2006), where wanting is the reward-seeking (incentive motivation) component that results in increased appetite, food cravings, and other behaviours associated with an increased motivation to obtain and consume food (Berthoud & Morrison, 2008; Finlayson et al., 2007). Shomaker et al. (2010) proposed that pleasure

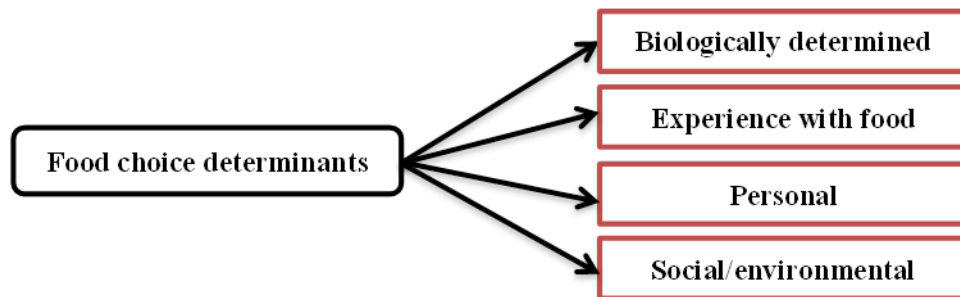
that is acquired from consuming palatable food has massive motivational power that in certain people can surpass homeostatic signals.

There is an interaction between the homeostatic and hedonic controls on food intake, but this interaction differs between individuals with normal body weights and obese individuals (Egecioglu et al., 2011). Food palatability promotes consumption by enhancing the motivational and hedonic components of the reward process. In non-obese individuals, food reinforcement is inhibited by homeostatic signals, whereas this does not seem to be the case with obese individuals. Obese individuals may have allostatic changes in the hedonic set point for food and hence attribute inappropriate reward value to foods, either through increased hedonic requirements (the reward hyperfunction theory) or an increased motivation to compensate for a hedonic deficit (the reward hypofunction theory) (Egecioglu et al., 2011). For example, according to the reward hyperfunction model of obesity, over-consumption could reflect a heightened responsiveness on the part of the reward circuits to rewarding foods (Davis et al., 2004b). It has been suggested that over-eating, like gambling or substance abuse, could reflect a reward deficiency syndrome, the consequences of which would be to increase motivation to obtain the reward, which is food in this case (Comings & Blum, 2000).

In short, the increased prevalence of obesity is usually attributed to overindulgence in the consumption of palatable/rewarding food. Our environment is rich with highly palatable food that is rich in calories and easily accessible. This promotes overconsumption by bypassing physiological signals (satiety signals). Foods rich in sugar and fat are rewarding because they provoke gratification and satisfaction, although these food are often low in micronutrients. Obviously, overconsumption is driven more by the reward system and the pleasure of eating palatable food (hedonic hunger) than by energy deprivation. The homeostatic regulation of food intake is highly important during the prolonged absence of food intake, whereas hedonic hunger is a highly significant factor in overconsumption after energy requirements have been met (Appelhans 2009; Lowe & Butryn 2007).

### **1.5.2 Food choice determinants**

There are several factors influencing food choice decisions. These factors are biologically determined behavioural predisposition, experience with food, personal determinants, and social/environmental determinants (Contento, 2011) (Figure 1.1).



**Figure 1.1** food choice determinants

### **1.5.2.1 Biologically determined behavioural predisposition.**

Humans are born with innate preferences for sweet tastes (Beauchamp & Mennella, 2008; Desor et al., 1997). This preference for sweet tastes continues throughout our lives, and it seems to span all cultures (Pepino & Mennella, 2005). However, the sensitivity to food taste varies between people as a result of their genetic differences (Duffy & Bartoshuk, 2000; Kaminski et al., 2000; Tepper & Nurse, 1997), which affect their food choices. Indeed, this variation in response to food may be connected to the variation in body weight and food intake (Keller & Tepper, 2004; Tepper, 2008). Also, it has been suggested that several genetic and biological mechanisms are responsible for controlling hunger and satiety (de Castro, 1999). However, throughout the history of humankind, the main aim of seeking food has been survival (Brownell & Horgen, 2004). This goal led to the development of physiological mechanisms that enhanced energy intake when food was available and promoted energy storage in the body (Chakravarthy & Booth, 2004; Lowe, 2003). However, given the current food-rich environment, this behaviour leads to increased body weight and obesity. Recently, conscious efforts to control food intake have come to be considered important in controlling and decreasing body weight (Peters et al., 2002).

Foods' sensory properties (taste, olfactory, visual, auditory) are crucial in food-related choices and also contribute to the biological learning of preferences and aversions (Bellisle, 2006). Our response to the orosensory properties of food is considered to be a major predictor of food intake in the absence of economic factors (Rozin & Schulkin, 1990; Rozin & Zellner, 1985). In addition to taste and smell, a food's appearance (colour and shape) has an important role in food liking (Bartoshuk, 1990; McBride & Pepper, 1990).

### **1.5.2.2 Experience with food.**

Numerous studies have reported that preferences for certain foods and food acceptance are predominately learned (Beauchamp & Mennella, 2008; Birch, 1999; Mennella & Beauchamp, 2005). Experience can alter biologically determined behavioural predispositions (Pelchat & Pliner, 1995). Moreover, experience can result in newly acquired food likes (Beauchamp & Cowart, 1985; Beauchamp & Moran, 1982). For instance, individuals who consume foods characterised by low salt content come to like them more (Beauchamp et al., 1983; Mattes, 1997). Food preferences are likely to continue over a lifetime, but food preferences can also change as a consequence of experience and learning. Those tastes that are experienced with negative consequences, such as becoming sick, often lead to aversions, whereas tastes that are associated with good consequences, such as having a ready supply of calories, tend to be liked more (Myers & Sclafani, 2006). This is probably the basis for the familiarity effect, in which foods that have been eaten before and whose consequences proved to be favourable tend to be preferred. This is very much the case among children. There is now evidence that systematic exposure can increase familiarity and promote the acceptance of hitherto-disliked vegetables (Mennella et al., 2001; Wardle, 1993). Furthermore, food acceptance is increased when the consumption of a given food is followed by positive consequences, such as pleasure (Contento, 2011). Whenever a food becomes familiar, the liking of this food is likely to continue (Skinner et al., 2002).

### **1.5.2.3 Personal determinants.**

Personal determinants, such as perceptions, expectations, attitudes, values, and beliefs, have a massive impact on food choices. Our expectations regarding food, such as pleasure, taste, convenience and familiarity, strongly influence our food choices. Also, our attitudes towards food, our food culture, and social factors are important when we choose our foods (Contento, 2011). Food value is an important factor in food choice. However, the conception of value differs from one culture to another. For example, food cost, convenience, and taste are the main food choice values in the USA (Glanz et al., 1998). In Europe, the main values are food price, freshness, nutritional value, and preference (Lennernas et al., 1997). Our beliefs about food are also a crucial factor. According to Rozin and Fallon (1987), food rejection can typically be attributed to one of three reasons: sensory-affective reactions (smell and taste), negative anticipated consequences (sickness or vomiting), and ideas about the source of a given food.



Reward sensitivity also affects eating. For example, high levels of consumption of and preference for sweet and fatty foods are always connected to a high level of sensitivity to the reward from eating these kinds of food (Davis et al., 2007). Attitudes toward food can also play a role in the relationship between nutritional information and liking (Eertmans et al., 2001).

#### **1.5.2.4 Social/environmental determinants.**

There is no doubt that the built environment and the food environment has major effects on health (Rozin, 1996; Sallis & Glanz, 2009). Recently, food has become accessible everywhere because of the proliferation of food products, supermarkets, and food vending machines in workplaces, schools, and elsewhere (Contento, 2011). Moreover, Bellisle (2003) suggests that environmental stimuli can affect people's food choices, including the amount consumed and when they eat (Bellisle, 2003), and these stimuli can influence liking and wanting, which are associated with food intake (Mela, 2006). Also, the social environment and cultural context have a clear impact on food choices and dietary behaviour (Rozin, 1996). Moreover, economic factors such as food price (Drewnowski et al., 2004b), income, and education level (Macino et al., 2004) are important determinants of food choices. Furthermore, socioeconomic status can also affect food choice; unhealthy food choices and habits are associated with low socioeconomic status (Giskes et al., 2006; Lallukka et al., 2007). The media also influences people's food choices through food advertisements on TV and radio and in newspapers, and magazines. The food industry spends a huge amount of money every year on marketing and advertising (Elitzak, 2001).

#### **1.5.3 Food craving**

Food cravings are generally defined as 'an intense desire for a specific food that is difficult to resist' (White et al., 2002); they could originate from either physiological or psychological underlying states (Baker et al., 1986). Several studies have identified important links between food cravings and BMI (White et al., 2002), gender (Lafay et al., 2001), weight loss (Martin et al., 2006), and caloric intake (Hill et al., 1991; Lafay et al., 2001). This suggests the comprehensive and important role of cravings in food consumption and body weight regulation (Franken & Muris 2005). These factors are believed to have a role in the failure to comply with weight loss programmes and dropping out of weight-loss treatments, which could lead to set backs to over-

consumption (Bjorvell et al 1985; Fedoroff et al 2003; Sitton 1991). They are also linked to overeating in obese individuals (Bjorvell et al., 1985). Food cravings are an important construct in the food intake literature. Studies of food craving consistently assume that individuals eat foods that they crave (Hill & Heaton-Brown, 1994; Weingarten & Elston, 1991) and that people who experience frequent food cravings tend to consume more kilocalories per day than those who do not regularly crave foods (Lafay et al., 2001). However, estimations of food cravings in the general population vary widely. For example, among college students, 97% of women and 68% of men reported food cravings (Weingarten & Elston, 1991).

Food cravings are well recognised as common among those suffering from obesity (Delahanty et al., 2002; Pepino et al., 2009; White et al., 2002). Individuals with obesity usually report higher food cravings (Fabbricatore et al., 2011; Jakicic, 2009), experience more negative effects from eating and eat arousing foods more frequently (Von Dennen & Liu, 2011) compared to average-weight peers. Notably, cravings for high-fat and high-sugar foods are positively associated with BMI (Burton et al., 2007). In addition, food cravings have been reported to have a function in increased food intake and weight gain (Forman et al., 2007; Moreno et al., 2008; Steel et al., 2006), withdrawal from obesity treatment (Lim et al., 2009; Moreno et al., 2008; Sitton, 1991) and setbacks in weight loss (Forman et al., 2007; Hill, 2007; Jakubowicz et al., 2012; Lowe, 2003). Meule et al. (2012) found that various dimensions of food cravings are related differently related to success and failure in dieting.

Many theories have been proposed about the food craving mechanism (Gleaves et al., 2000; Plechat, 2002; Rogers & Smit, 2000, Weingarten & elston, 1990). Physiological theories have stressed the homeostatic role of food cravings. Wardle (1987) found that food cravings often exist in people who are food-deprived. Wurtman and Wurtman (1986) suggested that carbohydrates can decrease depression by increasing central serotonin levels. Also, psychological theories underline the influence of negative emotional states, such as anger, which serves as a stimulus for food cravings (Hill et al., 1997; Rogers et al., 1994; Schuman et al., 1987). Moreover, learning theories assume that food craving is an adapted response to circumstantial and emotional, interoceptive or food-related cues and stress the expected reward and the enjoyable consequences of eating the desired food (Rozin et al., 1991). Clearly, there is no agreement about the precise mechanisms that are responsible for food cravings. Indeed, food craving is a complex and multidimensional phenomenon, and it is likely

that it can be expressed in both physiological and psychological ways (Cepeda-Benito et al., 2000; Pelchat, 1997).

The research on weight loss and food cravings has produced a diversity of results on whether food cravings are an obstacle to weight loss. While some studies have stated that cravings decrease with weight loss (Alberts et al., 2010; Jakubowicz et al., 2012; Lim et al., 2009; Martin et al., 2006), other studies have reported increased cravings with dieting (Massey & Hill, 2012), while yet others have found that cravings stabilised with weight loss (Gilhooly et al., 2007). These differing results can be explained by the variations in the diets used in these studies. The diversity of the findings is also due to the studies having used different intervention components and different assessment tools to measure food cravings. Most studies have used questionnaires that do not differentiate between food craving at state and trait level, and they are related to specific food items. For example, the food craving inventory (FCI) asks about the “intensity” of desire for 28 specific food items related to four different classes of food (high fat, sweets, carbohydrates and fast foods) over the previous month (White et al., 2002). This means that the FCI evaluates general cravings concerning specific food items, and it does not explore other dimensions of food craving, whereas food craving questionnaires (FCQ) were design to evaluate cravings for food in general on a multidimensional level, either generally (FCQ-T) and currently (FCQ-S) (Meule et al., 2012 ).

#### **1.5.4 Attitudes and obesity:**

Obesity is a highly prevalent and very important problem among various cultures (Popkin, 1998). It is acknowledged that an important cause of obesity is the pattern of unhealthy food over-consumption. Moreover, studies have found that individual attitudes might help to explain eating behaviours. However, an important factor in the development and maintenance of obesity is one’s attitude towards food (Brug et al., 1995; De Bourdeaudhuij et al., 2005, Dennison & Shepherd 1995). Several studies on food choices have shown that individuals with obesity tend to consume foods high in sugar and fat, and with more protein, compared to peers of normal weight (McGloin et al., 2002, Nicklas et al., 2003). A likely interpretation of this pattern might be different people’s attitudes about food (Brug et al., 1998). Individuals with obesity seem to have a positive attitude about unhealthy food. However, empirical studies have obtained results that disagree with previous interpretations. The discrepancy between

attitudes and behaviours could be understood by knowing that there are two forms of attitudes, explicit and implicit, which can direct behaviour (Fazio, 1990). Explicit attitudes might direct behaviour by deliberate and conscious analysis of its costs and benefits, whereas implicit attitudes could direct behaviour in a more automatic way, regardless of the pros and the cons of this behaviour (Fazio, 1990).

Implicit attitudes have been shown to be related to diet behaviours (Swanson et al., 2001), food choices (Karpinski & Hitt, 2001; Maison et al., 2001; Roefs & Jansen, 2002) and soft drink preferences (Maison et al., 2004). Individuals who overeat might be unaware that they have a high preference for palatable food, which could have a clear impact on their eating behaviour and unintentionally result in overeating (Aarts et al., 2008). Implicitly liking such foods could be an important reason for the difficulty in resisting the tasty and seductive qualities of some food items. This would suggest that a major part of eating is motivated by the hedonic and rewarding properties of food, rather than by the homeostatic mechanisms related to hunger (Finlayson et al., 2008; Lowe and Butryn, 2007; Mela, 2006; Stroebe, 2000; Yeomans, 1998). Recently, implicit attitude evaluations have been successfully implemented in studies on health-hazard behaviour to predict various aspects of addictive behaviours (Ames et al., 2006; Ostafin & Palfai, 2006; Wiers et al., 2006) and psychopathology (Huijding & De Jong, 2006; De Jong, 2001). Excessive food consumption, which can result in increased body weight, has several physiological and cognitive similarities to other forms of addiction (Gold et al., 2003; Di Chiara, 2005; Jornaby et al., 2005; Volkow & Wise, 2005; Wang et al., 2004). It is believed that appetitive processes can be under the influence of both the automatic appetitive motivation to consume a substance and more controlled, inhibitory processes (Wiers et al., 2007). The automatic appetitive processes might result in craving and wanting to ingest a drug, despite having explicit negative attitudes about the substance. An imbalance between automatic appetitive motivation and a more controlled system by which people organise their impulsive actions is suggested to account for the disinhibition observed in addictive behaviours. Understanding the principles involved in addiction to a substance may be useful in understanding the mechanisms that underlie eating disorders. Automatic processes likely affect eating behaviours and excessive consumption of food (Czyzewska & Graham, 2007).

Obese individuals compared with normal-weight individuals have a positive attitude about unhealthy food. Studies have found that explicit attitudes to food are comprised of a number of dimensions linked to the different sensory, affective and

cognitive aspects of particular food items (Aikman et al., 2006). The importance of these different dimensions in determining attitudes varies among individuals (Czyzewska & Graham, 2007). For instance, studies have suggested that the perceived healthiness of food products affects their palatability ranking, and that in females greater importance is placed on health information and weight concerns in forming explicit food preferences than in males (Mialon et al., 2002; Steptoe et al., 1995; Wardle et al., 2004; Westcombe & Wardle 1997). Thus, it is likely that self-reported preferences could reflect participants' opinion of what they wanted in a diet, instead of the real appetitive value of different foods. Explicit preference might be closely determined by nutritional recommendations for a healthy diet, whereby people prefer low-calories foods rather than their automatic food preferences (Czyzewska & Graham, 2007). Consciously attitudes might predict controlled food choices and eating behaviours affected by willpower (Czyzewska & Graham, 2007). On the other hand, implicit attitudes could be more immediately important in people's appetitive response to particular foods, and thus a better predictors of automatic eating behaviour. This disintegration between explicit and implicit attitudes about particular foods might explain inconsistency in food choices and the risk of disinhibited eating, particularly under conditions in which unprompted appetitive behaviour is more likely to occur (Czyzewska & Graham, 2007).

Nowadays, a large portion of consumers are aware that a healthy diet promotes their health. However, in spite of this change in attitude and the increasing awareness of many individuals of healthy food products, alterations in actual nutritional behaviour have not resulted in satisfactory outcomes (Mai et al., 2011). Food consumption occurs under awareness is explicit, but control over food consumption is not entirely explicit (Mai et al., 2011). Obviously, unconscious factors affect consumers' choice of food products. Several empirical studies have found that consumers' implicit and explicit attitudes healthy food frequently differ (Cervellon et al., 2007; Craeyest et al., 2008; Czyewska & Graham, 2008; Finlayson et al., 2008; Roefs & Jansen, 2002; Spence & Townsend, 2007). The discrepancy between implicit and explicit processes affecting food buying, preparation and consumption help to account for the positive explicit attitudes toward healthy food but the consumption of unhealthy food (Mai et al., 2011).

### **1.5.5 Food decisions (conscious and non-conscious).**

As a result of technological advancements in food preservation and packaging, as well as the increase food production and decline in food costs in relation to total income, food has become within most people's reach most the time (Contento, 2011; Drewnowski, & Barratt-Fornell, 2004). Moreover, food is now highly tempting and encourages people to overeating. As a consequence, individuals on average make more than 200 decision about food each day. These decisions include choosing what, when, and where to eat (Wansink & Sobal, 2007). However, most individuals do not think these decisions through. A consumer research survey illustrated that approximately three-quarters of people are not wary of what they eat (Balzer, 1997; Contento, 2011). Clearly, this situation has made the act of eating more complex. Numerous studies have found that the complexity of food-related decisions (about what, when, where, how much to eat) has contributed to overconsumption and resulted in long-term obesity (Berthoud & Morrison, 2008; Davis & Carter, 2009; Holland & Petrovich, 2005; Kessler, 2010).

With regards to food decision and eating behaviour, Individuals might believe that their behaviours are under their control and that they reflect their intentions and plans (Neal et al., 2006). The classical economic view posits that human beings make rational and that they make thoughtful decisions by weighing various criteria. However, researchers in behavioural economics, social psychology, and neuroscience have suggested a contrary view. They have proposed that individuals can be illogical and that their choices might be under the influence of automatic and innate processes that occur beyond conscious awareness (Cohen & Babey, 2012).

In many parts of the world, food is available to all socioeconomic classes in almost every daily setting, and the consumption of unhealthy food has increased. Individuals are eating too much calorie-laden, high-fat food and drinking sugar-sweetened beverages. This brings us to an important question: Why are they engaging in this pattern of behaviour? It could be because they are not aware of the detrimental influence of this behaviour on their weight and health. If the consequences were obvious, why would they continue to consume in this way? Maybe they cannot connect the instantaneous reward of and pleasures from eating unhealthy foods to the long-term negative impact of their unhealthy food choices (Rothman et al., 2009). It has been suggested that there are neurophysiological pathways within humans that facilitate the consumption of readily available food, and these mechanisms should affect all

population groups similarly, regardless of income or level of education (Cohen, 2008). Truong and Strum (2005) proposed that the likelihood of being overweight or obese is approximately the same in well-educated and uneducated people. Thus, it would appear that the mechanisms affecting food intake might not be a matter of conscious decision making based on knowledge but are operating below the level of individual awareness and thus beyond individual's control (Cohen, 2008).

Human behaviour does not typically originate with a conscious decision. One conceptualization of human brain functioning separates our thinking into two components: conscious (deliberate) and non-conscious (automatic). The conscious component allows us to make careful and thoughtful decisions, but it has limited capacities. It can consciously process only 40 to 60 bits of information per second — equivalent to a short sentence. The other component, the unconscious (automatic), is responsible for impulsive, automatic decision making, which happens quickly. However, its processing capacity, which includes the visual system and the unconscious mind, is estimated to be about 11 million bits per second (Dijksterhuis, 2004). Therefore, the brain uses mechanisms that do not require cognitive awareness in order to perceive the environment and react to it. Indeed, human beings' ability to be high-functioning depends not only on their ability to think abstractly and creatively but also on their ability to free up the limited capacity for higher-level thinking by assigning routine tasks to lower-level brain involvement. Therefore, automatic behaviours are not a sign of weakness but rather an adaptation that allows human beings to be a uniquely productive species (Bargh & Chartrand, 1999; Bargh & Ferguson, 2000).

In recent years, psychologists have developed a greater understanding of automatic behaviours, which can be defined as those that operate without conscious awareness (Bargh & Chartrand, 1999; Moors & Houwer, 2006). Mental effort is required to make conscious decisions and then implement them in the form of behaviours (Bargh & Chartrand, 1999). Bargh (1994) has defined four characteristics of automatic behaviours: They occur without awareness or direction, are initiated without intention, continue without control once initiated, and operate efficiently with little effort. However, not all of these criteria are required for behaviour to be considered automatic.

It has been estimated that the majority of human decisions are implemented based on automatic responses to the environment (Bargh, 1999; Dijksterhuis et al., 2005; Dijksterhuis & Bargh, 2001). Eating behaviours, compared to other behaviours,

seem to rely mainly on automatic processes and are heuristically cued, this may be due to their relation to survival strategies (Cohen & Farley, 2008). Several studies on food consumption indicate that eating should be viewed as partly automatic behaviour (Diliberti et al., 2004; Kral et al., 2004; Levitsky & Youn, 2004; Painter et al., 2002; Rolls et al., 2006; Wansink et al., 2006). Individuals sometimes make food choices rapidly, without thinking about the consequences of their choices. They base their choices on various factors, such as price, shape, size, convenience, and familiarity (Kahneman, 2011), which might result in selecting foods with more calories that are high in sugar and fat (Friese et al., 2008; Shiv & Fedorikhin, 1999). Prior to making decisions and buying a product, individuals engage in conscious information processing (Chaiken, 1980; Petty et al., 1983). The processing of the information may result in particular attitudes (Fazio, 1990; Krugman, 1965). These attitudes can be influenced by cognitive beliefs (e.g., the usefulness of products) and by affect (e.g., the symbolic meanings of products) (Venkatraman & Mac-Innes, 1985). However, although people sometimes deliberate regarding the pros and cons of their decisions, they often do not, especially when interacting with stimuli that trigger automatic responses (Dijksterhuis et al., 2005). One study used 50 random images to measure the speed of decision-making while participants chose a favoured candy or snack food. It found that individuals used about 313ms to select their favoured foods. Participants were asked to repeat the test after being asked to make sure that they were certain before choosing. Researchers found that participants' decisions then took about 404ms (Milosavljevic et al., 2011). Moreover, rapid decisions drive individuals to choose products with health symbols, which may not actually be healthier foods. Many food products use health symbols only to enhance sales (MacVean, 2009). Scheibehenne et al. (2007) stated that there is no difference between a simple process that is based on a single characteristic and a complex process that relies on multiple features, this means that individual decisions are made with a low level of cognitive effort. In the past 25 years, surveys of food sales have shown that the greatest increases in sales have been for soft drinks, salty snacks, French fries, and pizza (Nielsen et al., 2002), which may reflect the fact that eating decisions are made automatically.

Many people firmly reject the notion that there are factors other than their own internal preferences that influence their decisions, even when evidence of such is made explicit (Bargh, 1999). In general, people cannot see the causes of their own actions or decisions. The mental work behind these rapidly made choices is hidden from conscious



awareness (de Camp Wilson & Nisbett, 1978; Kahneman, 2011). Most people's shopping choices are made without them being aware of these choices because the proportion of information processing used during shopping is minimum or nil. Thus, they are unable to describe why they chose the items in their shopping carts, because they did not engage in conscious information process before buying (Dijksterhuis et al., 2005).

The notion of cognitive ability limitation in food choices is supported by physiological findings. During tests of executive control, brain imaging studies showed that those who performed better on a variety of cognitive challenges used different neural pathways than those with lower levels of executive control (Casey et al., 2011). The human brain is tailored to deal with stimuli automatically. Signals are transmitted from people's sense organs to their brains via neurons that are connected to motor neurons, and people respond to a stimuli automatically (Libet et al., 1993).

There are many mechanisms that operate to maintain energy balance, such as the physiological signals of satiety. In spite of this, unconscious factors can bypass homeostatic regulations. While non-conscious decisions occur without much control and effort, cognitive decisions require high levels of effort, which likely leads to the depletion of cognitive energy and may affect subsequent performance and self-control (Vohs et al., 2008). Food is a temptation, and individuals require a large amount of mental effort to resist this temptation and refrain from eating (Cohen & Farley, 2008). When the mental reserves, or cognitive resources, are exhausted, the ability to withstand food temptation declines, and eating is the result (Baucom & Aiken, 1981). The massive mental efforts that are required when dieting for weight management lead to cognitive exhaustion. This can probably elucidate a weight change pattern in which dieters successfully lose weight during the initial period but fail to maintain their achieved weight loss over the long term (Baumeister et al., 2000; Rosenbaum et al., 1997; Vohs et al., 2008).

Consistent with Baumeister's theory, several studies revealed that self-control, like the muscles, can become exhausted, although it can be restored with rest (Baumeister et al., 1998; Baumeister et al., 2000; Muraven & Baumeister, 2000). There are many ways in which the demands on the cognitive system can deplete self-control, including the provision of too much information. Self-control can also be depleted by the very act of making a decision concerning what to eat, leaving cognitive resources subsequently unavailable when making choices (Vohs et al., 2008). Also, this could

occur when eating while shopping, driving, or watching TV (Spears, 2010). Individuals can only focus on one activity a given moment, so when performing many activities, they tend to concentrate on the main activity, while the other activities happen automatically. This means that when eating is a secondary behaviour, it is performed automatically, without consciousness or control.

Indeed, the limitations on information processing at a given time make individuals make spontaneous decisions when overwhelmed with information; thus, they frequently resort to non-cognitive processing. It has been proposed that non-cognitive decisions predominate over cognitive decision making when too much information is available. Regarding food choices, if cognitive resources are depleted, people make decisions based on non-cognitive resources, which don't require information processing. The non-cognitive options are often foods rich in sugar and fat (Cohen, 2008). One experiment conducted by Shiv and Fedorikhin (1999) aimed to examine food decision-making in the face of too much information and cognitive load. Participants were asked to choose fruit salad or chocolate cake after memorizing either a two-digit number or a 7-digit number. They found that 45% of participants who had to memorize a 2-digit number chose chocolate cake, while chocolate cake was chosen by 62% of participants who memorized a 7-digit number, an increase of about 50%. Researchers have concluded that cognitive load biases food choice (Shiv & Fedorikhin, 1999). There has been a dramatic increase in the information that individuals must process every day, which suggests that most individuals lack the ability to steadily choose healthy food without losing cognitive control over other areas of their lives (Levitsky et al., 2005).

In short, people believe that their behaviour is under their control and that they are making rational decisions. If this is the case, why do they buy unhealthy foods, and why has the rate of obesity hugely increased in recent years? Even with all the important information and knowledge available, people make unwise decisions. They fail to understand the extent to which their food decisions and eating behaviours are being manipulated by the non-conscious information processing system. Indeed, numerous decisions related to food rely on the non-conscious, or automatic, processing of information, which is characterized by rapid occurrence, little reflection, and a lack of cognitive direction. In fact, most of our eating behaviours reflect automatic responses to food cues. This may explain why many people fail to understand their unhealthy food choices. However, cognitive capacity is too limited and can become depleted due to

various actions, too much information, and engaging in eating while performing other behaviours, which results in making poor choices that require no processing.

### **1.5.6 Regulation of eating behaviours**

It is well-documented that eating a healthy diet can substantially help in maintaining health and play a major role in reducing the risk of obesity-related diseases (OMS/WHO Global Strategy on Diet, Physical Activity, and Health, 2013; USDA, 2000). Access to the pertinent knowledge regarding nutrition and diet is an important factor in changing behaviours (Fisher et al., 2003) and is related to healthful eating pattern (Shaikh et al., 2008). However, knowledge alone is not enough, because well-educated people must still be committed to perform positive behaviours (Baranowski et al., 2003; Schwarzer et al., 2008).

There is no doubt that eating habits are an important element in obesity management (Al-Rethaiaa et al., 2010; Bonanno & Goetz, 2012; Sciamanna et al., 2011). The self-regulation of eating is a crucial element in weight loss via which people can impact their own health and well-being positively by following dietary recommendations and choosing healthy diet. Regrettably, in the current environment, eating behaviour regulation is considered one of the most difficult and challenging tasks, especially in the long term (Teixeira et al., 2006; Teixeira et al., 2010). However, this difficulty appears to be the result of multiple factors that influence the regulation of eating behaviours: physiological factors (appetite and satiety signal), acquired preferences, habits, and environmental factors (Teixeira et al., 2011).

Several studies have found that large numbers of dieters will regain the weight lost during the initial period, while only a few of them will reduce their body weight over the long-term and maintain this weight loss (Elfhag & Rossner, 2005; Jeffery et al., 2000; Mann et al., 2007). Indeed, when dieters have stopped dieting, they may even regain more weight than they initially lost (Mann et al., 2007). Most dieters having negative feelings about themselves, and they try to evade these unpleasant feelings by investing their cognitive resources in immediate gratification and neglecting the long-term impacts of their actions. This evasion also makes them feel noncommittal with regard to long-term planning, which inhibits the struggle against food temptation and intake (Heatherton & Baumeister, 1991). In several studies, the difficulty in maintaining weight loss was attributed to a lack of self-regulation, which refers to the inability to continue thinking about what one is eating and react accordingly. For

example, Vieira et al. (2013) stated that women who maintained their weight loss in the long-term have some form of improved self-regulation as compared to similarly heavy women who are not trying to lose weight.

Self-regulation can be defined as series of actions and/or processes that aid in obtaining an individual's goal by encouraging them to have control over their emotions, impulses, appetites, awareness, and task performance (Baumeister et al., 2006; Maes & Karoly, 2005; Muraven et al., 1999; Muraven & Baumeister, 2000). Based on motivational system theory, self-regulation indicates evaluative thoughts that direct and guide choices (Ford, 1992). Self-regulation refers to both unconscious and conscious processes that affect the ability to control responses (Carver, 2004). There are three components of successful self-regulation: (i) standards of thought, feeling, or behaviour that individuals endorse, mentally represent, and monitor; (ii) sufficient motivation to invest effort into reducing discrepancies between standards and actual states; and (iii) sufficient capacity to achieve this in light of obstacles and temptations along the way (Baumeister & Heatherton, 1996; Carver & Scheier, 1981; Heatherton & Wagner, 2011). Self-regulation involves goal adherence (setting and planning) and goal ownership (Webb & Sheeran, 2000). Goal setting is a significant part of adherence and can promote eating behaviour change. For example, meeting weight loss goals was positively related with the consumption of fruits and vegetables (Webb & Sheeran, 2000). Webb and Sheeran (2000) pointed out that planned responses were more likely to result in goal fulfilment than unplanned responses. Self-regulation is crucial in resisting food temptation by keeping one's goal in mind (Shah et al., 2002). In terms of ownership, health behaviour changes are strongly depending on the reinforcement personal ownership (Ryan & Deci, 2006).

Self-regulation facilitates individuals in changing and regulating their eating behaviours, achieving their weight-loss goals, and maintaining their health throughout their lifespan. It helps them learn to make healthy choices, control impulses, inhibit unpleasant thoughts, and enhance compliance with rules, plans, and diet guidelines. Therefore, the failure to self-regulate can have a role in increased obesity related-behaviour and consequently increased risk of numerous health diseases, such as type 2 diabetes, cancers, hypertension, and cardiovascular diseases (Duckworth & Seligman, 2005; Baumeister & Heatherton, 1996; Carver & Scheier, 1996; Hagger et al., 2010; Heatherton, 2011; Hofmann et al., 2009; Schroeder, 2007; Tangney et al., 2004; Wagner & Heatherton, 2010).

In short, the self-regulation of eating habits seems to be complex and difficult for individuals who aim to reduce their body weight in the long term. Thus, the rates of obesity and obesity-related diseases have increased rapidly. Self-regulation is the tendency to utilise cognitive, emotional, and behavioural resources to attain a goal. Eating behaviour and self-regulation are intertwined to constitute the basis of attaining successful weight loss in the long term. Together, they play a role in overcoming a multitude of barriers, impulses, and temptations to seek immediate gratification in the short term (food reward) in order to achieve a goal (weight loss). Thus, self-regulation would appear to be the key to a successful weight loss program.

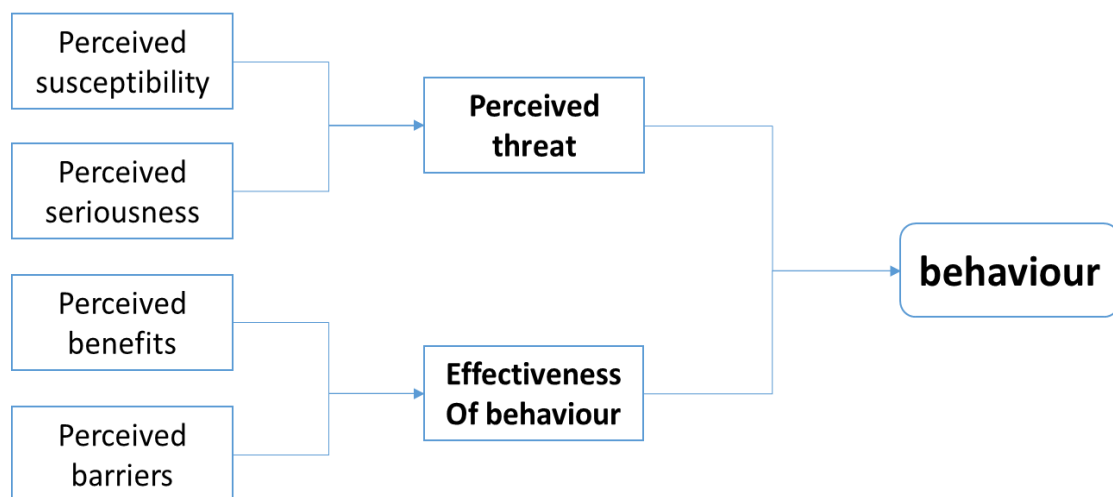
### **1.6 Theories and models for behaviour change**

An understanding of behaviour and behavioural change is required, in order to make the most of the potential efficiency of an intervention. Therefore, it is important to have a theoretical comprehension of behaviour change. The use of theory is considered as a fundamental step in the design and evaluation of an intervention, as well as in the synthesis of evidence (Campbell et al., 2000, 2007; Craig et al., 2008; Glanz & Bishop, 2010). Theory is deemed to be fundamental in design and evaluation of an intervention due to several reasons. One of the reasons is to understand the antecedents of behaviour and the underlying determinants of change that can be recognized and used during intervention (Hardeman et al., 2005; Michie & Abraham, 2004; Michie et al., 2008). In addition, the techniques of behavioural change can be chosen and modified to suit the particular situation of the patient (Michie & Prestwich, 2010; Michie et al., 2008; Rothman, 2004). Another reason is that the mechanisms of action, which are theoretically identified (e.g., as mediators), can be further delved into to achieve better comprehension of how the intervention works (Michie & Abraham, 2004; Rothman, 2004, 2009). The third reason is that theory-based interventions can be optimised through rigorous testing, thereby enhancing their improvement (Michie et al., 2008; Rothman, 2004).

There are several health behaviour theories. However, their application varies. While there is a general consensus that there are numerous influences on an individual's behaviour, health professionals are inclined to concentrate on how to change individuals' health behaviours. The next section provides an overview of some of the most prominent health behaviour theories.

### 1.6.1 The Health Belief Model (HBM)

Rosenstock (1974) is credited with developing the Health Belief Model (HBM), which was among the first health behaviour theories, and it is still one that is most extensively applied. According to Hochbaum (1958), HBM was developed to aid in comprehension of the probability of individuals' performing protective health behaviours. According to HBM, health behaviour is founded on a rational evaluation of the hurdles and merits of action (Blackwell, 1992; Champion & Skinner, 2008; Rosenstock et al., 1988). According to Redding et al. (2000), HBM postulates that the probability of someone performing a specific behaviour is contingent on a number of factors which include: the perceived risk that accompanies the condition (perceived vulnerability), the perceived risk of worsening of the condition (perceived severity), the perceived efficacy of reducing the individual's susceptibility (perceived benefits), the perceived expense of embarking on the behaviour change (perceived barriers) and the individuals optimism in their aptitude to productively accomplish an action (self-efficacy) (Figure 1.2). Becker et al. (1979) also stressed that the likelihood of an individual embarking on a recommended behaviour change is impinged on by the perceived risks, barriers, as well as the perceived merits of embarking on it.



**Figure 1.2** The Health Belief Model (HBM) (adapted from Morris et al. 2012)

### 1.6.2 Social-cognitive theory (SCT)

According to Redding et al. (2000), SCT evolved from social learning theory, and is perhaps the most comprehensive behaviour change theory that has been developed to date. McAlister et al. (2008) argued that SCT's basic organising principle

of behaviour change is reciprocal determinism, by which an individual's behaviour is impinged on by their constant and dynamic interaction with the environment (Figure 1.3). According to SCT, knowledge of health risks and benefits is recognized as the requirement for behaviour change. However, it is the additional self-influences that are more essential for change (Bandura, 2004). One of the fundamental premises of SCT is that people learn through a combination of their own experiences and observation of the repercussions of other people's actions (Bandura, 1986; McAlister et al., 2008). According to Will et al (2004), the key constructs of SCT, which are pertinent to interventions for health behaviour, are comprised of observational learning, self-control, reinforcement, and self-efficacy.

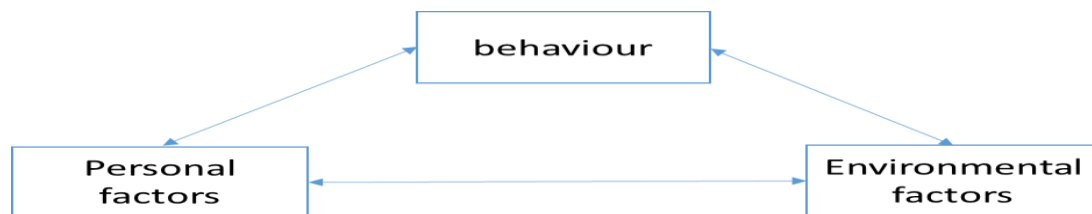


Figure 1.3 Social-cognitive theory (SCT) (adapted from Bandura 1986)

### 1.6.3 Information-motivation-behavioural skills (IMB) theory

According to Fisher and Fisher (1992), IMB was developed to be conceptually based, generalizable and straightforward. According to IMB, there are three key factors upon which health behaviours can be changed and maintained, namely availability of accurate information upon which health behaviour performance can be established, personal and social driving force to take action based on that information, and finally, behavioural skills to assertively and efficiently adopt healthy behaviour (Fisher et al., 2006; Misovich et al., 2003; Osborn et al., 2010) (Figure 1.4).

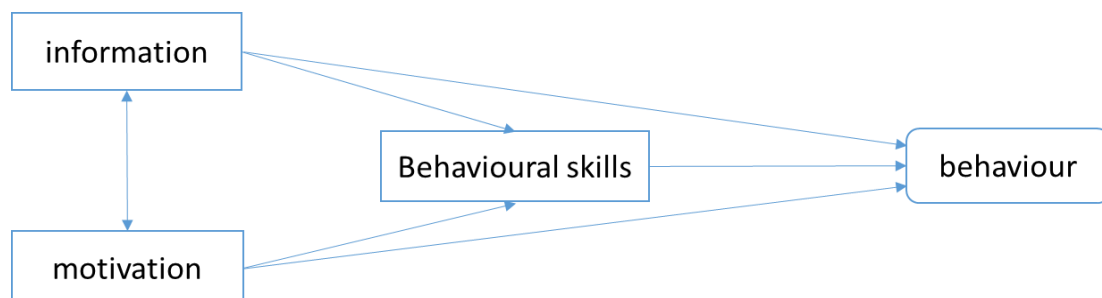


Figure 1.4 Information-motivation-behavioural skills (IMB) theory (adapted from Fisher & Fisher 1992)

Fisher and Fisher (1992) pointed out that the most appropriate intervention should be based on development of the baseline levels of information, as well as target information gaps. According to WHO (2003), the motivation/ driving force to take actions based on the information stems from an individual's personal mind-sets regarding adherence, perception about social support for behaviour, as well as an individual's subjective norm (how they think another individual would behave in the same condition). According to Fisher and Fisher (1992), behavioural skills take account of factors, such as making sure that the patient is well equipped with the requisite skills, tools and strategies, so that they perform the behaviour to develop a sense of self-efficacy. According to Fisher and Fisher (1992), IMB concentrates on the informational, motivational and behavioural skills that facilitate successful execution of health-related behaviours that are preventive. Fisher et al. (2009) pointed out that according to IMB, the health behaviour of an individual can be changed and maintained if they are well-informed and motivated to wield the behavioural skills needed to take effective actions.

#### 1.6.4 Theory of planned behaviour (TPB)

TPB is among the most extensively referenced and applied theories of behaviour. Ajzen (1991) drew references from the Theory of Reasoned Action (Ajzen & Fishbein, 1980) and developed TPB. Behaviour, attitudes, beliefs, and intentions are the concepts looked at in TPB (Figure 1.5).

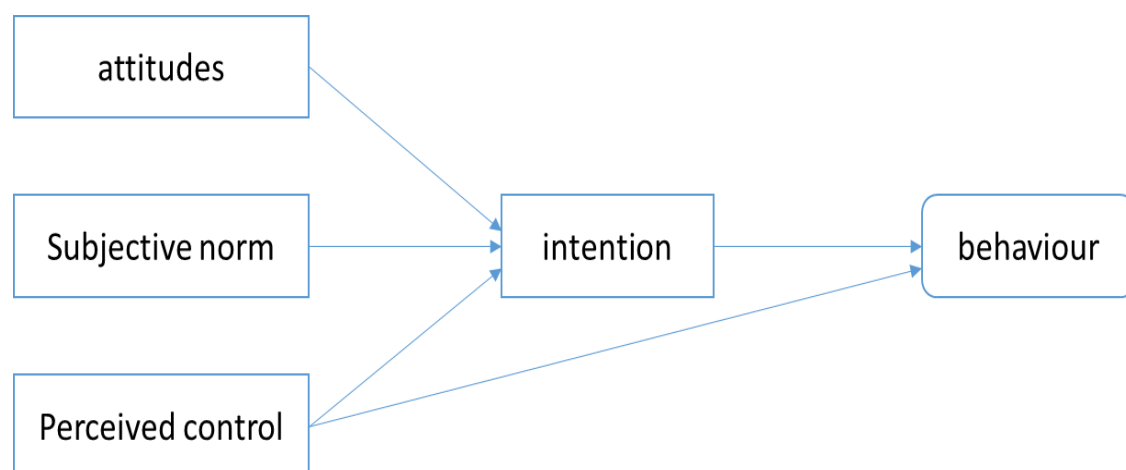


Figure 1.5 Theory of planned behaviour (adapted from Munro et al. 2007)



According to TPB, the behavioural intentions of an individual are affected on by their perceived subjective norms, attitudes, as well as perceived behavioural control (PBC), and this in turn determines how the individual behaves (Ajzen, 1991). The degree of influence which attitudes, subjective norms, and PBC have on the prediction of behavioural intention, is contingent on the particular behaviour and intention. According to Ajzen (1991), when an individual's behavioural performance is completely dependent on a particular situation, intentions alone can be used to predict that individual's behaviour. According to Ajzen (1991), PBC can be defined as the perception of simplicity or intricacy of performing a specific behaviour. Finlay et al. (1999) defined subjective norms as "an individual's perception or opinion about what important others believe the individual should do" (P. 2015). According to Montano and Kasprzyk (2008), an individual's attitude regarding behaviour is contingent on his/her belief about the end result of performing that behaviour. If the individual strongly believes that the end results of performing the behaviour will be positive, they will develop a positive attitude towards that behaviour. On the contrary, if the individual strongly believes that the end results of performing the behaviour will be negative, they will develop a negative attitude towards that behaviour. Therefore, the intention of a person to perform a particular behaviour is dependent on how they perceive it, positively or negatively. Barker and Swift (2009) observed that similar to other social cognition models, TPB fails to provide sufficient information on how behavioural beliefs can be changed. The most common application of TPB is to delve into the process through which behaviour is influenced by interventions, rather than how interventions can be developed (Hardeman et al 2002; Sniehotta, 2009).

### **1.6.5 Control theory**

The development of control theory, also known as self-regulation theory was influenced by cybernetic theory. According to Carver and Scheier (2001), it is extensively used to explain human behaviour. Cybernetics generally pertains to how self-regulating systems function (Ashby, 1956; Wiener, 1948). Cybernetics principles have been used in the development of human behaviour theories (Carver & Scheier, 1982; Miller, 1965; Powers,1973), mental and physical health theories (Hyland,1987; Pyszczynski & Greenberg,1987; Schwartz,1983), and organizational behaviour (OB) theories, for example theories of motivation (Campion & Lord,1982; Klein, 1989; Taylor et al.,1984). The theory is comprised of four elements, i.e. reference, input,

comparator, and output, which are structured in a linear feedback loop (Carver & Scheier, 1982, 2001; Wiener, 1948) (Figure 1.6).

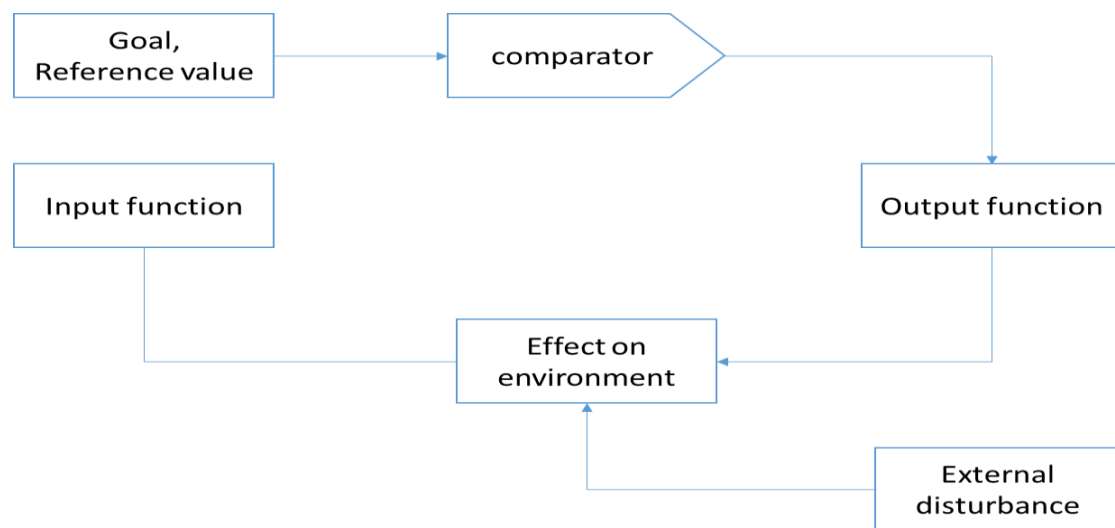


Figure 1.6 Control theory (adapted from Carver & Scheier 2002)

According to control theory, after a goal is set, it becomes a ‘reference value’ in a control system, which contrasts the rate of present behaviour change (input function) with this reference point. It is assumed that the goal systems are organized in the form of a hierarchy, from abstract to self-relevant to highly important ‘to be’ goals (for example, I do not want to be a ‘smoker’). To ‘do’ goals pertain more to instant gratification (for example, I want to smoke a cigarette). If an action influences some higher-level goals, it becomes more self-relevant. As a result, successful self-regulation is, to some extent, the process of constraining a lower-level goal to pursue higher-level goal. If there is a discrepancy between the reference value and present perception, the output function is engaged, whereby the person’s system signals are put into action to minimize the discrepancy. The relationship between the present rate of behaviour change and the reference value is then reassessed by the comparator, and the system cycles around. (Webb et al., 2010)

### 1.6.6 Self-determination theory (SDT)

According to Deci and Ryan (2000), the basic premise upon which SDT was developed is that a person’s motivation to embark on a particular behaviour is contingent on the extent to that the behaviour is self-determined. Motivation to embark on a particular behaviour can be organized along a continuum that ranges from

controlled (influenced by external forces) to autonomous (self-determined). Deci and Ryan (2000) asserted that for behaviour change to be sustainable, it is imperative that it is autonomously motivated and not influenced by an external force.

The Basic Needs Theory is one of the most important sub-theories of SDT. With reference to the innate psychological needs, the basic needs theory provides a framework upon which the origins of self-determined motivation can be explicated. According to Deci and Ryan (2000), the innate inclination to gratify three basic psychological needs. i.e.: competence, autonomy, and relatedness impinges on self-determination to embark on a particular behaviour. (Figure 1.7).

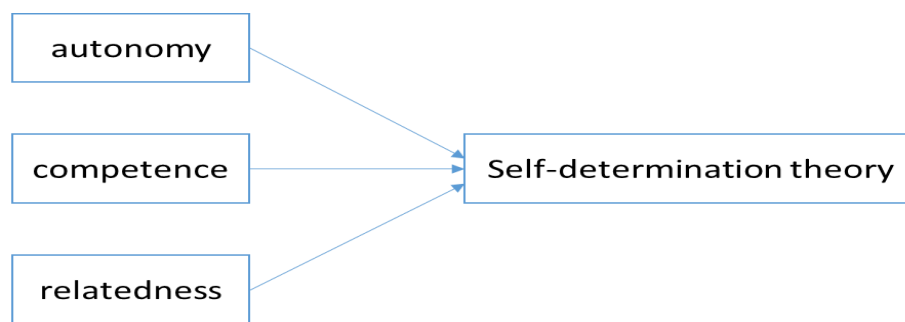


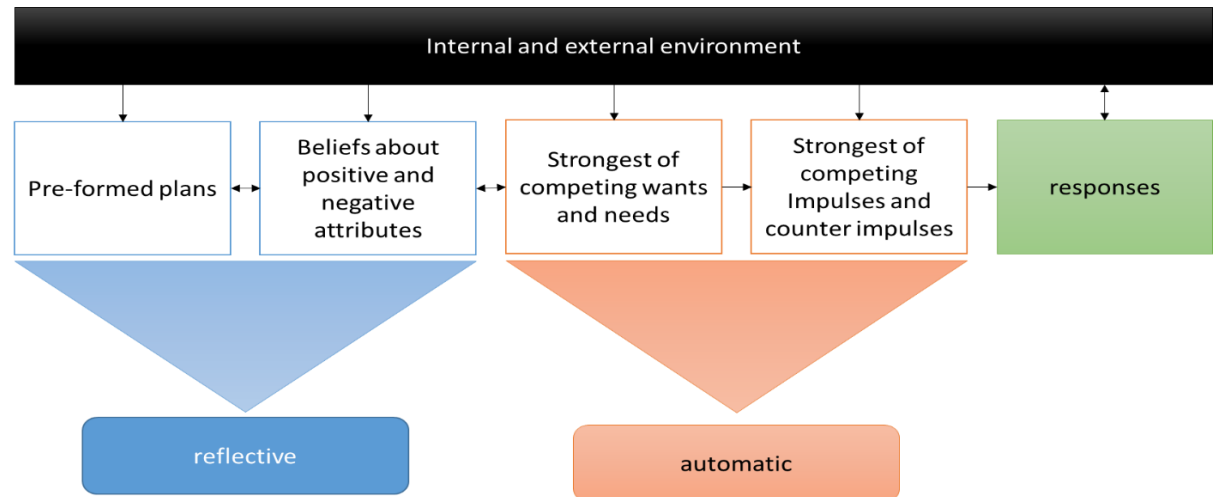
Figure 1.7 Self-determination theory (SDT) (adapted from Deci and Ryan 2000)

Autonomy refers to the desire to embark on a particular behaviour on the basis of one's values. Competence on the other hand, refers to an individual's desire to master how to effectively relate to the environment; finally, relatedness is the desire to feel a form of connection with others in social relationships. Deci and Ryan (2000) asserted that fulfilment of these needs leads to autonomous motivation to engage in the behaviours. Therefore, behaviour change can be explicated as a reflection of the extent to which a person's environments facilitates their competence, autonomy, and relatedness. If an intervention has the ability to provide synergistic support for these three basic psychological needs, it will have a greater behavioural impact (Deci et al., 1994). In general, it has been shown that satisfaction of all the three basic psychological needs leads to autonomous motivation (Edmunds et al., 2007; Hagger et al., 2006; Standage et al., 2007). It has also been shown that interventions which facilitate autonomous motivation increases satisfaction of the psychological needs and enables regulation of motivations (Edmunds et al., 2007).

### 1.6.7 Plans–Responses–Impulses–Motives–Evaluation: The P.R.I.M.E. Theory of Motivation

Motivation is regarded as the central determinant of whether or not a behaviour is performed. An individual has limitless opportunities to do the things that he/she can do. However, the person’s motivation determines the activity he/she actually engage in and how he/she does so (Michie & West, 2013). According to Mook (1995), motivation surpasses reason, as well as choice. It is responsible for the psychological and physiological processes, such as biological drives, emotions and habits which determine behaviour which is performed. In the last few years, there has been a propensity to concentrate on reflective facets of motivation, without considering the automatic facets which are also of paramount importance (Mook, 1995). Even those who have delved into the automatic facets have failed to recognise important differences between these facets (Keren & Schul, 2009).

West (2006) asserted that PRIME Theory comprehensively represents the structure of human motivation. It relies on several levels, including Plans, Responses, Impulses/Inhibition, Motives and Evaluations. (Figure 1.8).



Plans are self-conscious intentions to perform an action in the future. Beliefs are propositions that are held to be true. Wants and needs are imagined futures to which are attached anticipated pleasure/satisfaction and relief from mental or physical discomfort respectively. Impulses are organised action schemas, and counter impulses are inhibitory countervailing processes. Responses involve initiating, modifying or stopping an action. The internal environment involves an ever-changing flux of emotional states, drive states, images and cognitive schemata. The external environment involves stimuli impacting on the sense organs. Reflective processes involve self-conscious information processing. Automatic processes do not require conscious awareness although their results may be the object of reflection and form part of ongoing experience (Michie et al., 2013).

Figure 1.8 The P.R.I.M.E. Theory of Motivation (adapted from Michie et al., 2013)

PRIME Theory presents a comprehensive conceptualisation of motivation, and how it can be capitalized on to help generate interventions that can enable changes in health-related behaviours (Michie et al., 2013).

To summarize, there are several psychological theories which have been developed to predict, explain, and change health behaviours. Recently, there has been growing attention in the application of these theories in the field of health. Numerous behavioural change theories have been applied to predict eating behaviour, explain food choice decisions, and design weight-loss interventions. However, each theory and model focuses on various factors in attempting to explain behavioural change. In fact, some theories were shown as highly successful in understanding behaviour while others were efficient in designing behavioural interventions. Therefore, the use of behavioural change theories as a framework is fundamental for any behavioural change intervention at both levels; designing the intervention and explaining the behavioural change

### **1.7 Aims and objectives of the thesis:**

Obesity has been confirmed to be one of the significant causes of chronic diseases, and it has negative effects on quality of life. The most common interventions aimed at countering obesity, such as prescription of specific diets and promoting physical activity have been confirmed to have no long lasting effects, often leading to even stronger weight gain after rapid weight loss. Often, diets are aimed to reduce caloric intake dramatically to initiate weight loss, but do not correct health-related behaviour or are only shown to be effective over a short period of time. Moreover, some interventions require attendance at hospitals or clinics, and other interventions are expensive (such as dietary programs, supervised exercise and cognitive behavioural therapy), or have many side effects (such as medication and surgery). Achieving successful weight loss for the short term is not difficult, but maintaining the achieved weight loss is much more complicated than a simple energy balance (caloric) equation. Thus, obese and overweight individuals worldwide urgently need an effective obesity-management intervention that is simple, inexpensive and not too time-consuming, does not rely on major assistance of health professionals, and can be performed at home.

Interventions that are characterized by being inexpensive, available for use by the general public and effective in terms of eating-behaviour changes and achieving significant weight loss, do not require specialist interference or frequent appointments

with a GP, and follow an effective behavioural theoretical framework are missing. Therefore, the main aims of this thesis are the following:

**Aim 1:** to develop a new weight loss intervention which is specially designed to simplify and manage changes in eating behaviours. The new intervention should be based on behavioural change theories. Moreover, the intervention must be characterized by a selection of simple components and tools connected to theory, with the aim that they can be performed with minimal supervision and training and with a view of potential future use on level 2 and 3 of the Wales Obesity Pathway. The content of the selected behavioural goals for the intervention will be extracted from the literature related to health and weight outcomes specific for particular health behaviours. The extracted set of health behaviours is aimed to be integrated in an intervention design which shall still be simple even if the various health behaviours are multiple or more complex in nature.

**Aim 2:** to examine the effectiveness of the developed weight loss intervention and identify which commandments (health behaviours) have the strongest influence on physiological (body weight measures, body characteristics) and psychological elements (food cravings, explicit and implicit attitudes) after 3 and 6-months of intervention and a subsequent 3-month follow-up. Additionally, we aim to find whether or not the measured parameters which are connected to behavioural theory are associated with the outcomes of the intervention.

**Aim 3:** To investigate the influence of the various health behaviours (commitment to commandments) on clinical blood parameters which are known to be risk factors for chronic diseases like insulin resistance, type 2 diabetes and cardiovascular disease. Moreover, we like to investigate whether blood parameters can be improved by commitment to health behaviours independently of weight loss.

The outcome of this thesis may add new and essential knowledge to our current understanding of practical issues about obesity treatment. The outcome, moreover, may make an important contribution to our understanding of the connection between the nutritional and psychological factors in overweight and obese population; this may help to improve the diet of individuals with obesity so that weight loss can be obtained and maintained, and adverse health consequences prevented. Furthermore, the outcomes of this thesis can have a role in assisting physicians and nutritionists, and enable them to better tailor individual weight loss interventions and improve eating behaviour.

## **Chapter Two**

### **Development of the new intervention.**

#### **2.1 Introduction:**

While the aetiology of obesity has been simplified as imbalance between energy intake and energy expenditure over a prolonged period, the psychological, social, physiological, environmental, and other factors causing this imbalance are complex (Butland et al., 2007). Complex interventions, targeting multiple causal factors and the interactions between them, may be necessary for obesity treatment (Craig et al., 2008). To address some of the complexities in defining, developing, and evaluating complex interventions, a number of frameworks have been proposed. One of these is the Medical Research Council (MRC) framework for developing and evaluating complex interventions originally published in 2000 and updated in 2008 (Campbell et al., 2000; Craig et al., 2008). Based on prior evidence and theory, relevant determinants are selected and associated with appropriate behaviour change techniques (BCT) (Abraham & Michie, 2008). Recently, a universal taxonomy of behaviour change techniques (BCT) used in behaviour change interventions (Abraham & Michie, 2008) was published. The taxonomy has been linked to the BCTs with theoretical accounts of behaviour change: information-motivation-behavioural skills model, theory of reasoned action, theory of planned behaviour, social-cognitive theory, control theory and operant conditioning (Abraham & Michie, 2008). BCTs are not exclusive to one theory, but instead, several theories might specify similar processes of behaviour change and hence imply the same BCTs.

#### **2.2 Methods:**

The present research was underpinned by the Medical Research Council (MRC) framework for development and evaluation of complex interventions to improve health. The MRC framework provides a sequential series of phases that help the researcher in the evaluation process of a complex intervention. The activities we undertook and the stages of the 2008 MRC framework they map onto are shown in more detail in Figure 2.1 (Craig et al., 2008):

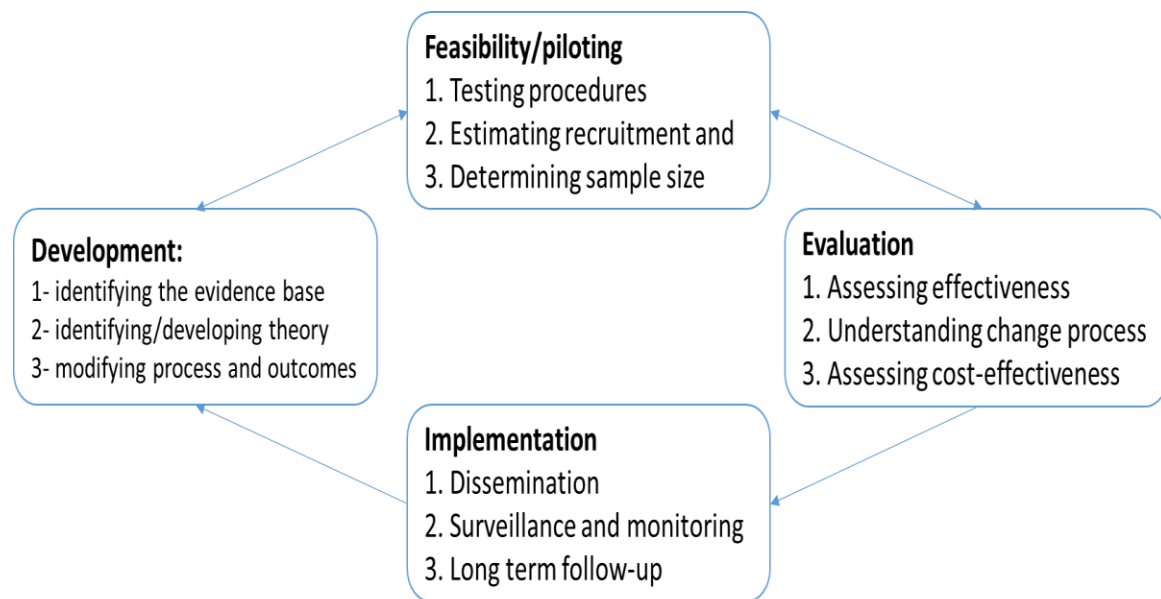


Figure 2.1 Key elements of the development and evaluation process

## 2.2.1 Developing a complex intervention

### 2.2.1.1 What is the evidence base?

Eating behaviours influence energy intake through choices about when and where to eat and the types and amounts of foods chosen, including decisions about starting and stopping eating (Blundell & Cooling, 2000; Blundell et al., 2005). Factors affecting the act of eating complex; eating is not based on one simple decision about what to eat. It involves many dimensions and questions: what to eat (meal or snack), when to eat (meal timing), where to eat (home or restaurant), how fast to eat (slowly or in a rush), how often to eat (meal frequency), and how much to eat (Kcal consumed and daily calorie allowance). Each decision has an impact on energy intake. For example, when skipping breakfast, people tend to select more calorie-dense foods later on than people who regularly eat breakfast (Morgan et al., 1986; Schlundt et al., 1992). Also, earlier decisions influence other decisions. For example, eating in a restaurant impacts what one eats (e.g. foods rich in fat) and the how much one eats because food served in restaurant often has a large portion size, which leads to increased energy intake (Young & Nestle, 2002). However, individuals vary in terms of their thinking about these decisions for each eating event, and many of them may function at low levels of conscious awareness, thus bypassing higher-level deliberation and control (Teixeira et al., 2011). Eating decisions are also influenced by other factors, including environmental, psychological, behavioural, and biological factors (Eertmans et al.,



2001; Mela, 2001; Rozin et al., 1998). Actually, individuals' eating behaviours encompass both conscious and unconscious factors, dictate food choices, and regulate energy intake factors, thus having a significant role in obesity treatment (Bryant et al., 2008; De Lauzon et al., 2004; Keskitalo et al., 2008; Moldovan & David, 2012). Such factors include sensory and flavour perceptions, knowledge about healthy foods, and social-context eating (Eertmans et al., 2001).

Numerous eating behaviours, such as eating breakfast, consuming high-dense food, and drinking soft drinks, have been addressed in studies concerned with obesity and eating behaviours. The outcomes of these studies have been disorganized and seem unlikely to present an obvious behavioural profile that may be used in designing a successful treatment (Moldovan & David, 2012). Thus, the question is which eating behaviours must be taking into account in the treatment of obese individuals. Obesity has been linked to a wide range of eating behaviours. While some behaviours have a role in increased body weight, such as eating away from home (Bes-Rastrollo et al., 2010), eating fast food (Duffey et al., 2007; Pereira et al., 2005), consuming high-density food (Halkjaer et al., 2009; Woo et al., 2008), and increased soft drink consumption (Ludwig et al., 2001), other behaviours can help in controlling weight, such as removing visible fat from meat (Gidding et al., 2009), avoiding watching TV while eating (Zazpe et al., 2011), and increasing one's intake of fruits and vegetables (Epstein et al., 2001).

In light of the previous literature search, we must utilize an integration of current knowledge about eating behaviour and nutritional factors, paired with beneficial behavioural change strategies and concepts to modify eating behaviours towards healthy patterns using reflective processes with a simple memorable structure not demanding high cognitive effort. Thus, we conducted a literature review to find mainstream evidence with regard to macronutrients and behavioural changes, and what directs and guides people's eating behaviours.

#### **2.2.1.1.a What the literature reveals.**

Part One of the development process was structured in a way that provided evidence regarding the type of topical focus required to be performed in the intervention, based on the best knowledge found in the literature and demonstrated effects on body weight.

### **2.2.1.1.a.1 Method**

For the purpose of the current study, a literature search was conducted looking into mainstream evidence on obesity, weight loss, weight loss maintenance, and changes in diet and eating behaviours. The review tried to identify most studies on the effectiveness of dietary and behavioural interventions in terms of obesity management in adults. The types of studies sought were as follows: Subject headings used in the online search included obesity/overweight/BMI/weight gain/weight loss/weight regain/weight loss maintenance/effectiveness of weight loss intervention/weight loss program and intervention/eating behaviours/eating habits/behaviour change/maintain behaviour change. A range of study designs were accepted, including randomized controlled trials (RCTs), intervention studies, observational and retrospective studies, systemic reviews and meta-analyses. Studies that were included were related to human adults and children, were published between 1980-2012, were reported in the English language, healthy, overweight, or obese subjects, and were assessed with one or more of the following measures: body weight, BMI, WC, WHR, or WHtR. Searches were conducted in the following online electronic databases: Medline, Google Scholar, and Medscape.

### **2.2.1.1.a.2 Results:**

This result section reports outcomes from extensive literature review with the focus to extract particular areas of health behaviours which are supported to be most important for weight loss and health. The next subsections will review the concerning topics; each topic will be supported by literature to explain its effect on weight loss, decreased risk of chronic diseases, and improvement in diet.

#### **2.2.1.1.a.2.1 Topic One: Health findings related to sugar intake with A focus on liquid calorie intake**

Since ancient times, sugar is presented has been part of the diet of humans (Kiple & Ornelas, 2000). High consumption of food high in sugar content may be linked to increase risk of many chronic diseases such as obesity, CVD, diabetes, some cancer, and dental caries (Bristol et al., 1985; Burt & Pai 2001; Johnson et al., 2007; Milich et al., 1986; Van baak & Astrup 2009). However, in the last 30 years, there has been noted increase in the intake of added sugar in food in Europe and the US (Olsen & Heitmann 2009; Popkin & Nielsen 2003).

Excessive consumption of sugar-sweetened drinks and soft drinks is a critical item in the shift in diet (Guthrie and Morton, 2000; Harnack et al., 1999; Ludwig, 2002). An increase in sugar-sweetened beverages has also been associated with increased energy and body weight (Ludwig, 2002; Ludwig et al., 2001). Hu and Malik (2010) pointed out that the intake of sugar-sweetened drinks should be changed to the intake of healthy substitutes to reduce obesity and chronic disease risks.

Numerous studies have linked obesity and BMI to high sugar consumption (Bolton-Smith & Woodward, 1994; Bowman, 1999; Bray et al., 2004a; Drewnowski & Bellisle, 2007; Gross et al., 2004; Hill & Prentice, 1995; Malik et al., 2010; Hu & Malik, 2010; Schulze et al., 2004b). Sugar is a source of energy and consuming food high in sugars results in increased energy intake which inevitably leads to increase body weight (Bachman et al., 2006). The majority of high-sugar foods are low in fibre and high in density (Fogelholm & Tetens, 2011). It has been suggested that sugar may enhance energy intake (Ludwig et al., 2001; Roberts, 2000).

For many individuals, food selection is affected by food taste (Glanz et al., 1998), which is considered to be the driving force behind the consumption of foods (Drewnowski, 1997). Sweetness, in particular, is the main factor that influences food selection (Birch 1999; Booth et al., 1987), and there is a positive association between the amount of calorie intake from sweets and sweet preference (Mattes & Mela, 1986). Sugar is highly palatable and represents 22% of the daily energy content of a typical American diet (Drewnowski, 1995). In addition, soft drinks represent 47% of added sugar in the American diet (Guthrie & Morton, 2000). The surge in popularity of soft drinks can be explained in terms of the high palatability of the sweet taste (Lenoir et al., 2007), and their high energy density and low cost (Drewnowski & Bellisle, 2007). Putnum et al. (2002) suggested that the main cause of increased calorie intake (300/day) in the period between 1985 and 2000 was an increase in the consumption of added fats and sugars.

Many studies have attempted to address the relationship between sweet taste perception and obesity; some of them have shown that obese individuals have a lower sensitivity to sweetness compared with individuals of normal weight (Bartoshuk et al., 2006). Several investigations have reported an increased tendency for a sweet taste among persons with moderate obesity (Cabanac & Duclaux, 1970; Rodin et al., 1976; Wooley et al., 1972). Furthermore, Sartor et al. (2011) concluded that individuals who are obese or overweight are more implicitly attracted to sweetness.

A daily intake of fruit juice is presented in most children, whether they were overweight or of normal weight (Ariza et al., 2004). Fruit juice consumption has increased among children in the last 50 years (Dennison, 1996). Around 50% of children consume 12 oz or more of fruit juice per day (Newby et al., 2004). Fruit juice accounts for 7.3% of the daily energy intake in children (over 2 years of age) (Nielsen & Popkin, 2004), and accounts for 5% of the total fluid consumption in subjects aged 4-18 years and the variation between the age groups in the consumption of fruit juice and soft drinks is too small, and for other beverages (He et al., 2008).

In summary, added sugar (food and drinks) plays a role in increase energy intake and enhancing obesity. Therefore avoiding food high in sugar and drinks sweetened with sugar should be the behavioural focus in our intervention.

#### **2.2.1.1.a.2.2 Topic Two: Health findings related to intake of a variety of vegetables and fruit**

Many national and international organizations have urged for an increase in the consumption of fruit and vegetables to 400g or five portions a day (Committee on Diet and Health, 1989; Report of the Cardiovascular Review Group Committee on Medical Aspects of Food Policy, 1994; WHO, 1990). The NICE guidelines recommend that one should eat at least five portions of a variety of fruit and vegetables. A portion is equal to 80g (400g a day) based on the WHO recommendation, which states that consuming at least 400g per day of fruit and vegetables could reduce the risk of death from several chronic diseases such as heart disease, strokes and some cancers (NICE, 2006; WHO, 1990). An intake of at least five servings of fruit and vegetables per day is recommended to reduce the risk factors for cardiovascular diseases (Krauss et al., 1996; Joshipura et al., 2001; Liu et al., 2000; USDA, 1995) and other chronic diseases (Ford & Mokdad, 2001).

The World Cancer Research Fund (WCRF, 1997) stated that the positive relationship between the incidences of cancers that is seen with some vegetables does not appear with potatoes. However, there is no evidence to support an inverse relation between potato consumption and the risk of cancer (Steinmetz & Potter, 1991). Furthermore, WCRF is concerned about the negative influence of a high consumption of potatoes on Type 2 diabetes because potatoes contain high amounts of readily absorbed starch; therefore, they are a major contributor to dietary glycemic index and load (WCRF, 1997). In addition, Halton et al. (2006) found a positive association

between potato intake and the risk of Type 2 diabetes. White potatoes have a high glycaemic index and high glycaemic load (Wolever et al., 1994) and numerous studies have shown a positive relationship between a high glycaemic diet and the risk of Type 2 diabetes (Salmeron et al., 1997a; Salmeron et al., 1997b; Schulze et al., 2004a).

A meta-analysis of 13 cohort studies found that consuming 3-5 portions of fruits and vegetables correlated with a 7% reduction in the risk of CHD, while consuming more than five portions a day can result in a 17% reduction in risks (He et al., 2007). Pomerleau et al. (2006) concluded that consuming 600g of fruit and vegetables per day is associated with a 17% reduction in ischemic heart disease and a 10% reduction in strokes.

COMA (1998) reviewed the evidence of the nutritional aspect of the development of cancers and concluded that a high consumption of vegetables can reduce the risk of colorectal cancer and gastric cancer (Department of Health, 1998). Moreover, the WCRF and the American Institute for Cancer Research (AICR) reviewed 7000 studies on food, nutrition, physical activity and body composition in association with cancers and found that dietary fibre in fruit and non-starchy vegetables could have a protective role against several cancers, such as mouth, stomach, bowel, pharynx, larynx and oesophagus cancers (WCRF, 2007).

Eating more portions of fruit and vegetables has a role in increasing the consumption of dietary fibre, which helps in reducing the total fat intake. In addition, it has been suggested that the consumption of fruit and vegetables assists in reducing energy dense foods (Dauchet et al., 2009). Fruits have always been considered to be healthy nutrients as they contain a variety of compounds with antioxidant capacity in plasma (AOP), such as vitamin C and E, which could be helpful actions (Djuric et al., 2003; Visioli et al., 2004). Fruit and vegetables are considered to be lower in energy-density (0.4-2.0kJ/g) because of their high water content (Drewnowski, 2003). Therefore, a higher consumption of fruit and vegetables is related to a lower gain in BMI (Newby et al., 2003). Energy-dilute diets are superior in terms of the amount of fruit and vegetables (Marti-Henneberg et al., 1999) and enhance a sense of saturation, which leads to a decrease in energy intake throughout the day (Rolls et al., 1998). The sense of saturation or satiating power of fruit and vegetables is presented as a result of the volume and water content in fruit and vegetables (Rolls & Barnett, 2000).

He et al. (2004) indicated that increasing the consumption of fruit and vegetables could reduce the long-term risk of obesity. The consumption of antioxidant

substances, which are contained in fruits, could be a beneficial strategy in diet design, which could be useful for improving the cardiovascular risk factor related to obesity (Crujeiras et al., 2006). Several studies have shown that the consumption of fruit and vegetables enhances weight loss and is associated with a decline in the incidence of and mortality from obesity (Hung et al., 2004; Joshipura et al., 1999).

Fruit juices contain a small percentage of fibre or even no fibre, and because beverages are less satiating than solid foods (Flood-obbagy & Rolls, 2009; Mattes, 2007), eating whole fruits is favoured for weight management (Dennis et al., 2009; Popkin et al., 2006). Schulze et al. (2004b) suggested that increased intake of fruit juices is correlated with weight gain. Furthermore, Popkin et al. (2006) concluded that juice drink consumption ought to decrease because of their high energy content and low nutritional value, while fruit consumption should be encouraged because of its high satiating ability (Dennis et al., 2009). The steady intake of sugar calories in liquid form has been responsible for the increased incidence of weight gain (Berkey et al., 2004; Bray et al., 2004a; Gross et al., 2004; Hu & Malik, 2010; Malik et al., 2006; Malik et al., 2010; Schulze et al., 2004b). The caloric content in sugar-sweetened beverages is similar to that of fruit juices, but they have limited nutritional value. Both of them have been related to the risk of increased body weight (Faith et al., 2006). Welsh et al. (2005) reviewed 10 articles and they found that three articles reported a positive correlation between an increase in the incidence of being overweight and a high consumption of fruit juice (more than 12fl oz per day); they also found one article reporting a positive association between BMI and a high consumption of fruit juice. Dennison et al. (1997) found that children who consumed 12oz or more of fruit juice per day were more overweight compared with children who consumed less than 12oz per day. Later this relation was held to be the case for apple juice only (Dennison et al., 1999). A small control study suggested that obese children consume more fruit juice than non-obese children (Hanley et al., 2000). Tanasescu et al. (2000) showed that weight gain is associated with fruit juice consumption. In one study, which examined changes in consumption in relation to changes in body weight over four years, found that the consumption of fruit juice results in weight gain (about 4kg) (Schulze et al., 2004b). Bazzano et al. (2008) found that the consumption of fruit juices was correlated with increased risks of type 2 diabetes among women aged 38-63 years while fruit and green leafy vegetable consumption was associated with lower risks of diabetes.

In summary, consumption of 400 to 600 grams of fresh vegetables and fruit per day plays a main role in combating obesity development as vegetables and fruit are high in fibre, which enhances the satiety. Also, vegetables are considered a low-density food as they are low in fat and high in water content. Moreover, consumption of vegetables and fruit is connected a healthier eating patterns. However, potatoes are excluded from the category of vegetables and bananas from fruit because of the starch and sugar content, and because of the large numbers of calories in these kinds of vegetables and fruit. Wide evidence has demonstrated the importance of vegetable and fruit in terms controlling body weight, so, we should include it in our intervention.

### **2.2.1.1.a.2.3 Topic Three: Health findings related to intake of foods which rich in fibre**

Dietary fibre is a term used to describe a variety of plant substances that are resistant to digestion by alimentary enzymes in humans. Fibre sources include fruit, vegetables, grain products, legumes, nuts, oats and wheat bran (Burton-Freeman, 2000). Dietary reference intakes (DRIs) are quantitative reference values for the recommended intake and safe upper limits of nutrients; 25g per day is recommended for women under 50 years of age and 21g for women over 50 years of age. It is recommended that men under 50 years of age take 38g per day and men over 50 years of age take 30g (Trumbo et al., 2002). The dietary guidelines for Americans are 14g of fibre per 1000 calories consumed or 25g/day for women and 38g/day for men (The dietary guidelines for American, 2010; USDA, 2010). Dietary Guidelines for Americans further advises consuming three or more of whole-grain products per day (USDA, 2005), and whole-grain intake is also stressed in WHO recommendations (WHO, 2003).

Diets rich in fibre are lower in saturated fat, and many national institutes have recommended a high consumption of grain products to control weight (USDA, 1995; USDA 2000; Krauss et al., 2000). There are numerous benefits of consuming fibre-rich foods, such as improving large bowel function to slow down the digestion and absorption of carbohydrates and fats, and reduce the risk of some diseases (Ali et al., 1982; Schneeman & Tietyen, 1994). Several studies have examined the benefits of fibre in promoting compliance with diets formulated for weight loss by reducing hunger, such as low-calorie diets (Astrup et al., 1990; Mickelsen et al., 1979; Pasma et al., 1997; Rytting et al., 1985). Dietary fibre can enhance valuable physiological effects:

laxation, decreased cholesterol in the blood and the amendment of blood glucose (AACC, 2001; Jones, 2000; NHMRC, 2006).

A high consumption of fibre has been associated with a lower risk of heart disease (Pereira et al., 2004). Trowell coined the fibre hypothesis related to coronary heart disease (CHD) (Trowell, 1972). Several epidemiological studies have suggested that individuals who consume high levels of whole grain have a lower risk of coronary heart disease (CHD) (Anderson 1995; Ascherio et al., 1998; Fehily et al., 1993; Fraser et al., 1992; Jacobs et al., 1998; Jacobs et al., 1999; Kahn et al., 1984; Liu et al., 1999; Rimm et al., 1996; Wolk et al., 1999). A high intake of cereal fibre is associated with a lower risk of heart attack among British working men (Morris et al., 1977). Rimm et al. (1996) found that a high intake of dietary fibre is related to a 40% lower risk of CHD. Two meta-analyses of several studies found that people who consume more than two servings/day of whole grain have a reduced risk of cardiovascular diseases (Mellen et al., 2008) and Type 2 diabetes (de Munter et al., 2007) by 21% compared with individuals who consume less than two servings/day. Krishnan et al. (2007) stated that diets high in cereal fibre are associated with a lower risk of type 2 diabetes. Anderson et al. (2004) suggested that individuals who have diabetes must consume 25-50g/day (15-25g/1000 kcal). In addition, consuming a diet high in fibre is linked to a reduced risk of diverticular diseases by about 40% (Aldoori et al., 1998).

Dietary fibre could influence obesity development and has an inverse relationship with body weight (Alfieri et al., 1995; Ali et al., 1982; Appleby et al., 1998; Birketvedt et al., 2000; Kimm, 1996; Kromhout et al., 2001; Lissner et al., 1998; Ludwig et al., 1999; Miller et al., 1994; Nelson & Tucker, 1996; Slavin, 2005) in that consuming fibre has been assumed to decrease energy intake by creating satiation and satiety (Blundell & Burley, 1987; Slavin, 2005). Howarth et al summarized the effects of dietary fibre on hunger, satiety and energy intake and body weight (Howarth et al., 2001). Fibres have an effect on palatability, and other sensory characteristics of the diet may have an impact on energy intake (Drewnowski, 1998a; Rolls, 1995). Heaton et al. (1973) suggested that dietary fibre may reduce energy intake through three mechanisms: 1) fibre displaces available calories and nutrients from the diet, 2) fibre increases chewing, which has a role in reducing intakes by enhancing saliva secretion and gastric juices, which leads to the stomach widening and increased satiety, and 3) fibre could reduce the absorption competence of the small intestine. In addition, Pereira and Ludwig (2001) suggested three physiological mechanisms (hormonal, intrinsic,



and colonic effects) by which dietary fibre affects body weight regulation. They stated that an increase dietary fibre leads to decrease insulin secretion and fat storage, and decrease fat oxidation. Also, high fibre food delays absorption of glucose and nutrient which result in decrease insulin secretion (Slavin, 2005; Yao & Roberts, 2001).

Dietary fibre has the ability to alter the cephalic-gastric-intestinal phase of ingestion, digestion and absorption, providing many chances to affect satiation and satiety (Burton-Freeman, 2000). The textural characteristics of some fibre-rich foods could increase the chewing effort and time needed for mastication; this increase could result in a variety of cephalic-gastric phase responses, which results in early satiation and a decrease in food intake (Duncan et al., 1983; Heaton, 1980; Howarth et al., 2001; Sakata, 1995). Whole grains are useful in that they have an influence on weight control through enhancing satiety (Jenkins et al., 1987; Jenkins et al., 1988; Slavin et al., 1999). Furthermore, there are influences of dietary fibre on gastrointestinal function including delaying gastric emptying which may prolong fullness feeling and delay glucose and nutrients absorption (Bergmann et al., 1992; Schneeman, 2002; Yao & Roberts, 2001).

Epidemiological studies have shown the role of a diet higher in fibre in the control of body weight (Liu, 2002; Ludwig et al., 1999; Roberts and Heyman, 2000). Two cross-sectional studies have shown an inverse relationship between fibre intake and body weight (Alfieri et al., 1995; Appleby et al., 1998) and body fat (Nelson & Tucker, 1996) and subscapular skin-fold thickness (Kromhout et al., 2001). A longitudinal study of young adults showed that fibre intake was inversely related to the body mass index (BMI) (Ludwig et al., 1999). Obese individuals of both genders have a significantly lower dietary fibre intake compared with lean individuals (Miller et al., 1994). In developed countries, an increase in the intake of dietary fibre throughout the life cycle is a significant step to eliminating the epidemic of obesity (Slavin, 2005). There has been a significant association between the development of obesity and a lower intake of dietary fibre suggested in epidemiological and cross-sectional studies (Alfieri et al., 1995; Appleby et al., 1998; Burkett and Trowell, 1975; Van Itallie, 1978). Howarth et al found greater weight loss in obese individuals who increase their consumption of dietary fibre (Howarth et al., 2001).

In summary, increase fibre intake has clear positive influences on body weight and obesity as they are low in fat content, increase satiety and satiation, reduce hunger, and enhance a feeling of fullness which leads to reduced energy intake.

#### **2.2.1.1.a.2.4 Topic Four: Health findings related to intake of meat and processed meat**

High consumption of meat is positively associated with increased BMI and body weight (Vergnaud et al., 2010) as a result of increase intake of total fat, particularly saturated fat, which consequently leads to increase total energy intake (Foster, 2003; Nicklas et al., 1995). Moreover, high intake of meat has an inverse relationship with vegetable intake (Leitzmann, 2005; Sabate, 2003). Wang and Beydoun (2009) aimed to assess the relationship between meat consumption and obesity. They found a positive association between consumption of meat and increased risk of obesity and central obesity. Furthermore, high intake of meat was linked to increased risks of some chronic diseases such as cancer, CVD, and Type 2 diabetes (Corpet, 2011; Fung et al., 2004; Nicklas et al., 1995; Micha et al., 2010; Vang et al., 2008).

The World Cancer Research Fund (WCRF) and American Institute for Cancer Research (AICR) recommended that people consume not more than 500g of red meat per week and avoid processed meat (WCRF & AICR, 2007), and Scientific Advisory Committee on Nutrition (SACN) made the same recommendation (SACN, 2010). The UK, Department of Health recommended that people should select lean cuts of meat to grill rather than fry (NHS Choices, 2009).

The COMA report provided potential connections between consuming red and processed meat and colorectal cancer and recommended that higher-level consumers should consider a reduction in their red meat intake, especially processed meat (Department of Health, 1998). According to SACN, there is a possible connection between the high consumption of red and processed meat and a higher incidence of colorectal cancer (SACN, 2010). The report on food, physical activity and the prevention of cancer published by the WCRF and the AICR in 2007 mentioned that there is persuasive evidence that high consumption of red meat and processed meat increases the risk of colorectal cancer (WCRF & AICR, 2007). Norat et al. (2005) concluded that a high consumption of red and processed meat correlates positively with the risk of colorectal cancer, but consumption of fish is not associated with colorectal cancer. A high-fibre diet has an inverse association with the risk of colorectal cancer risk (Bingham et al., 2003a), and individuals who have a diet based on meat tend to consume less fibre.

The WCRF and AICR reported that diets containing a large amount of processed meat might increase the risk of stomach cancer (WCRF & AICR, 2007). Larsson et al. (2006) suggested that a high intake of processed meat might increase the risk of stomach cancer (Larsson et al., 2006). Several studies have shown a positive association between a high consumption of processed meat and an increased risk of stomach cancer (Boeing et al., 1991a; De Stefani et al., 2004; Lee et al., 1989; Takezaki et al., 2001; Ward & Lopez-Carrillo, 1999); this positive association was found for certain processed meat such as bacon (Hansson et al., 1993; Nazario et al., 1993), sausage (Boeing et al., 1991b; Nazario et al., 1993; Sanchez-Diez et al., 1992) and ham (La Vecchia et al., 1987; Nazario et al., 1993).

Meat is a major source of saturated fat, which is related to colon cancer (Peters et al., 1992; Potter & McMichael, 1986; Whittemore et al., 1990; Willett et al., 1990). Willett et al. (1990) suggested that a high intake of red meat may be related to an increased risk of colon cancer; this finding was supported by a systemic review carried out by the WCRF/AICR 1997 (WCRF & AICR, 2007) and a meta-analysis (Norat et al., 2002; Sandhu et al., 2001). An increased risk of colon cancer is positively associated with an increased consumption of meat and negatively with an increased consumption of fruit, vegetables and grain products (Shannon et al., 1996). In addition, Potter et al. (1993) reported a negative association between colon cancer and vegetable intake. Moreover, several observational studies (Kampman et al., 1995; Iscovich et al., 1992; Zaridze et al., 1992) and cohort studies (Steinmetz et al., 1994; Willett et al., 1990) have shown an inverse relation between fruit and vegetable consumption and colon cancer.

Meat consumption varies across the world, but the influence of a higher consumption of meat on the mortality rate associated with chronic diseases is unclear (Appleby et al., 2002; Fraser, 1999; Kahn et al., 1984; Key et al., 1998; Key et al., 1999; Thorogood et al., 1994). Sinha et al. (2009) concluded that the consumption of red meat and processed meat has a modest link to an increase in cancer mortality, CVD mortality and mortality in total. With respect to the link to cancer, meat is a source of many multi-site carcinogenic substances, including heterocyclic amines and polycyclic aromatic hydrocarbons (Kazerouni et al., 2001; Knize et al., 1994; Sinha et al., 1998a; Sinha et al., 1998b; Skog et al., 1995; Sugimura et al., 1991); both are constituted with deep frying of meat, as well as N-nitroso compounds (Cross & Sinha, 2004; Hughes et al., 2001). Iron in red meat could increase oxidative damage and increase the configuration of N-nitroso compounds (Kato et al., 1999; Kabat et al., 2007; Lee et al., 2004;

Wurzelmann et al., 1996). Moreover, meat is considered to be a main source of saturated fat, which has been found to have a high correlation with breast cancer (Bingham et al., 2003b; Midthune et al., 2008; Thiebaut et al., 2007) and colorectal cancer (WCRF & AICR, 2007).

With respect to the link to CVD, a higher consumption of red meat and processed meat has been shown to correlate significantly with an elevation in blood pressure (Steffen et al., 2005). Total cholesterol and triglycerides decline in people who consume fish instead of red meat (Gascon et al., 1996; Wolmarans et al., 1991). Meat consumption is related to a higher risk of diagnosed diabetes (Snowdon & Phillips, 1985). Van dam et al. (2002) concluded that the frequent consumption of processed meat could increase the risk of Type 2 diabetes. Furthermore, Song et al. (2004) suggested that a high intake of red and processed meat in women could increase the risk of developing Type 2 diabetes. There is a significant association between consuming processed meat frequently and an increased risk of Type 2 diabetes (Schulze et al., 2003; Van dam et al., 2002).

Processed meats are considered a main source of nitrites, which are used for meat preservation (Knight et al., 1987). The interaction between nitrites and amines from meats form nitrosamines in food (Lijinsky, 1999). A high intake of processed meat, which contains Nitrites and nitrosamines, has a positive association with Type 1 diabetes (Dahlquist et al., 1990; Helgason and Jonasson, 1981; Virtanen et al., 1994).

In summary, high consumption of meat is related to increased body weight as meat is a main source of saturated fat. Also, high consumption of meat is related to several disease risks such as cardiovascular diseases.

#### **2.2.1.1.a.2.5 Topic Five: Risks of eating energy dense foods for obesity and health**

The World Health Organization (WHO, 2003) considers foods' energy density as a main contributor to the global obesity epidemic. However, determining that the energy density foods is one of major causes of weight gain was based on evidence rated as "convincing" (WHO, 2003). Depending on the epidemiological criteria, convincing relationships between diets and illness should rely on randomized controlled trials, or prospective and observational studies (WHO, 2003).

The energy density of foods is defined as dietary per unit weight (kJ/g or MJ/Kg). Oil has an extreme energy density (37 kJ/g). In addition, water (0 kJ/g) has been identified as a major contributor to energy density, even more than other

macronutrients, because it accounts for the bulk of food weight (Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b). Consequently, water weight accounts for most of the variance in energy density among studies (Stookey, 2001; Yao & Roberts, 2001). Contrary to common beliefs that added sugar and fatty foods have the highest energy density (WHO, 2003; Prentice & Jebb, 2003), dry foods are the most energy dense foods (Cox & Mela, 2000; Grunwald et al., 2001; Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b). Oils, dry roasted peanuts, candy and cookies are high energy density foods (Drewnowski, 2003), while tomato juice, low fat milk, and soft drinks are dilutes energy foods (Drewnowski et al., 2004a). In addition, vegetables and fruits are low energy density foods (3 kJ/g) because of their water content (Drewnowski et al., 2004a).

The World Health Organization report mentioned that energy dense foods are high in fat, sugar, and starch (WHO, 2003). However, the term 'energy dense' has been used to indicate how low the micronutrient count of foods is, not the calories in foods, and this illustrates the incorrect categorisation of soft drinks to the energy dense category, and whole grains in the diluted energy category (Drewnowski et al., 2004a). Actually, the energy density of a cola soft drink is 1.8 kJ/g, which is lower than the energy density of cereals (15 kJ/g), whole wheat bread (12 kJ/g) or beans (5kJ/g) (Jat, 1998). Strictly speaking, because soft drinks and other beverages have a high water content, they are included under the dilutes energy category (Drewnowski et al., 2004a).

Westernized fast food has increased the energy density of foods and this has caused an increased risk of obesity and a deficiency of micronutrients (Pena & Bacallao, 2000). High energy density foods are related to increased body weight (WHO, 2003). Many studies have shown that people readily overeat high energy density foods (Bludell et al., 1996; Rolls & Bell, 1999), and individuals prefer the taste of high energy density foods (Birch et al., 1990). A greater consumption of food prepared away from home is usually related to unhealthy dietary properties (Guthrie et al., 2002; French et al., 2001b) and high energy density, which has an impact on body weight (Nielsen & Popkin, 2003).

The WHO (2003) reported that dietary changes include consuming large amounts of energy density foods with a major role for fat, saturated fat and added sugar, and a decline in the consumption of complex carbohydrates and fibre, and fruits and vegetables (Ferro-Luzzi & Martino, 1996). The high intake of fat in diets is the most important factor in nutrition transition reflected in the national diets of various

countries. Across the world, there are large variations in the amount of total fat consumption (WHO, 2003). Fats represent around 37% of the daily energy content of a typical American diet (Drewnowski, 1995). Most cross-sectional studies, but not all, have shown a small positive correlation between fat intake and obesity (Lissner & Heitmann, 1995). Hill et al. (2000) concluded that a high fat diet increases the probability of obesity, and individuals who consume a low fat diet appear to have a low obesity risk.

An ecological study performed a time trend analysis to investigate the relationship between obese subjects and their past diets, and found a noteworthy parallel between increased obesity and increased proportion of energy intake from fat (Sonne-Holm & Sorensen, 1977). A Chinese longitudinal survey suggested that increased weight gain is related to the increase in fat consumption (Paeratakul et al., 1998; Popkin et al., 1995). Several studies have suggested that an increase in fat intake may play a significant role in the increased risk of obesity (Heitmann et al., 1995; Lissner & Heitmann, 1995; Sonne-Holm & Sorensen, 1977), and this is considered an important contributor to obesity in some people (Bray et al., 2004b), especially for individuals who have a genetic predisposition to obesity. However, regular exposure to high fat foods is due to the high consumption of energy which results in obesity (Lawton et al., 1993).

Several observational studies concluded that an association exists between eating an energy dense diet and obesity (Cox & Mela, 2000; Cuco et al., 2001; Kant & Graubard, 2005; Ledikwe et al., 2006; Marti-Henneberg et al., 1999; Stookey, 2001). Moreover, fast-foods are more likely to be fried, and frying is considered to be source of saturated fat (Ebbeling et al., 2002; Ebbeling et al., 2004). In adults, the consumption of food away from home could contribute to the rise in being overweight (Bowman and Vinyard, 2004; French et al., 2000; Litin and Sacks, 1993; Paeratakul et al., 2002;) and body fatness (McCrorry et al., 1999). Taveras et al. (2005) suggested that an increase in the consumption of fried food has resulted in an increase in weight gain. Individuals who eat more at home have a lower BMI than those who eat away from home (Binkley et al., 2000). Furthermore, numerous trials have suggested that consuming foods low in energy density, such as fruits, vegetables, and low fat diets in general, play a major part in the decline of the energy in diets and reduced body weight (Appel et al., 2003; Epstein et al., 2001; Fitzwater et al., 1991; Stamler and Dolecek, 1997). Hence,

decreasing the energy density of diets could be an effective strategy for weight loss (Fitzwater et al., 1991; Ello-Martin et al., 2004; Rolls et al., 2005a, 2005b).

A review by Astrup et al. of many studies which examined the influence of low fat diets on body weight among overweight individuals (Astrup et al., 2000a; Astrup et al., 2000b) found that declined body weight was greater in individuals who combined a low fat diet with a reduction in total energy intake. Weinsier et al. (1982) reported the effectiveness of a low energy density diet for long-term weight control. Among several studies, men and women who reported consuming a diet lower in energy density consumed fewer calories compared to those who consumed higher energy density food (Cuco et al., 2001; de Castro, 2004; Drewnowski et al., 2004a; Ledikwe et al., 2006; Stookey, 2001). The results from recent studies proved that a low energy density diet can decrease the calories from energy intake without affecting the intake of foods. Rolls et al. (1999) pointed out that starting a meal by consuming a low energy density soup plays a role in maintaining satiety and decreasing energy intake.

Food energy density is strongly related to fat content (Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b; Yao & Roberts, 2001). However, there is no strong evidence to suggest an association between foods' energy density and their sugar content (Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b; Gibson, 2000). Energy density is more strongly related to the water content of foods than sugar or fat content (Drewnowski, 2003; Drewnowski et al., 2004). For instance, the energy density of cereal is around 15 kJ/g, but when it is mixed with half a cup of low fat milk, the energy density is reduced to around 6 kJ/g (Jat, 1998).

These variations, described above, could be evidence for the difficulty of blaming foods' energy density directly for increased obesity prevalence, but the energy density of total meals could be a convenient variable (Drewnowski et al., 2004a; WHO, 2003). Indeed, high energy density foods defy the appetite control system which results in over consumption and weight gain (Prentice & Jebb, 2003). In addition, the calculation of the energy density of total diets requires an accurate methodology; for example, in terms of whether to exclude or include caloric and non-caloric beverages and water from the analysis (Cox & Mela, 2000). Some studies included caloric beverages in their diet energy density analysis, while water and non-caloric beverages were excluded (Cox & Mela, 2000; Grunwald et al., 2001). Relying on this procedure, the dietary energy density is about 4kJ/g when water and beverages are included, but

the energy density can reach 6 kJ/g when water and beverages are excluded (Cox & Mela, 2000).

Numerous clinical and laboratory studies have addressed whether the energy density of foods affects appetite and satiation (Drewnowski et al., 2004a). Satiation is the internal state of energy repletion after a meal; it has been measured in terms of fullness, reduced hunger and faster finishing of meal consumption (Bell et al., 1998; Drewnowski, 1998a; Drewnowski, 1998b; Himaya & Louis-sylvestre, 1998). However, foods that provide lower energy per consumed meal are described as being highly satiating, while foods that are over consumed tend to have less satiation power (Green et al., 1994; Green & Bludell, 1996). The lower satiating power of fat accounts for the passive overeating of fat-rich foods (Blundell et al., 1993; Bludell et al., 1996). Some researchers have argued that sweet and fat-rich foods have high palatability which over run the satiety signals, thus resulting in over consuming and weight gain (Green et al., 1994; Green & Blundell, 1996; Blundell et al., 1993; Bludell et al., 1996).

Palatability and satiation have an inverse influence on food consumption. Palatability contributes to a rise in appetite and consequently increased energy consumption, whereas satiation limits energy intake by decreasing meal size (Drewnowski, 1998a; Drewnowski, 1998b). Holt et al. (1995) suggested that more palatable foods were less satiating compared to low palatable foods. Moreover, low satiation power is associated with palatable and sweet tasting foods (Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b). Dilute energy foods are often lower than palatable foods but more satiating, whereas high density energy foods are high palatable foods but have lower satiating (Drewnowski, 2003; Drewnowski, 1997). Several investigators have reported that dilute energy foods have strong a satiety value (Kissileff 1985; Jordan et al., 1981; Mattes, 2005; Rolls et al., 1990). Jordan et al. (1981) suggested that decreased body weight in overweight subjects has a significant association with the frequent consumption of soup. An explanation for this relationship between soup consumption and weight reduction is that soup could have an influence on satiety, which can lead to reducing food overconsumption and consequently a decrease in weight (Bertrais et al., 2001).

Several studies have demonstrated that soup may be more satiating compared with other foods when consumed as a starter (Kissileff, 1985; Rolls et al., 1990; Spiegel et al., 1994). Himaya & Louise-Sylvestre (1998) observed that soup is more satiating and results in a significant reduction in food consumption (150 kcal) on a meal basis or



around 20% of the total daily intake, particularly in overweight individuals. Mattes (2005) suggested that eating soups lead to decreased levels of hunger and increased feelings of fullness. The WHO (2003) suggested that consuming vegetable soup could be contributory factor in decreased weight. Moreover, some studies have observed an association between soup intake and nutritional status. Out of 698 subjects, Giacosa and Filiberti (1997) recognised that obesity was higher in subjects who did not consume soup compared with subjects who consumed soup. Bertrais et al. (2001) suggested that eating soup can contribute to a balanced diet, and it has a beneficial effect on the nutritional status of the whole population.

There is an inverse link between palatability and satiating (Drewnowski, 1998a; Drewnowski, 1998b). Also, there is an inverse link between energy dense foods and their water content (Drewnowski, 2003; Drewnowski, 1998a; Drewnowski, 1998b). The WHO has stated that humans have a weak innate ability to realize the dilute of energy soft drinks and fail to compensate adequately to preserve the balance of energy (WHO, 2003). In contrast, some researchers stated that humans have a weak innate ability to recognize the energy density of foods and fail to compensate adequately to preserve the balance of energy (Prentice & Jebb, 2003). In fact, both views have contributed to overconsumption and obesity (Drewnowski et al., 2004a).

In summary, high-density food is usually high in sugar and fat. Moreover, the satiety power of high energy-dense food is lower than low-dense food.

#### **2.2.1.1.a.2.6 Topic Six: Health risk of consuming high-salt food**

High intake of salt has been identified as a main factor in increased risk of hypertension, stroke, kidney diseases, cancer (stomach and gastric), and likely obesity (Devine et al., 1995; He & MacGregor 2008, 2010; Tsugane et al., 2004). Salt is not one of the direct causes of the increased prevalence of obesity, but it is considered a major factor because of its effect on the increased intake of soft drinks. Salt leads to increased thirst, which consequently increases the amount people drink. He et al. (2008) suggested that around a third of the fluid consumed is in the form of soft drink consumption, and many studies have shown an association between soft drinks and obesity (Ludwig et al., 2001; James et al., 2004).

Epidemiological studies and controlled trials have shown a correlation between salt intake and fluid consumption (He et al., 2008; He et al., 2001; Karppanen & Mervaala, 2006). He et al (2001) found that a reduction in salt intake leads to a reduction

in the consumption of fluids; this is well known. Soft drinks represent a major part of fluid intake, which can have a crucial role in reducing the prevalence of obesity when they are controlled.

However, Cook et al. (2007) suggested that increased food and sodium consumption is associated with long term risk of CVD and obesity. The USDA (2006) revealed a 55% increased use of salt per capita between 1983 and 1998, and during the same period the use of sweetened and soft drinks increased by 45% (Karppanen & Mervaala, 2006). Obviously, there was a parallel relationship between increased salt intake and soft drink consumption.

Traditional food habits are being changed by fast foods, soft drinks and an increased intake of meat (Drewnowski, 2000). The increase in the consumption of foods prepared away of home has paralleled the increase in the prevalence of being overweight (Guthrie et al., 2002; Nielsen and Popkin, 2003). This vast increase has resulted from the consumption of high-energy foods at restaurants and fast-food establishments (Lin et al., 1996; Nielsen et al., 2002a,b). Most people are not aware of the amount of salt in ready-made meals and fast and processed food (Dotsch et al., 2009). In recent years and as a result of modern life, there has been a dramatic turn to fast food (French et al., 2000), which has resulted in increased consumption of foods high in salt. Dunford et al. (2012) found that people who eat fast foods frequently have high intake of salt compared to people who do not consume these kinds of food. Regular intake of foods high in salt (fast foods) is linked to poor diet quality (Haines et al., 1992). It is well known that fast foods are high in fat, saturated fat, and salt, and low in fibre (Lin, 1999; Lin et al., 1999).

In summary, salt is usually prevalent in prepared, packed, and fast foods. Salt is usually linked to the palatability of food, which could enhance energy intake. Also, salt can increase the consumption of high-caloric beverages. The majority of individuals have no idea of how much salt is in canned, ready-made, and fast food, this leads to increased salt intake without awareness.

#### **2.2.1.1.a.2.7 Topic Seven: Health benefits of improve eating pattern**

Eating rate has been assumed to influence food consumption since the beginning of behaviour therapies for weight loss. It has been hypothesized that people will decrease their food intake if they decrease their eating rate (Stuart, 1967). It was believed that slower eating could promote satiety, probably by providing enough time

for the body to prepare physiological satiety signals (Stuart, 1967; Stuart and Davis, 1972). Other authors assumed that a decreased consumption rate would promote and prolong satisfaction from eating and this would reduce feelings of deprivation that could happen during restricted food intake (Brownell, 2000; Privitera et al., 2012).

Some findings have correlated rapid food ingestion with greater energy intake (Andrade et al., 2008; Gerace & George, 1996; Kaplan, 1980; Scisco et al., 2011). The first investigation conducted to find the association between eating rate and food intake was carried out by Spiegel and Jordan (1978). They found that a quicker eating rate was related to increased food intake, which led to increased body weight and obesity (Maruyama et al., 2008; Tanihara et al., 2011). Spiegel et al. (1993) manipulated the bite size of food (5, 10, and 15g), and they found that smaller bite sizes were related to slower eating rates. Another study suggested that increased eating rate was associated with increased food intake (Kaplan, 1980). Epidemiological studies in Japan have shown a positive association between eating rate and BMI (Otsuka et al., 2006; Sasaki et al., 2003; Takayama et al., 2002).

In terms of eating rate in obese women, Spiegel et al. (1991) found that reduced eating rate was associated with greater weight loss. Moreover, Andrad et al. (2006) manipulated the eating rate of females in the laboratory and found that a quick eating rate was associated with increased food intake compared to a slow eating rate. Watching TV follows work and sleep in terms of time-consuming activities (Dietz, 1990). Watching TV has thoroughly altered the use of leisure time, and it competes for time which would otherwise be spent on physical activity (Comstock et al., 1978; Pearl et al., 1982). Besides leading to decreased physical activity, it might also increase snack consumption (French et al., 2001a; Gerbneer et al., 1982). It is generally recognized that media-based secondary behaviours such as watching TV, playing video games, and working at computer can lead to obesity (Andersen et al., 1998; Tremblay & Willms, 2003). It is important that while food is being consumed, the individual's attention is focused on the food (Bellisle & Dalix, 2001). If attention becomes divided, such as when working at a computer, the reward gained from eating is reduced, and people tend to eat more. Food should not be associated with other activities, such as watching television, because this will lead to less healthy eating behaviours (Coon et al., 2001). Individuals should be advised to eat only in a dining-room or at a kitchen table at mealtimes (Holt, 2005).

Lifestyle plays a significant role in the prevention and development of chronic diseases such as obesity. Studies have identified that frequent TV watching might play an important role in a number of chronic diseases (Dietz and Gortmaker, 1985; Tucker, 1985; Tucker, 1986; Tucker and Friedman, 1989). For instance, TV watching has been determined to be an incentive for overeating and related secondary behaviours (Robinson & Killen, 1995). Also, the prevalence of obesity is greater among people who watch TV for a long time each day. Several studies have found an association between higher BMI and higher a level of TV watching (Eisenmann et al., 2002; Jeffery & French, 1998). This relationship between watching TV and increased body weight could result from most people increasing their food intake while they watch TV. For example, Stroebel and de Castro (2004) reported relatively high food intake during meals eaten in front of the TV. Tucker and Bagwell (1991) concluded that adult females who reported watching TV for 3-4 hours/day showed almost twice as much obesity, and those who reported more than 4 hours/day of TV watching showed more than double the amount of obesity, compared with adult females who reported less than one hour/day of TV watching. This study showed that an overweight adult female was more likely to spend time watching TV as her principal source of recreational activity because of the minimum effort required, compared with a non-obese female who would prefer a recreational activity with greater physical involvement. Moreover, eating snacks between meals increases while watching TV, and the relationship between TV watching and being overweight is significant statistically (Marshall et al., 2004). Blass et al. (2006) suggested that watching TV increases the amount eaten of high-density, palatable, familiar foods and may constitute one factor contributing to the current obesity crisis. Finally, Mota et al. (2006) suggested that obesity was positively associated with computer use on weekdays.

Sedentary patterns of behaviour are considered to have an important function in long-term weight regulation (Bouchard & Katzmarzyk, 2000). Therefore, it is important for a successful treatment for obesity to decrease behaviours that are sedentary to eating itself (Epstein et al., 1997); watching TV is a major such sedentary behaviour. Hu et al. (2003) suggested that reducing prolonged TV watching and other sedentary behaviours played a key role in preventing obesity and diabetes. Watching TV results in a lower metabolic rate compared with other sedentary lifestyles (Ainsworth et al., 1993). Hu et al. (2003) concluded that among women-sedentary

behaviours (especially watching TV) were positively associated with risk of obesity and Type 2 diabetes.

In summary, emphasizing reduced speed of food intake and avoidance of food intake while being distracted by watching TV or computer work has the potential to be an important factor in weight control.

#### **2.2.1.1.a.2.8 Topic Eight: Health findings related to having regular meals and reduce snacking**

The portion size and the number and composition of foods that people eat each day differ according to time, history and culture (Meiselman, 2000). In traditional societies, individuals tend to have fixed meal times; they eat three times to five times a day (Simopoulos, 1992); and most meals comprise more than one kind of food (Meiselman, 2000). Blundell and Halford (1994) suggested a formalized scheme to demonstrate the various effects that might govern the inter-meal interval and the amount of food intake at the next meal. Four factors of sensation play a role in dietary regulation: hunger (drive to eat), appetite (willingness to eat), satiation (feeling offfullness, which causes someone to stop eating) and satiety (feeling satisfied, which affects future hunger) (Blundell & Halford, 1994).

Many techniques have been used in an attempt to reduce appetite in order to manage weight gain and obesity, such as those involving diets, hormone treatment, drugs and surgery; the timing of meals could also contribute to effective intervention (Halberg, 1974). An effective programme for reducing weight focuses on changing the diet and including physical activity and behaviours to enhance the loss of excess body fat and maintain lean body mass (ACSM, 1990; Hendee, 1988). Specific aspects of eating behaviour, such as the time of eating, could have significant consequences for weight control (Halberg, 1989). Some studies have shown that the timing of food intake is an important factor in weight gain (Colles et al., 2007; Ma et al., 2003).

Circulating satiety hormones could have a circadian fluctuation independent of meal timing and could affect food consumption (Scheer et al., 2009). The timing of food intake in adult can displace the acrophase (time of peak) of some circadian metabolic rhythms (Bazin et al., 1979). Whatever the meal schedule, lipolysis is inclined to occur in the morning while lipogenesis occurs in the evening (Bellisle et al., 1988).

Breakfast is an important component of nutrition, especially for children and young people; yet it is the most commonly missed meal (Dwyer et al., 2001). Many large studies have tested the affect of eating breakfast in nutrition (Nicklas et al., 1998; Morgan et al., 1986; Stanton and Keast, 1989). For example, Stanton and Keast (1989) found that adults who frequently skipped breakfast had highest serum cholesterol levels compared to adults who were eating breakfast regularly. Eating breakfast is said to be a likely preventive factor for increased body weight in childhood (Dietz, 2001), and this is very important because overweight children are more likely to becoming overweight adults (Stark et al., 1981). In adolescents, skipping breakfast has been related to several health-compromising behaviours and high risk lifestyles such as tobacco and alcohol use (Hoglund et al., 1998; Isralowitz and Trostler, 1996; Revicki et al., 1991). Furthermore, the health-compromising behaviours that are associated with skipping breakfast occur in adults as well as adolescents (Keski-Rahkonen et al., 2003). In industrialized countries, skipping breakfast has been related to families' low socioeconomic levels (Baumert et al., 1998; Hoglund et al., 1998; Nordlund and Jacobson, 1999; O'Dea and Caputi, 2001).

The behavioural and physiological effects of skipping meals may have an impact on weight-loss attempts; this view was supported by Fabry et al. (1964) findings. They found that consuming one large meal is associated with obesity and a high level of body fat compared to consuming frequent small meals. Some individuals neglect eating breakfast, probably because of their belief that by skipping breakfast they are reducing the total calorie intake, which helps them to control their weight (Nicklas et al., 1998; Zabik, 1987). When skipping breakfast, people tend to select more calorie-dense foods later on when compared with people who regularly eat breakfast (Morgan et al., 1986, Schlundt et al., 1992). People who eat breakfast consistently have sufficient micronutrient intake (Morgan et al., 1986; Nicklas et al., 1998; Ruxton & Kirk, 1997) and lower proportions of calories from fat (Ruxton & Kirk, 1997).

Butte reviewed several studies to examine the association between eating breakfast and later obesity, and he found that two studies suggested a positive relationship, four studies suggested a negative relationship, while other studies found no difference (Butte, 2001). Schlundt et al. (1992) suggested that eating breakfast is an important part of weight reduction because it helps to reduce dietary fat and snacking. Moreover, several studies have indicated that skipping breakfast might place people at risk to gain weight, to be obese, and to have a sedentary lifestyle (Baumert et al., 1998;

Keski-Rahkonen et al., 2003; Nordlund and Jacobson, 1999; Terre et al., 1990; Wolfe et al., 1994). Eating breakfast is the common feature in successful weight loss and could be a factor in the success of weight loss maintenance (Wyatt et al., 2002).

Many studies have shown that eating a single daily meal (2000 kcal) in the evening causes an increase in weight, while it causes a reduction in weight when ingested in the morning (Halberg et al., 1974; Hirsch et al., 1975; Jacobs et al., 1975). In addition, Armstrong (1980) suggested that the timing of meals is a very important contributor to the amount of weight loss. One study stated that obese children ate less at breakfast compared with non-obese children, but at the next meal they ate more than 60% of their total daily intake (Machinot et al., 1975).

Keim et al. (1997) compared the consumption of a large meal in the morning with one later in the day, and they found that consuming a large meal in the morning resulted in just a little more weight loss than a large meal consumed later in the day, but they found that consuming a large meal later in the day resulted in better maintenance of fat-free body mass. Therefore, consuming large meals later in the day could be beneficial to reducing fat-free mass (Halberg, 1989). In addition, they concluded that consuming very small meals in the evening permanently promoted fat oxidation (Keim et al., 1997).

Sensi and Capani (1987) concluded that there was no significant difference between having a very low energy diet in the morning and having one in the evening. However, an alternative timetable for meals (lunch/dinner) has been successfully implemented in weight reduction programmes for obese adults (Armstrong et al., 1981). Arble et al. (2009) pointed out that using behaviour-modification principles, such as timing of food intake, could be an important factor in slowing down a sharp increase in the prevalence of obesity.

A decrease in the number of people eating meals and increase having snacks, particularly away from home, has coincided with an increase in the prevalence of obesity (French et al., 2001a; Jeffery and French, 1998; McCrory et al., 1999). In young adults, there has been a clear increase in energy intake from snacks (Rolls et al., 2002). Many epidemiological studies have stated that snacks have an aetiological role in body weight gain and obesity (Basdevant et al., 1993; Takahashi et al., 1999). An increase in the frequency of eating, especially in the form of snacks, is considered to have a main role in the increased prevalence of obesity in children as well as adults (Manson & Bassuk, 2003; Serdula et al., 1993). Nowadays, snacks comprise a larger proportion of

the total daily energy and macronutrient intake compared with the late 1970s (Cleveland et al., 2005; Nielsen et al., 2002b). According to some estimates, consumption of snacks has increased from three per day, sometimes reaching four per day (Cleveland et al., 2005). The rise in the consumption of snacks is frequently assumed to be one aspect of changes in dietary patterns, which could have a role in the increased prevalence of obesity (Jahns et al., 2001; Zizza et al., 2001). Forslund et al. (2005) concluded that obese individuals consume more snacks than lean individuals. In addition, Bjorvell et al. (1985) and Basdevant et al. (1993) stated that frequent consumption of snacks is more common in obese individuals, and it is likely to have a causal link to obesity, high BMI, and high body fatness (Booth, 1988; Kruger et al., 2008; Boutelle et al., 2007; Chung et al., 2007; Duffey et al., 2007; Niemeier et al., 2006; Pereria et al., 2005; Schroder et al., 2007; Taveras et al., 2005). Restaurant food and fast food is usually linked to high calorie consumption, high saturated fat, and with little fibre and few vegetables (Befort et al., 2006; Beydoun et al., 2009; Boutelle et al., 2007; Crawford et al., 2007; Schroder et al., 2007; Wiecha et al., 2006).

The majority of snacks have high energy density. However, sweet snacks are high in both sugar and fat; their energy content is around 1500–2000 KJ/100g (400–500 Kcal/100g) (Stichting, 2004, Whybrow, 2005). The energy content of savoury snacks, such as potato chips, is about 2200KJ/100g (550Kcal/100g) (de Graaf, 2006). Numerous studies have associated snacking with increased energy intake as snacking represents about 25% of energy intake (Kerver et al., 2006; Savige et al., 2007). Moreover, increased energy intake related to snacking may contribute to high energy density and the portion sizes of consumed snack and an associated nutrient-poor diet (Jahns et al., 2001; Kerr et al., 2009Phillips et al., 2004). According to Sebastian et al. (2008), snacks have an excessive number of calories in the form of sugar and fat, and consuming snacks repeatedly has a negative impact on the intake of macronutrients and micronutrients.

Two studies examined the behavioural and metabolic consequences of consuming 1-MJ snacks (Marmonier et al., 1999; Marmonier et al., 2000). In the first study, the investigators found that consuming snacks at different inter-meal intervals did not affect the satiety effect of participants' lunch, dinner or energy intake, and, therefore, led to storage of fat (Marmonier et al., 1999). Researchers in the second study found that consuming high-protein snacks postponed dinner orders by 60 min, while consuming high-fat snacks postponed dinner orders by 25 min, and consuming high-



carbohydrate snacks postponed dinner requests by 34 min. The authors concluded that snacks have no influence on energy or macronutrient intake during dinner (Marmonier et al., 2000). Marmonier et al. (2002) concluded that the amount of energy intake during dinner does not change between a no-snack session and a session with snacks. Zandstra et al. (2002) suggested that energy intake at lunch is not affected by consuming low-energy drinks or high-energy drinks.

Castonguay et al. (1983) suggested that snacks are often consumed when people are not hungry. One study showed that meal initiations in the absence of hunger could be conditioned by external stimulus (Birch et al., 1989). Silverstone et al. (1966) showed a gradual decrease in hunger level during three weeks of fasting in the absence of meal cues. De Greef et al. (1993) showed that the appetite for meals has three peaks — just before breakfast, just before lunch and just before dinner — while the an appetite for snacks is higher before lunch, before dinner and in the late evening. Marmonier et al. (2002) suggested that snack consumption in terms of satiety status has small satiating effects regardless of the composition of the snacks, which confirms the view that snacks have a role in obesity.

The nature of the snacks contributes to energy intake; some studies have shown that solid foods are higher in terms of their satiety level compared to liquid foods (Haber et al., 1977; Hulshof et al., 1993; Mattes, 1996). Thus, snacks in the form of soft drinks can increase energy intake more than snacks in solid form, and this leads to an increase in weight gain (Raben et al., 2002; Tordoff & Alleva, 1990). Booth (1999) and Booth et al. (2004) concluded, “the first line of defence against weight gain is avoiding all sources of energy during drink breaks” (P. 277). De Graaf (2006) suggested that although individuals consume many snacks, particularly at irregular times, they do not compensate for the energy intake from snacks. Snacks are consumed at more irregular times, which can contribute to an increased energy intake in a short period of time (De Graaf, 2006). Limiting the availability of snacks may enhance the prevention of healthy food displacement and may play a role in reducing total fat consumption (Booth, 1988; Cullen et al., 2000; Kubik et al., 2003; Wildey et al., 2000).

In summary, having regular meals, especially breakfast, plays a role in reducing caloric intake at the next meal. Also, avoiding snacking can lead to reduced energy intake, which can help in regulating food intake and reduce body weight.

### **2.2.1.1.a.2.9 Topic Nine: Daily caloric allowance and physical activity**

#### **2.2.1.1.a.2.9.a Recommended dietary allowances (RDAs)**

Recommended dietary allowances (RDAs) have been designed by the Food and Nutrition Board (FNB) since 1941. The first recommendation appeared in the Journal of American Dietetic Association in 1943 (NRC, 1943; RDAs, 1989). (RDAs) are “the levels of intake of essential nutrients considered, in the judgement of the Committee on Dietary Allowances of the Food and Nutrition Board on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons” (NRC, 1980, P. 10).

In principle, these recommended allowances depend on several factors: (1) studies of subjects maintained on diets containing low or deficient levels of a nutrient, followed by correction of the deficit with measured amounts of the nutrient, (2) nutrient balance investigations that measure nutrient status in relation to intake, (3) biochemical measurements of tissue saturation or adequacy of molecular function in relation to nutrient intake, (4) nutrient intakes of fully breastfed infants and of apparently healthy people from their food supply, (5) epidemiological observations of nutrient status in populations in relation to intake, and, in some cases (6) extrapolation of data from animal experiments (RDAs, 1989).

The personal energy requirement has been described as “the level of energy intake from food which will balance energy expenditure when the individual has a body size and composition, and level of physical activity, consistent with long-term good health; and which will allow for the maintenance of economically necessary and socially desirable physical activity” (RDAs, 2005, P. 20). In terms of groups, RDAs take into consideration average personal needs. However, allowances for other nutrients are sufficiently high in order to match the upper limit of requirement variability among individuals within the group (RDAs, 1989).

In case energy intake is permanently above or below the personal need, alteration in body energy stores might be expected. In other words, imbalance between energy intake and energy expenditure over a long period leads to alteration in body weight or body composition, which has a negative effect on health (DHHS, 1988; NRC, 1989). RDAs are provided as kilocalories per day of physiologically available energy. The majority of food composition schedules list physiologically available energy values that rely on digestibility trials of certain foods carried out by Atwater (Merrill & Watt

1955). Other have also emphasized specific energy values (Bernstein et al., 1955; Southgate & Durnin, 1970).

#### **2.2.1.1.a.2.9.b How are RDAs determined?**

First, RDS estimated from resting energy expenditure (REE) derived from an equation developed by the Food and Agriculture Organization (FAO). Secondly, REE is multiplied by an activity factor representing light-to-moderate activity. For adult men, the reference body size, energy allowances ranged from 2300 to 2900 kcal/day, and from 1900 to 2200 kcal/day for adult women.

#### **2.2.1.1.a.2.9.c Argument Against Recommending daily allowance**

##### **2.2.1.1.a.2.9.c.1 Misunderstanding of RDAs**

There are many purposes for using RDAs: (a) Improving information about food and nutrition and developing education programmes; (b) Establishing standards for food regulations; (c) developing diet foods; (d) Providing baseline information for therapeutic diets; (e) Setting standards for diet-assistance programmes; (f) Assessing information collected in diet surveys (Harper, 1987).

In fact, there is confusion about the purpose and uses of RDAs among the general population, even among scientists. Perhaps the term “recommendation” contributed to this confusion. Nowadays, RDAs are widely interpreted as the amount that should be consumed, while their main purpose to serve as baseline for intake, below which risk of inadequacy begins to increase. This has been neglected or forgotten (Harper, 1987).

RDAs are not used as guides for therapeutic diets, but they can provide the starting point. However, they do not provide guidelines for adequate intake of carbohydrate, fat and fibre. However, they do not address the relationship between diets and diseases. In fact, RDAs are not intended as guides for food choices or obesity prevention. In short, RDAs are not recommended policy, but a set of reference standards approved by scientists, which could be used in specific nutrition programmes to establish sound public health policy (Harper, 1987).

##### **2.2.1.1.a.2.9.c.2 FAO/WHO/UNU equations accuracy**

In 1985, data from Schofield, Schofield and James were developed and used to form the FAO/WHO/UNU prediction equations (FAO/WHO/UNU report, 1985;

Schofield, 1985a; Schofield, 1985b; James, 1985; Schofield et al., 1985). The Schofield databases consist of 114 published studies of resting metabolic rates (RMRs) (Henry, 2005). Most findings were acquired from European and North American individuals (Henry, 2005), including 2,279 men and 247 women (Italian descent represented 45–50% of the subjects). Most were young European military and police personnel (James, 1985; Schofield, 1985a; Schofield, 1985b; Schofield et al., 1985).

The Schofield equations made accurate resting metabolic rates (RMR) predictions for most individuals from temperate climates, while in the case of those from the tropics, the accuracy decreased (Ismail et al., 1998; Piers and Shetty, 1993). De Almeida was the first author to report that RMRs might be different for people living in tropical climates (Ozorio de Almeida et al., 1919). He showed that Brazilians' RMRs were lower by 24% than Aub-Dubois standards. Indeed, many studies have examined the FAO/WHO/UNU prediction equations in populations in tropical countries (Shetty et al., 1996; Valencia et al., 1994). For instance, Henry and Ress (1991) found that the FAO/WHO/UNU predictive equations overestimated RMR by an average 8% and up to 13% in males older than 30 years. Similar findings were obtained in several studies in Japan, India, Asia and China (Hayter & Henry, 1994; Henry & Ress, 1991). According to Ismail et al. (1998) the FAO/WHO/UNU prediction equations overestimate RMR in Malaysia by an average 13% and 9% in males and females, respectively (Ismail et al., 1998). Similar results were reported in a study of Vietnamese adults (Nhung et al., 2005).

Most studies (1980–2000) concluded that the FAO/WHO/UNU predictive equations overestimated RMR in several communities (Henry, 2005). Also, in some populations in North America, the Schofield equations appear to be less accurate (Clark & Hoffer, 1991). In addition, these equations seem to overestimate RMR in several other populations (Hayter and Henry, 1994; Piers and Shetty, 1993; Soares et al., 1993). In fact, further analysis showed that the FAO/WHO/UNU predictive equations were inclined to overestimate RMR in most populations (Henry, 2005). Piers et al. (1997) reported that the FAO/WHO/UNU predictive equations overestimated RMR in Australia, among both males and females.

Hasson et al. (2011) found that the FAO/WHO/UNU prediction equation overestimated RMR in about 55.2% of the values, especially in overweight individuals. In addition, these equations have significantly overestimated the values of obese individuals. This overestimation may result in cases of consumption of 504 kcal/day

over caloric needs. In 16 weeks, obese individuals would be consuming about 8064 kcal and gaining around 1 kg of weight (Hasson et al., 2011). Hill et al. (2003) concluded that intake of 100 kcal/day of surplus energy can lead to a significant increase in body weight (Hill et al., 2003). Subsequently, several authors have questioned the validity and application of FAO/WHO/UNU predictive equations (Arciero et al., 1993; de Boer et al., 1988; Hayter and Henry, 1994; Piers and Shetty, 1993; Valencia et al., 1994; Wong et al., 1996), while others have questioned the use of these equations in the current context of international alterations in body weight and body composition (Cunningham, 1980; Cunningham, 1991; Dietz et al., 1991).

The Schofield database included males aged 10–60, and approximately 45–50% of the data were derived from Italian studies. RMR per kilogram for the latter tended to be higher than the Caucasian group (Hayter & Henry, 1993; Hayter & Henry, 1994). Involving an asymmetrical large Italian group with higher RMRs per kilogram may lead to overestimated RMRs using the FAO/WHO/UNU predictive equations (Schofield et al., 1985a,b). The Italian subjects used in RMR studies were young and perhaps inclined to be physically active (Henry, 2005). Poehlman et al. (1988) reported that RMRs were higher in such individuals than those with a sedentary lifestyle.

Frankenfield et al. (2005) reported that, in terms of the predictive validity of the FAO/WHO/UNU equations, validity for group means has been found but not individuals' prediction accuracy. Thus, the accuracy of predicted caloric requirements using the FAO/WHO/UNU equations has not been evaluated on the same basis as other equations (Frankenfield et al., 2005). Therefore, FAO/WHO/UNU prediction equations are no longer used to develop RDAs in Japan (Nhung et al., 2005). WHO/FAO/UNU's predictive equation was derived from data from 114 studies from 23 different countries, but most participants were of Italian descent (45%-50%). Moreover, the majority of the Italian subjects were young and had a police or military background, which enhances the hypothesis that they had a physically active lifestyle. In addition, it is not always clear whether the subjects used in predictive equations were living in modern or affluent societies (Muller et al., 2004).

The precise measurement of physical activity is an important issue for epidemiological studies in determining the association between physical activity and health (Bouchard et al., 1994; Macera & Powell, 2001). It is also important for being able to recommend a suitable physical activity pattern to maintain good health (Bouchard, 2001). In the past, participants' reported occupation was an accurate way to

categorize the level of physical activity (Powell et al., 1987; Shephard & Futcher, 1997), but nowadays technology, automation and the skill of the ergonomist have resulted in a decrease in the energy cost for many occupations (Shephard, 1990), which means that classifying activity on the basis of occupation does not have great value.

Recommended daily allowances (DRAs) are based on values of different physical activity levels with different occupations to predict physical activity. However, it is obvious that very sedentary people spend a lot of time sitting, watching TV or reading, or lying down. In addition, DRAs used for some physical activity values rely on values reported by Durnin and Passmore (1967) and the WHO (1985). However, based on published data, physical activity values may result in variability in estimating energy expenditure because there could be differences between subjects for specific tasks (Durnin and Namyslowski, 1958). Moreover, the published values have usually been derived from the assessment of young, active males, who do not represent the general population (LaPorte et al., 1985). Thus, the published values of activity intensity may not provide a precise estimate of energy expenditure; the survey procedures seem to be appropriate for rank-ordering subjects according to their overall activity levels (Bouchard, 1993).

Physical activity can be assessed by means of subjectively (using surveys, participant recall or questionnaires), and many studies have investigated the accuracy and validity of these methods. Several studies that have investigated exercise patterns have been based on self-reported data provided by the subjects. However, concerns have increased about the accuracy of this method for subjects generally, but especially for obese and overweight individuals. Studies have found that subjects often report levels of activity higher than actual levels; obese individuals, for example, overestimate their physical activity by 30% to 50% (Lightman et al., 1992; Jakicic et al., 1998). Conway et al. (2002) found overestimation of physical activity in self-reports from people of normal weight by 8% to 30%. Shephard (2003) concluded in a review of physical activity questionnaires that, despite the wide use of questionnaires for a long time, the reliability and validity of these questionnaires was still limited. Inaccurate data could result in an imbalance of energy, which might have an impact on body weight (Jakicic et al., 1998).

In conclusion, numerous studies have shown that the FAO/WHO/UNU predictive equations overestimate RMR in many populations in both tropical and temperate climates. They were developed using the Schofield database, which were

comprised predominately of young, active Italian subjects and few from a tropical climate. Thus, the equations did not adequately represent the global populations. Indeed, RMR was used to estimate total energy needs. Overestimating RMR by applying FAO/WHO/UNU equations could lead to inaccurate calculations of total energy needs, which might consequently change body weight composition.

Exercise is usually promoted as a method to increase energy expenditure and weight control (King et al., 2007). However, adaptive compensatory responses will oppose the energy deficit caused by exercise (king et al., 2007; King et al., 2008). The compensatory increase in energy intake after exercise was first suggested by Mayer (1953), who claimed that ‘the regulation of food intake functions with such flexibility that an increase in energy output due to exercise is automatically followed by an equivalent increase in caloric intake’ (P. 544). In 1980, Epstein and Wing also stated that ‘exercise may stimulate the appetite so that persons who exercise increase their eating and do not lose as much weight as expected’ and “a person who exercises in the early evening may go to sleep earlier or require more rest in the evening.”

Recently, the influence of exercise on compensatory responses in energy intake has drawn attention. Although several studies concluded that acute bouts of exercise do not induce compensatory increases in food intake (King et al., 1994; King & Blundell, 1995; King et al., 1996; Tsofliou et al., 2003), coupling energy intake and expenditure was highlighted in some studies (Blundell & King, 1999; Edholm et al., 1955; King et al., 2012; Saris et al., 1992). Many recent studies have been shown partial significant compensation in energy intake (~30%) when energy expenditure during exercise is more than 14 days (Pomerleau et al., 2004; Stubbs et al., 2004; Whybrow et al., 2008). Previous findings indicated that compensatory coupling might needs a few weeks to offset a negative energy balance (Doucet et al., 2011; King et al., 2008). King et al. (2008) stated that after 12 weeks of supervised exercise, all individuals experienced an increase in meal-induced satiety post-exercise, regardless of the amount of weight loss.

Several studies have shown that people who are overweight or obese overestimate their physical activity (Buchowski et al., 1999; Irwin et al., 2001; Jackicic et al., 1998; Lichtman et al., 1992; Mahabir et al., 2006). Common forms of aerobic exercise are running and walking. Studies have suggested that energy cost of both walking and running increases gradually with movement speed (Bransford & Howley, 1977; Dill, 1965). Many studies have shown that the expansion in energy expenditure in running is greater than that seen in walking (Chang & Kram, 1999; Fletcher et al.,

2009; Gottschall & Kram, 2003; Holt et al., 1991; Morgan & Daniels, 1994; Noakes, 1988; Noakes & Tucker, 2004; Pate et al., 1992). Several studies have measured the magnitude of running energy cost and they obtained values ranging from 0.83 to 1 kcal.kg.km (Fletcher et al., 2009; Lloyd and Zacks, 1971; Margaria et al., 1963; Pugh, 1971).

#### **2.2.1.1.a.2.9.c.3 Daily caloric allowance**

BMI is a good indicator of health; it is based on a simple formula:  $BMI = \text{Weight (Kg)} / \text{Height}^2$ . We can predict ideal body weight by using this formula. One takes the upper limit of normal BMI, which is 25, and uses the median height of the British population obtained from a national survey, which is 1.77 m for males and 1.62 m for females. The results show that the median ideal weight for males is about 78.5kg, and for females it is 65.5kg. The ideal body weight for different heights can be calculated by adding approximately 0.75kg for every 1 cm of additional height, and vice versa.

#### **2.2.1.1.a.2.9.c.4 Calculation of resting metabolic rate (RMR)**

The resting metabolic rate (RMR) is the largest component of total energy expenditure. RMR can be estimated by using the Mifflin-St Jeor equation:

Men:  $RMR = 9.99 * \text{weight (kg)} + 6.25 * \text{height (cm)} - 4.92 * \text{age} + 5$ .

Women:  $RMR = 9.99 * \text{weight (kg)} + 6.25 * \text{height (cm)} - 4.92 * \text{age} - 161$ .

To explain the use of this equation we will use the median height of British people (1.77 cm) and the ideal weight for this height (78.5kg) for males and (1.62 cm, 65.5 kg) for females, aged 18 years. The RMR in men is approximately 1807 kcal and the total energy expenditure is 2168.5, while the RMR in females is approximately 1418 Kcal and the total energy expenditure is 1700. However, individuals vary in terms of height and age, which can alter these values. Therefore, we can obtain some approximate values for different ages and heights by adding 14 kcal for every cm added and subtracting 5 kcal for every year added, and vice versa.

In summary, individuals, especially overweight and obese individuals, overestimate the caloric equivalent of their physical activity. Also, most people are not aware of their appropriate daily caloric needs. Consequently, a simple calculation to reduce overestimation of caloric needs and energy expenditure is needed.



### **2.2.1.1.a.2.10 Topic Ten: Limit calories from alcohol and liquids**

There is an important relationship between alcohol intake and BMI; both are related to disease risks such as breast cancer, hypertension, coronary heart disease and Type 2 diabetes (Aronne, 2002b; Stampfer et al., 1988; Willett et al., 1987). Moreover, alcohol consumption could be related to an alteration in nutrient intake (Gruchow et al., 1985; Thomson et al., 1988). The caloric value of alcohol is about 7.1 kcal/g; it is considered to be a nontrivial source of energy, which could have an impact on a positive energy balance, and a long-term increase in body weight and an increase in obesity might result (Suter & Tremblay, 2005). Heavy alcohol consumers might take in 50% of their calories from alcohol (Bebb et al., 1971). It obvious that heavy alcohol consumption contributes directly to obesity and increased body weight (Gordon & Kannel, 1983; Wannamethee & Shaper, 2003).

There have been several cross-sectional studies suggesting that there is a positive relationship between alcohol consumption and weight gain (Fisher & Gordon, 1985; Kromhout et al., 1988; Lahti-Koski et al., 2002; Wannamethee et al., 2005). This positive relationship has also been found in cohort studies that examined this relation in the long term (Rissanen et al., 1991; Wannamethee & Shaper, 2003). There is a significant increase in weight gain in individuals who consume alcohol more frequently compared with less frequent consumers (Gordon and Doyle, 1986; Gordon & Kannel, 1983; Trevisan et al., 1987). The association between alcohol consumption (moderate and high) and BMI is very important because both alcohol consumption and obesity are related to disease risks (Stampfer et al., 1988; Willett et al., 1987). Alcohol consumption may be related to alterations in nutrient intake patterns (Gruchow et al., 1985; Thompson et al., 1988).

Over the past two decades, caloric intake has increased, and the consumption of beverages (Duffey & Popkin, 2007) and snacks (Nielson et al., 2002) accounts for the majority of this increase. Energy-yielding fluids, particularly beverages, are used extensively as snacks and meal replacements. In the USA, they represent about 25% of total energy consumption (Putnam & Allshouse, 1999). In addition, beverage intake has increased in conjunction with the growth in obesity (Bleich et al., 2009; Nielsen & Popkin, 2004; Woodward-Lopez et al., 2006). This parallel increase has directed great interest to the possible role of liquid calories in positive energy balance and increased body weight (Mattes, 2006; Mourao et al., 2007; Woodward-Lopez, 2011). Addressing patterns of caloric beverage consumption, especially in children and adolescents, are a

major objective for improving body weight treatments (Ludwig et al., 2001; Sanigorski et al., 2007). The consumption of sweetened beverages is likely to result in a negative effect on public health, which seems to support the proposal for a tax on sugar-sweetened beverages (Brownell & Frieden, 2009).

Actually, exaggerated caloric consumption has been associated with foods high in sugar, such as high-fructose corn syrup (HFCS) (Bray and Popkin, 1998; Elliott et al., 2002; Putnam & Allshouse, 1999; Young & Nestle, 2002). In the US the estimated consumption of HFCS and glucose syrup increased by about 11.6 times between 1966 and 2003 (Haley, 2004). In addition, sweet corn syrup accounts for nearly one-half of the caloric sweeteners consumed by Americans (Higley & White, 1991; Vuilleumier, 1993). Indeed, high soft drinks intake is correlated with increased weight and obesity (Malik et al., 2006), the likelihood of metabolic syndromes (Dhingra et al., 2007) and a higher risk of Type 2 diabetes (Malik et al., 2010; Montonen et al., 2007; Palmer et al., 2008; Schulze et al., 2004b).

High-calorie beverages do not impact food consumption during acute meal settings (Almiron-Roig & Drewnowski, 2003; Canty & Chan, 1991; DellaValle et al., 2005; Harper et al., 2007; Rolls et al., 1999; Tsuchiya et al., 2006); however, consumption of high-calorie beverages increases the total meal energy intake (Almiron-Roig & Drewnowski, 2003; de Castro, 1993; DellaValle et al., 2005). Beverages have a low satiety value, which could be because water was the only beverage consumed throughout human evolutionary history (Wolf et al., 2008).

The increased prevalence of being overweight or obese has coincided with the increased consumption of high-calorie beverages (soft drinks and fruit drinks), and the daily energy intake from sweetened beverages has increased by 222 kcal in recent decades (Duffey & Popkin, 2007). For example, in the USA there was a 278 kcal/day increase in beverage energy intake in the period 1999-2001 compared to in 1977-1978 (Nilson & Popkin, 2004). In adulthood, individuals tend to consume high-calorie beverages more than healthy diets (Duffey & Popkin, 2006; Popkin et al., 2005). According to Block (2004), soft drinks, which are the primary source of energy, represent approximately 7% of the total energy in the American diet, which means that every person consumes around 12.3 fl oz per day (Wolf et al., 2008).

Milk is considered a main source of energy and calcium (Cotton et al., 2004). It is rich in nutrients, but a high intake of milk can increase dietary fat, cholesterol, and energy consumption, which could lead to weight gain (Barr et al., 2000; Cotton et al.,

2004; Hollis and Mattes, 2007). Barr et al. (2000) found that increasing the consumption of skimmed milk (3/day) resulted in increased body weight among adults aged 55-85 years.

The Institute of Medicine's report presented a primary review of the advantages of water consumption (panel on dietary reference intake, 2005). The report mentioned that dehydration leads to the disruption of cognition, moodiness, weakness in thermoregulation, decreased cardiovascular function, and an imbalance in the ability to do physical work and an increased risk of bladder cancer (panel on dietary reference intakes, 2005). Popkin et al. (2005) suggested that water consumption is possibly a dietary component that could be enhanced. It has a role in a healthy diet because high consumption of water is linked to healthier eating patterns.

Increasing daily water consumption is acknowledged as being a beneficial strategy to decrease body weight in the general public (Dennis et al., 2009; Wallenghen et al., 2007). Two studies have shown decreased levels of hunger and increased levels of satiety when water was consumed with a meal (DellaValle et al., 2005; Lappalainen et al., 1993). Stookey et al. (2007) suggested that drinking water could enhance reduction in body weight in overweight women who are dieting; they found that overweight women who consume more than 1L of water per day successfully lost about 2kg of their weight compared with women who consumed less than 1L per day of water. Dennis et al. (2009) found that consuming about 500ml of water before each low-caloric meal (30 min) resulted in greater weight loss compared with consuming a low-caloric diet alone. This weight loss may be a consequence of the reduction in energy intake following water ingestion. Epidemiological studies have concluded that energy intake is significantly higher in non-water drinkers compared with water drinkers (Duffey & Popkin, 2006; Popkin et al., 2005; Wallegghwn et al., 2007). Therefore, a decline in energy density can be achieved by adding water to overall diets (Roll et al., 1999). A number of studies were reviewed by Daniels and Popkin (2010), who concluded that the consumption of water has a potential role in decreasing energy intake levels and thereby preventing obesity.

Stookey et al. (2007) suggested that drinking water instead of sweetened caloric beverages can help in reducing the total energy intake. In addition, there have been several studies that have shown the same results (Almiron-Roig & Drewnowski, 2003; Beridot-Therond et al., 1998; Canty and Chan, 1991; Davy et al., 2008; DellaValle et al., 2005; Engell, 1995; Hagg et al., 1998; Malik et al., 2006; Mattes, 1996; Poppitt et

al., 1996; Rodin, 1990; Van Wymelbeke et al., 2004). However, drinking water versus no beverage increases energy expenditure and lipolysis rates (Berneiset et al., 1999; Bilz et al., 1999; Boschmann et al., 2003; Keller et al., 2003).

In summary, most calories in liquid form are low in fibre and high in sugar. Moreover, the satiety power of sweetened beverages is weak, and this leads to heavy consumption. Liquid calories are empty calories, and people are not aware of the high calorie content of liquids when they consume sweetened alcoholic drinks.

In summary the former literature review lead to a collection of 10 health behaviours which are addressed and summarised in table 2.1.

**Table 2.1** Topical areas

	<b>Topic goal</b>
Topic 1	Decrease energy intake from foods rich in sugar, especially sweet and beverages
Topic 2	Increase intake of a variety of vegetables and fruits
Topic 3	Increase intake of food rich in fibre
Topic 4	Control intake of meat and processed meat, and improve awareness that these types of foods are high in salt, fat and sugar, which encourage overconsumption
Topic 5	Decrease intake of high energy-dense food and increase consumption of low energy-dense food
Topic 6	Reduce consumption of salty foods and improve awareness that processed, ready-made, and fast foods are rich in salt
Topic 7	Improve eating patterns by eating slowly and increasing chewing time, and increase awareness of food intake
Topic 8	Improve regularity of meal times (eating breakfast every day and preventing late dinners), and reduce eating between meals
Topic 9	Improve awareness of daily calorie needs to achieve weight loss, and improve knowledge about energy burned through exercise
Topic 10	Limit calories from alcohol and liquids, and increase awareness that consuming liquids increases total daily calories consumed

### **2.2.1.2 Identifying appropriate theories and models:**

Understanding why we eat what we eat is important from the perspective of the current obesity epidemic and has received much research interest. In the contemporary food-rich environment, an increasing proportion of eating is motivated by pleasure, not just by the body's energy-deficits (Lowe & Butryn, 2007). Thus, food choices are a complex process influenced by the interplay of multiple factors, including genetic, physiological, psychological, situational, social and cultural ones. An individual's experiences with foods are largely determined by cultural traditions, and culture and food availability have long been recognized as the most important determinants of food choices (see, e.g., Rozin, 2006). However, within a culture, various factors, such as food preferences, psychological attributes, social factors and economic resources, can explain the differences among individuals in their selection of food (Drewnowski & Shultz 2001; Locher et al., 2009).

The emphasis in the study presented in this thesis was on the psychological and behavioural factors affecting food choices and, consequently, weight changes. Interventions informed by psychological theories are necessary for behaviour change (Hardeman et al., 2000). Psychological constructs have been found to predict behaviour better than knowledge (Eccles et al., 2007). Knowledge-targeting interventions are less effective than those based on psychological theories. Theories provide an explanation for outcomes; thus, they are needed for intervention design (Michie et al., 2007).

In effect, A growing body of evidence suggests that theory-based interventions have been shown to be more successful in engendering behaviour change than those not based on theory and that some strategies that combine multiple theories and concepts have larger effects than those that do not (Legler et al., 2002; Noar et al., 2007). A recent review of online health behaviour interventions concluded that the more extensive the use of theory, the larger the effect (Webb et al., 2010). A systematic review of school health promotion interventions also concluded that use of theory differentiated between effective and ineffective interventions (Peters et al., 2009). Moreover, theoretical understanding of the processes involved also enables replication and adaptation of interventions to other settings. For these reasons, application of theory in health promotion practice and research is strongly advocated (e.g. IOM, 2002; NICE, 2007).

A number of psychological factors (e.g., beliefs and emotions) and environmental factors are involved in learning new behaviours and changing existing

behaviours. Theories or models provide an overarching framework for the psychological and environmental factors that explain behaviours to be targeted by an intervention. Theories can guide the search (a) to understand why people do or do not follow medical advice, (b) to help identify what information is needed to design an effective intervention strategy, and (c) to provide insight into how to design an educational program so it is successful. Thus, theories help to explain behaviour, as well as suggest how to develop more effective ways to influence and change behaviour (Lakshman et al., 2014). Interventions to improve health behaviour can be best designed with an understanding of relevant theories of behaviour change and the ability to use them skilfully (Bernstein, 1971; Glanz et al., 2008). No single theory or model dominates research or practice in health-related behaviour.

An increase in morbidity and mortality as a result of poor health-related behaviours has led to the development and subsequent use of behavioural models to predict behaviour as well as develop interventions that are geared at reducing behaviours that increase disease risks (Glanz et al., 2008). One of the most significant health-related behaviours is eating habits. Healthy eating behaviour is imperative for one to achieve optimal health (Chin & Mohd Nasir, 2009). Some of the models developed to explain changes in eating habits include Health Belief Model, control theory, the Theory of Planned behaviour, prime theory of motivation, and Self-Determination theory (Webb et al., 2010). The importance of understanding the theoretical underpinnings of behavioural interventions has been highlighted in previous research suggesting theoretical bases for combining behaviour change techniques within interventions to allow synergistic effects and enhancement of effectiveness (Dombrowski et al., 2012; Michie et al., 2009; Taylor et al., 2011; Webb et al., 2010).

#### **2.2.1.2.a Health belief model (HBM)**

The health belief model (HBM) views health behaviour change as based on a rational appraisal of the balance between the barriers to and benefits from action (Blackwell, 1992). According to this model, the perceived seriousness of, and susceptibility to, a disease influences individual's perceived threat of disease. Similarly, perceived benefits and perceived barriers influence perceptions of the effectiveness of engaging in healthy behaviour (Champion & Skinner 2008; Glanz & Bishop 2010). It derives from psychological and behavioural theories and includes two components of health-related behaviour: are (a) the desire to avoid illness, or conversely get well if

already ill, and (b) the belief that a specific health-related action will prevent or cure illness. Ultimately, an individual's course of action often depends on the person's perceptions of the benefits of and barriers to engaging in healthy behaviour. The model has been used successfully for many decades to promote healthy behaviours such as seat-belt use and the use of health screening (Becker 1974; Ghaffari et al., 2012). HBM is based on the premise that people are most likely to take health-related action (e.g., eat a healthy diet) if they feel that by doing so they can avoid a negative health condition. The model asserts that to plan a successful educational intervention, several things must be taken into account: the individual's or group's perceived susceptibility to illness (e.g., to obesity), perceived severity of the condition and its consequences, perceived benefits of taking certain actions to reduce risk, perceived barriers, and cues that lead to action.

We judged this model as useful for the design of an intervention to help participants to overcome their problematic body weight. In order for participants to perform the recommended diet commandments, we collected information that could raise their awareness and increase their perceived threat or risk of acquiring obesity or related consequences, such as Type 2 diabetes or hypertension. At the same time, we add further information to improve participants' knowledge, reduce barriers and explain the healthy benefits of following our recommendations. These were expected to increase the expectation of positive outcomes and improve participants' eating by helping them to adopt healthier eating habits. We believed that using HBM in the intervention would play an important role in achieving the study's aim. We assumed that if participants perceived a threat from obesity and obesity-related diseases, and they perceived that benefits from taking preventive action would exceed the barriers to change, then they would be able to change their negative eating behaviours, which might result in a significant reduction in their body weight.

#### **2.2.1.2.b Control theory**

Self-control is thought to underlie an impressive array of behaviour, and failure of self-control is believed to cause many problems in society (Baumeister et al., 1994). Control theory has its roots in the perpetual control theory and is generally in the class of 'feedback loop' models. The theory posits that a set goal serves as a 'reference value' in the 'control system'. The reference value acts as a point for assessing the rate of behavioural (input function). Control theory assumes that goals are ordered

hierarchically, from abstract to 'self-relevant'. They are also arranged from most important (e.g. 'I want to maintain a healthy body') to goals that lead to immediate gratification ('I want to drink a sugary drink'). Actions that are higher in the hierarchy related to 'higher level goals' (Webb et al., 2010). According to the theory, 'successful self-regulation' results from pursuing higher-level goals as opposed to lower-level goals. If the system detects that there is an action that has a negative value from the point of reference, the system signals the person to make a change (output function). An individual may take actions that either reduce the discrepancy, or he or she might fail to act in the right manner, further increasing the discrepancy. For example, an obese person may set a goal to lose weight by using a combination of dieting and exercise; if the individual sets a goal of losing four pounds in one month and fails at the end of the month, the individual will be compelled to examine how effectively he or she is adhering to the exercise and dieting regime and acts accordingly. The new action will be assessed in reference to the 'reference value', and the system cycles again, providing feedback or output in reference to the new behaviour or action (Webb et al., 2010).

There exist various studies that have investigated the applicability of this model to eating behaviour change. In most cases, the studies have concentrated on the notion that most people fail to set appropriate goals and therefore fail to meet their objectives. Michie et al. (2009) carried out a meta-analysis of the efficacy of control theory in eating behaviour change and found that the theory was effective in guiding the development of successful programs geared at changing eating behaviours. In addition, self-regulation techniques are postulated in control theory 'to work synergistically,' supporting the need for a multifaceted approach in creating interventions geared at changing eating behaviour. A study by Castle et al. (2012) on the efficacy of control theory in promoting fruit consumption among young people showed that although the intervention did not have an effect on perception of self-efficacy, other facets of control theory worked together to help change the eating behaviour of the young adults. This experimental study suggests that interventions developed by using the control theoretical framework are likely to succeed.

We identified control theory as a useful approach in designing the intervention to help participants to gain control over their food choices and decisions. The central tenet of control theory is that setting goals, monitoring behaviour, receiving feedback and reviewing relevant goals in the light of feedback are key to self-management and behavioural control (Atkins & Michie 2013). Indeed, the number of complex



behaviours and factors that were identified in the review could be used to build a complex behavioural structure, which could be used to facilitate different levels of control. Understanding self-control theory and its effects on eating behaviour might help explain overweight people's urges to eat, craving for food, and their impulsiveness. Moreover, we might find that people's ability to self-regulate and control their own behaviour improves with repeated practice over time.

#### **2.2.1.2.c The theory of planned behaviour**

The theory of planned behaviour (TPB) is regarded as one of the most influential behavioural theories. It is mostly used to predict whether or not certain behaviours will occur. Its main objective is to predict and understand behaviour and its causes. The theory, an off-shoot of the theory of reasoned action, posits that a person's intention is an 'immediate antecedent' or the most important predictor of a person's specific behaviour. Intention is operationalized as the person's motivation to behave in a specific way. Three factors affect a person's intentions; they include subjective norms, perceived behavioural control and attitudes. These factors are preceded by 'salient beliefs.' These salient beliefs include 'salient normative beliefs,' 'salient behavioural beliefs,' and 'salient control beliefs.' Salient beliefs are beliefs that are accessible to a person when he or she is asked open-ended questions about the beliefs (Castle et al., 2012).

With reference to behaviour, an attitude is defined as a negative or positive personal evaluation of a specific behaviour. A subjective norm as a social factor refers to perceived social pressure to adopt or disregard a specific behaviour. Subjective norms, a third tenet of TPB, address behaviours that are not controllable by volition. They refer to a person's evaluation of their ability to adopt and perform a specific behaviour. An attitude can simply be defined as how an individual positively or negatively perceives or evaluates a person, place, or an object. How attitudes are formed has remained an area of interest in many studies that pertain to attitudes. The process of attitude formation is impinged on by a number of psychological factors. For example, Fazio and Olson (2007) asserted that there are three processes through which attitudes can be formed, i.e. affect, cognition, and behaviour. One of the most significant ways through which attitudes are formed is through cognitive information (i.e. beliefs) regarding the attributes about the target. Information of the attributes of the target may arise from direct experience from indirect sources e.g. parents, friends,

and the media. According to cognitive theories of attitude, information is imperative in the formation of an attitudes. When an individual receives information about a person, place or object, they evaluate the information based on their perception of the person, place or object. Hogg & Cooper (2003) pointed out that the formation of an attitude is particularly based on whether an individual believes that the target has desirable/undesirable attributes, or whether the target will cause desirable/undesirable outcomes.

Fishbein and Ajzen's (1975) theory of reasoned action (TRA) is another theory that we drew upon to develop our intervention for overweight individuals. TRA is one of the models that emphasises the role of cognition in the formation of attitudes. TRA also distinguishes the three aforementioned components of attitudes, but it refers to them as attitudes, beliefs, and intentions. According to Fishbein and Ajzen (1975), an individual's attitude is dependent on that individual's cognitive structure. Weiner et al. (2003) explain that the TRA model of attitude formation is based on the assumption that humans are "rational and deliberate thinkers" who use information that they receive regarding a particular target in order to form their attitudes and their action towards it. The theory of planned behaviour seeks to examine the rational behaviour over which individuals have complete control. A meta-analysis of current literature shows there are studies that have sought to investigate the extent to which the theory can predict healthy eating behaviour. A study by Chan and Tsang (2011), for instance, found that attitude, perceived control, and subjective norms explained 45% of the variance in behavioural intentions. A study by Barberia et al. (2008) found a strong correlation between positive attitudes and the success of weight loss treatments. A longitudinal TPB study on the applicability of the theory in predicting college students' 'intention and self-perceived' behaviour to avoid taking high sugar snacks and drinks by Masalu and Astrom (2001) showed that perceived control was the strongest factor in determining their behaviour.

The theory was very useful in developing our intervention. It posits that a person's intention to adopt a certain eating behaviour increases if the person's attitude is positive. Thus, for any intervention aims to change behaviour, the program must seek to increase positive attitudes towards healthy food and behaviour and decreases negative attitudes towards unhealthy food and unhealthy behaviour. This is one of the principles that we used in our intervention.

#### **2.2.1.2.d PRIME theory of motivation**

The PRIME theory of motivation (West, 2006) provides a framework for conscious and unconscious motivational processes, in which more specific theories of choice, self-control, habits, emotions and drives can be integrated. The theory was developed as a synthesis of motivational processes from conscious decision-making through to classical and instrumental learning processes. It proposes five sub-systems making up the human motivational system. Going from most proximal to most distal in terms of moment-to-moment influences on behaviour these involve: (a) P = plans (self-conscious intentions plus commitment); (b) R = responses (starting, stopping or modifying actions); (c) I = impulses/inhibitory forces (which can be consciously experienced as urges); (d) M = motives (wants and needs); (e) E = evaluations (evaluative beliefs) (West, 2006). The components influence each other inside and outside of the motivational system and are influenced by the immediate internal and external environment. In terms of deliberate actions the core proposition of the theory is: ‘At every moment we act in pursuit of what we most want or need at that moment’. The motivational system can be changed by a range of processes, including associative learning, imitation, habituation, and inference. Identity is a particularly important source of motives and the source of self-control. Behaviour starts from reflexive responses; however, impulses, motives and evaluations allow flexibility to consider a wider range of factors (West, 2006). Contrary to other motivation theories, PRIME theory stresses the flow of behaviour on a moment-to-moment basis (West, 2006), which is not always predictable.

In our intervention, the motivation for changing eating behaviour was very important. It is clear that the motivation to change involves both reflective processes (i.e. self-conscious intentions and plans and the beliefs a person holds) and automatic processes (i.e. wants, needs and impulses). One’s intentions and plans can influence behaviour only if they generate sufficiently strong wants or needs at the relevant moment so that competing wants or needs can be overcome (West 2006). Looking at motivation and behaviour in this way allows us to understand why intentions often do not translate into behaviour. We might plan to eat a healthy meal and fully intend to choose salad rather than a burger in the canteen at lunch, but if there is a stronger competing desire, our intentions will lose out to these desires. We suggest that processes such as craving and implicit attitudes towards food tap into subconscious levels of

motivation, which might reflect an interaction between the automatic and the reflective system.

#### **2.2.1.2.e Self-determination theory (SDT)**

Self-determination theory (SDT) focuses on the extent to which self-determination affects human behaviour. Self-determination is defined as the degree to which a person acts as a result of personal choice. There are several motivational foundations that can both be intrinsic or autonomous and extrinsic or controlled. Behaviour arising from autonomous foundations leads to adaptive behavioural and psychological functioning. SDT also focuses on social-cultural factors and how they encourage or undermine a person's initiative or volition. The pivotal tenet of the theory is that people have inherent psychological needs that are considered imperative for integration and growth. The three needs are competence, autonomy, and relatedness (Webb et al., 2010).

The higher the degree of autonomy, the more a qualitative sophistication and characterization of motivation appears; the autonomy drives the promotion of behavioural change and its maintenance in the long run. Autonomy refers to psychological freedom in doing something or in adopting or disregarding a particular behaviour. The theory posits that satisfaction of a needs is related to individual actions. There exists a large body of research on the importance of satisfaction of a needs for health and wellbeing. Studies by Vansteenkiste et al. (2010) found a positive correlation between satisfaction of a needs and well-being. Leong et al. (2012) study on autonomous motivation in the facilitation of healthy eating habits shows that autonomous motivation can lead to the adoption of healthier eating habits.

Autonomy dictates the charting of one's way towards weight loss. For instance, people might feel that self-monitoring their diet helps keep them motivated, and they thus they start keeping a diary to monitor their eating habits. Another reason might be that the activity is interesting, i.e. the person has intrinsic motivation. The underlying principle is the whether the person has made a choice and can claim 'authorship' of the course of action related to changing the diet and controlling the weight. For dietary changes aimed at weight loss, if goals are internalized, there are a greater chance that the changed behaviour patterns will be maintained. Ownership of goals is more important than having them formed from external support or incentives. SDT allows long-term behavioural changes that lead to effective dietary changes and weight loss

(Silva, et al., 2011). In cross-sectional studies, autonomous motivation for healthy eating has been associated with healthier eating patterns (Pelletier et al., 2004; Pelletier & Dion, 2007). These findings are consistent with a body of research indicating that autonomous forms of motivation, such as intrinsic motivation, predict long-term adoption of healthy behaviour (Hagger & Chatzisarantis 2008).

In designing our intervention, self-determination theory (SDT) was beneficial as it uses 'internalisation' to bring about changes in behaviour that become more autonomously regulated and valued over time. Autonomous self-regulation is particularly important for health-related behaviours because the more autonomously regulated an individual is for a given behaviour, the greater effort, engagement, persistence and stability the individual is likely to have to make that behaviour occur. Autonomous motivation is based on how decisions and behaviours are influenced by personal endorsement and engagement, which are coupled by a sense of volition and choice. The concept is opposed to external pressure or manifestations of tension and motivation based on incentives. Whenever an individual embarks on a program to lose weight, he/she will have particular goals, but it is important to know what kinds of goals these are. The main aim of the self-determination theory is the prioritisation of specific goals. For weight loss to be effective, the feeling of autonomy and volition must be cultivated when a goal of weight is being pursued, so that the person feels effective and is challenged optimally. The feeling is intrinsic to the individual and is essential for behavioural persistence and personal wellbeing.

#### **2.2.1.3. Behaviour change techniques (BCTs).**

The aetiology of obesity is usually simplified as an imbalance between energy intake and energy expenditure over a long-period of time. However, there are several factors that affect this imbalance, such as psychological, social, physiological, environmental, and other factors, which cause the imbalance to be complex (Butland et al., 2008). For obesity treatment, it might be important to have a complex intervention targeting several causal factors. Many frameworks have been suggested to address some of the complexities. The Medical Research Council's (MRC) framework for developing and evaluating complex interventions originally published in 2000 and updated in 2008 has been recommended. Based on prior evidence and theory, a universal taxonomy of behaviour change techniques (BCT) used in behaviour change interventions (Abraham & Michie, 2008) was published. The taxonomy has linked the

BCTs with theoretical accounts of behaviour change: the information-motivation-behavioural skills model, theory of reasoned action, theory of planned behaviour, social-cognitive theory, control theory and operant conditioning (Abraham & Michie, 2008). BCTs are not confined to one theory, but instead, several theories might specify similar processes of behaviour change and hence imply the same BCTs (Table 2.2).

Table 2.2: behaviour change techniques (Abraham & Michie, 2008)

Technique	goals	theoretical framework	Type of technique
Provides information about behaviour health link	Give general information about behavioural risk	IMB	Information
Provides information on consequences	Gives information about the benefits and costs of action or inaction, focusing on what will happen if the person does or does not perform the behaviour	TRA, TPB, SCT, IMB	Information
Prompts intention formation	Encourages the person to decide to act or set a goal	TRA, TPB, SCT, IMB	Information
Prompts barrier identification	Identifies barriers to performing the behaviour and plan ways of overcoming them	SCT	planning
Provides instruction	Tells the person how to perform a behaviour and/or preparatory behaviours	SCT	teaching
demonstrates the behaviour	An expert shows the person how to correctly perform a behaviour	SCT	teaching
Prompts goal setting	Involves detailed planning of what the person will do, including a definition of the behaviour specifying frequency, intensity, or duration and specification of at least one context, that is, where, when, how, or with whom	CT	planning
Prompts review of behavioural goals	Reviews and/or reconsideration of previously set goals or intentions	CT	monitor
Prompts self-monitoring of behaviour	The person is asked to keep a record of specified behaviour	CT	monitor
Provides feedback on performance	Provides data about recorded behaviour or evaluating performance in relation to a set standard or others' performance,	CT	teaching
Teaches to use prompts or cues	Teaches the person to identify environmental cues that can be used to remind them to perform a behaviour	OC	teaching

Prompts practice	Prompts the person to rehearse and repeat the behaviour or preparatory behaviours	OC	teaching
Uses follow-up prompts	Contacting the person again after the main part of the intervention is complete		implementing
Fears arousal	Involves presentation of risk and/or mortality information relevant to the behaviour as emotive images designed to evoke a fearful response	IMB, TPB	information
Acts planning	Involves detailed planning of what the target will do	CT	planning
Relapses prevention	Planning how to maintain behaviour that has been changed.	Relapse Prevention Therapy	planning

#### **2.2.1.4 Intervention tools design**

##### **2.2.1.4.1 Intervention concepts:**

###### **2.2.1.4.1.a Goal setting**

The first step in improving self-control is setting goals. Goals are mental representations of future desired outcomes to which people are committed (Mann et al., 2013). Because goals refer to a future desired state that differs from the current state, goal setting can be thought of as a process that creates a discrepancy between what one wants to be like and what one is currently like (Inzlicht et al., 2014). According to Locke and Latham (2002), the aims or objectives of an action, such as achieving a particular standard of proficiency within a specific time frame, is referred to as a goal. There are four mechanisms that affect goals: (a) Effort and attention is directed toward goal-relevant activities and away from the ones that are irrelevant, (b) Lower and unrealistically attainable goals lead to poor performance than higher set goals and this indicates that goals serve an energizing capacity; (c) Persistence is impacted by goals whereby the most difficult goals result in prolonged effort; and (d) actions can indirectly be affected by goals through the discovery of task- related approach and knowledge. To achieve optimal goal attainment, these mechanisms assist individual to acquire the skills that will enable them to adjust their plans and actions (Locke and Latham 2002). Setting concrete and measurable goals within a time frame leads to superior performance because it allows for straightforward monitoring of goal-behaviour mismatches; it allows for the generation of feedback that provides information about the degree to which standards are being met. (Inzlicht et al., 2014).

In promoting physical activity and dietary behaviour change, goal setting is a key behavioural strategy among adults (Shilts et al., 2004). As revealed by Schnoll and

Zimmerman (2001), those participants who set goals to enhance the intake of dietary fibre ate 91% more fibre than the participants who failed to set goals. Butryn et al. (2011) suggested that during interventions for behavioural weight loss, participants are given particular goals, which can be measured easily. This measure may be a goal related to average calorie intake per day or number of minutes of physical activity per week. Regular goal setting in interventions for behavioural weight loss is essential in allowing the participants to work towards behaviour change instead of solely spotlighting weight associated goals (Nothwehr & Yang 2007).

In the self-regulation literature stated that goals may be set either internally or externally (e.g., Austin, 1989). By definition, goals are ideas about future states that the individual wishes to attain. However, it must be noted that goal attainment is a process rather than an end state (Bickhard, 2009). Goals vary on a continuum of specificity, such that some goals are more abstract than others (Carver & Scheier, 2001; Frese & Zapf, 1994; Gollwitzer, 1990; Powers, 1973). This hierarchical system ranges from lower-order goals to higher-order goals. Each of these distinct reference points operates within an independent self-regulatory feedback loop; more specifically, there is an individual self-regulatory process for each goal that is set (Mackenzie et al., 2012); see Figure 2.3. A lower-order goal might serve as a means to a higher-order goal or a higher-order goal could direct an individual's behaviour towards performing a subset of lower-order goals (Mackenzie et al., 2012).

#### **2.2.1.4.1.b Self-monitoring**

The next step in establishing and improving self-control is paying attention to discrepancies between goals and current behaviour (self-monitoring). These discrepancies alert people to the possibility that their goals are in jeopardy, and they might bring shifts in behaviour from routine to deliberate. People should pay attention to when they have failed to meet a goal, or when goal failure is likely. Attention to such failures can help individuals avoid future mistakes (Inzlicht et al., 2014).

According to Wadden et al. (2005), the most important component of behavioural interventions for weight loss is self-monitoring. It is the orderly observation and documenting of behaviours to guide individuals towards behavioural self-regulation (Bandura 2001; Wadden et al., 2005). For example, during behavioural weight loss programs, participants usually record number of calories consumed and their weight and physical activity in order to be conscious of their recent behaviours



(Foster et al 2005). This practice may help participants to realize patterns of which they are unaware, such as having a snack in the evening (Wadden et al. 2005).

It helps participants in setting goals appropriately to adjust their behaviours in advance so that they progress towards a desired health result or behaviour (Pearson, 2012). Numerous studies have indicated that participants who monitor their physical activity and diet stand a better weight loss control both short-term and long-term than participants who never monitor themselves (Butryn et al 2007; Helsel et al 2007; Wadden et al 2005). Helsel et al. (2007) observed the impact of self-monitoring on weight control. The participants were randomized to an abbreviated way of self-monitoring or a traditional exhaustive method of self-monitoring. The researchers discovered that the group of participants in the abbreviated method returned considerably more entries than those in the other method. Between the two groups, there was no major difference in weight loss, although loss of weight was linked to the number diaries completed (self-monitoring). Self-monitoring in weight loss enables an individual to realize how patterns or situations of physical activity and eating behaviours are connected to body weight. For that reason, individuals who are successful in losing weight and upholding weight loss usually shows more regular self-monitoring (Butryn et al., 2007); see Figure 2.3.

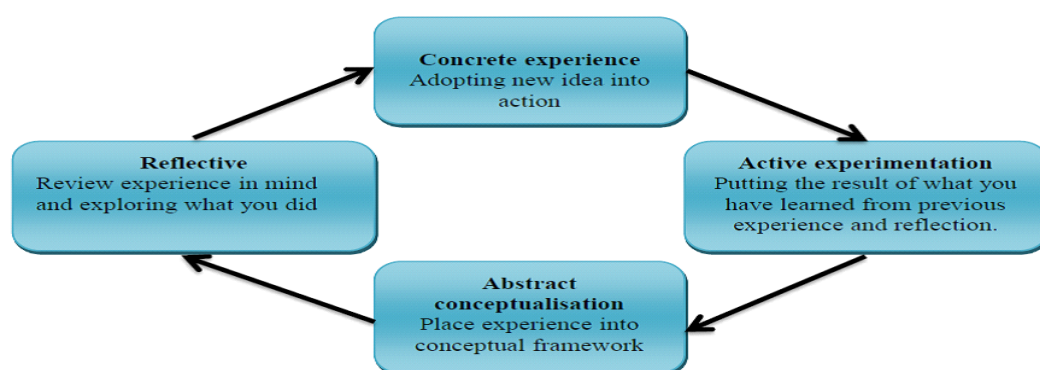
Self-control is improved when people acknowledge and accept their errors. The reason for this may be that the acceptance of errors increases people's ability to remain focused on their goals and to monitor further goal conflicts (Teper et al., 2013). By "acceptance," we refer to the open and non-judgmental ownership of mistakes. Acceptance of mistakes as learning opportunities (Dweck, 2006) predicts brain-based measures of conflict monitoring, which in turn improves self-control (Moser et al., 2011). This connection between acceptance and monitoring can explain the benefits of acceptance for self-control. It could be why overeating does not lead to further indulgence for dieters who treat their self-control mistakes compassionately (Adams & Leary, 2007). Thus, the more people respond to their self-control lapses with acceptance, the more they can objectively appraise and correct them.

#### **2.2.1.4.1.c Self-reflection**

In the literature, there are numerous definitions of reflection. For example, Boud et al. (1985) defined reflection as "a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to a

new understanding and appreciation”. Moon (1999) describes reflection as “a form of mental processing with a purpose and/or anticipated outcome that is applied to relatively complex or unstructured ideas for which there is not an obvious solution”. Reid (1993) stated, “Reflection is the process of reviewing an experience of practice in order to describe, analyse, evaluate and so inform about practice.” However, among the definitions there is a consensus that reflection includes critical thinking about knowledge and experiences in order to attain a deeper understanding (Mann et al., 2007).

In fact, reflective practice is not a modern notion. In 1983, the phrase “reflective practice” was first coined by Donald Shon, who suggested that being able to reflect on action is part of a continual learning process. Moreover, Kolb (1984) presented reflection as the second stage in the learning process (Figure 2.2).



**Figure 2.2** learning cycle (adapted from Kolb 1984)

Boud et al. (1985) considered reflection to be the core of effective learning, and Johns and Freshwater (2009) described reflective practice as a means of learning. Reflective practice presents a structure for transferring learning into practice (Duffy, 2009; Fealy, 1999). The ability to reflect on one’s practice represents an important element in improving learning and therefore having experience (Mamede & Schmidt, 2004). Learning is the outcome of doing (action) and thinking about what we have done (reflection). In other words, it is knowledge construction based on both action (experience) and thinking (reflection). Recently, reflective practice has been utilized in various sectors. Reflection is a fundamental element in the action research process (Reason & Bradbury, 2001), as well as a key element in learning theory (Kolb, 1984)

and in teaching and learning practice (Cruickshank, 1987; Grimmatt & Erickson, 1988; Munby, 1992; Pollard & Tann, 1993; Posner, 1985; Ross et al., 1993; Schon, 1987).

Schon (1983) stated that reflection can take one of two forms: reflection-in-action, which is more advanced, and reflection-on-action, which occurs after the experience. The second manner (reflection-on-action) is the most common manner of reflection (Somerville & Keeling, 2003). Reflective achievement can be greatly improved through experience, feedback, and the use of a framework or structure to guide the reflective process (Duffy, 2009; Levett-Jones, 2007; Mann et al., 2009). Several studies have highlighted the value of recording experience in written form, especially using a reflective diary (Tryssenaar, 1995; Zubizarreta, 1999). Some research on reflection has focused on determining the negative aspects of the behaviour (Grant & Grrene, 2003; Revans, 1998, 2011). Ciarocco et al. (unpublished data) had people experience an initial failure and then randomly assigned them to reflect on (a) what they might have done wrong, (b) the implications of the failure regarding themselves in general, or (c) task-irrelevant information (Baumeister et al., 2011). Only the first of these led to improvements in subsequent performance. Thus, conscious thoughts following failure affect how well one performs the next time. Bennett-Levy (2006) stated that a reflection system encompasses three principal components: (a) focusing on a problem, (b) the mental representation of that problem, and (c) a set of cognitive operations used in an attempt to resolve the problem.

#### **2.2.1.4.1.c.1 The importance of self-reflection in behaviour change.**

Self-reflection is a strategy that should be used to promote behaviour change. Behaviour is an important social construct because it has the ability to impact on how people are perceived, their social relationships, and other elements. Morris et al. (2012) indicated that behaviour reflects social standards. Individuals with behaviours that do not fall within the boundaries laid out by society are expected to change them so that they become aligned with social norms. In addition to the negative social influences of poor behaviour, there are also other negative effects associated with it. First, it interferes with people's abilities to create long-term goals, and second, poor behaviour may result in interpersonal conflict (Hofmann et al., 2008; Hardeman et al., 2000). Due to these negative effects, it is necessary for individuals to adopt behaviours that are not only socially acceptable but which also benefit them on a personal level. There are several strategies that can be used by individuals and one of them is self-reflection.

According to Grant et al. (2002), self-reflection is crucial for ensuring that individuals change their behaviours so that they become more socially acceptable and healthy. Self-reflection, in this case, refers to the process of introspection. It involves critically evaluating one's behaviour in order to understand it and determine the factors that drive it (Morris et al., 2012). In essence, self-reflection is believed to trigger a process through which individuals assess themselves and work on changing undesirable behaviours. Through reflection, people view themselves within the context of their experiences, which enables them to perceive the difference between their desired outcomes and present efforts (Johns, 2013). Continual thinking and reflection are believed to reduce the gap between theory and practice and may stimulate personal development (Argyris & Schön, 1974; Boud & Walker, 1998; Epstein & Hundert, 2002; Schon, 1983; Schon, 1987;). The more self-reflection an individual engages in, the more likely it is that he or she will be capable of changing negative behaviour into positive behaviour.

Baumeister et al. (2011) stated that conscious reflection can shape subsequent behaviour. Anseel et al. (2009) provided participants with feedback on from Internet-based work simulation task. Some were taught to go back and review their thoughts and actions, while others were not. The combination of reflection and feedback led to significant improvements in later performance. The proposition of individuals who need to change their behaviour using self-reflection is based on several tenets associated with its utilization. First, self-reflection is a way in which individuals can exercise self-control (Hofmann et al., 2008). Hofmann et al. (2008) indicate that some undesirable behaviours result from a lack of self-control. Self-reflection allows individuals to utilize their high-order mental operations which provide a fairly large and flexible degree of control over decisions and actions (Hofmann et al., 2008). This is also supported by Heimlich and Ardoin (2008), who suggested that self-reflection allows people to make conscious decisions. Reflection concerns critical thinking about people's experiences, actions, feelings, and responses and then analyzing them consciously with a view to learning from past experience (Atkins & Murphy, 1994; Kemmis et al., 1994). Thus, it requires a high level of mental functioning because we must consciously examine what we did, how successfully we did it, and what we can learn from it (Schon, 1991). As individuals engage in self-reflection, they engage in reasoning that allows them to establish feasible plans that they can follow in their day-to-day lives. In addition to

allowing individual to plan their actions, self-reflection also allows them to overcome the temptation to engage in undesirable behaviours.

Second, self-reflection supports motivational strategies that promote behavioural change. Colineau and Paris (2011) and Michie et al. (2011) suggest that motivation is a major determinant of behaviour. Self-reflection allows individuals to clearly perceive intrinsic motivating factors. As individuals engage in self-reflection, they set goals that they can achieve in the future, and they become motivated to achieve those goals. In this case, individuals feel motivated to set positive behavioural goals. Self-reflection allows people to evaluate their patterns of behaviour against set goals and supports the motivation needed to promote behaviour change. As individuals reflect on their actions, they are able to weigh the outcomes of their behaviours and choose to adopt positive behaviours that are intrinsically rewarding. Colineau and Paris (2011) suggest that although extrinsic motivation may be useful in supporting changes in behaviour, the positive changes achieved may be lost once the extrinsic motivator is removed. Based on SDT, individuals engage in an activity or performing a behaviour because of their internal factor and own sake rather than external factor, are more likely to sustain the activity/behaviour (Ryan & Deci, 2002). Self-reflection therefore supports more intrinsic motivation and, in turn, long-term behavioural changes.

Third, self-reflection supports cognitive changes that promote behavioural changes. Hofmann et al. (2008) stated that self-reflection supports the development of positive health behaviours based on its influence on cognitive processes. As individuals reflect on their actions, they analyse their belief systems and their thinking as it relates to behaviour. In other words, it supports the permanence of change by initiating changes at the starting point of behaviour. This is supported by Morris et al. (2012) and Rutter (2002), who indicate that behaviour is based on cognition. Self-reflection allows individuals to establish cognitive bases for their behaviours and, in turn, target changing them. The cognitive basis for behaviour is linked to motivation because people act on what they believe about specific behaviours and their capabilities and what they expect as outcomes (Morris et al., 2012). Reflective practice is more useful than thoughtful practice because it examines the shortcomings of performance. Thus, it likely creates learning, growth, and development through practice (Jarvis, 1992).

Self-reflection promotes the unlearning of negative health behaviours, and this makes it a strong base for the formation of positive behaviours (Colineau & Paris, 2011; Hofmann et al., 2008). Self-reflection is indirect because it does not entail telling people

to change their behaviours but rather supports individual efforts in the process of recognizing poor health behaviours and changing such behaviours.

In conclusion, learning is the outcome of doing (action) and thinking about what we have done (reflection). In other words, knowledge construction is based on both action (experience) and thinking (reflection). Self-reflection is a form of mental process (mental function) used to obtain desired outcomes. It relies on understanding the knowledge processes involved in the actions we perform. The main aim of reflective practice is for individuals to reflect on actions or behaviours that have been performed, thus allowing them to learn to improve future actions or behaviours. As individuals reflect on their behaviours, the previous behavioural plans that had been developed and supported poor behaviours are replaced by fresh behavioural plans that promote the appropriate behaviour. Self-reflection is highly useful in supporting behavioural changes among individuals. People who have routine unhealthy habits may change their behaviours when they undertake self-reflective processes.

#### **2.2.1.4.1.d Feedback**

An integral component of successful goal attainment is providing feedback at various time points through technological and personal methods (Locke & Latham, 2002; Strecher et al 1995). Participants require feedback and support with regard to accuracy and advancement relative to their goals and attainments, in order to promote changes in behaviour during interventions for behavioural weight loss. Participants can assess their efforts and accordingly alter their performance (Locke & Latham, 2002). Feedback has the capability of increasing self-monitoring adherence that may also improve goal achievement, see (Figure 2.3).

Burke et al. (2011) conducted a study to establish whether self-monitoring one's diet by the use of a personal digital assistant (PDA) only or a personal digital assistant with customized day-by-day feedback (PDA+FB) was better to use than a paper record (PR) at six months in a program for behavioural weight loss. They discovered that the individuals in PDA+FB had a considerable reduction in intake of energy and saturated fat and enhanced adherence to self-monitoring when contrasted with the ones using paper diary.

#### **2.2.1.4.1.e Reinforcement and motivation**

In the early phases of treating weight loss, tangible rewards can be very reinforcing for the participants such as receiving good wishes from others or being able to wear smaller clothes (Levy et al., 2007). Nonetheless, enthusiasm for healthy behaviours and involvement lessens as the treatment continues. For instance, self-monitoring adherence commences at a high level but drastically drops with time (Burke et al., 2011). In addition, only about eight percent of the participants who commenced the treatment of weight loss went through the whole process to the end (Wadden et al., 2007). Hence, ways that encourage the participants to maintain enthusiasm to carry on with health behaviours and remain involved in weight loss treatment are vital. In order to boost motivation and self-monitoring for behaviour changes, program for behavioural weight loss advocate that participants acquire sustainable changes that are small instead of large unrealistic changes via numerous goal setting (Wadden et al., 2005); see Figure 2.3.

As suggested by Self Determination Theory (SDT), an individual should feel that he/she is carrying out certain behaviours to better himself/herself and that they are motivated to carry on the behaviour on their own in order for that behaviour to be continued and maintained (Ryan & Deci, 2000). On the contrary, motivation that is controlled is linked to a need to comply with the feelings of pressure and anxiety that the individual has internalized or by outside unforeseen events such as incentives or anticipated negative results from behaviour (Deci & Ryan 1987). A limited number of studies have reviewed the motives of an individual for starting to attempt weight loss or the effect that initial motivation has on the outcomes of treatment. Motivation appears to play a vital role in weight-loss behaviours (Elfhag & Rossner 2005). Other studies have shown that the self-monitoring supports the autonomous reasons that the participant had to continue the treatment, which during the six-month weight control intervention, resulted in higher attendance and enhanced weight loss (Williams et al., 1996).

To initiate and continue with healthy behaviours among participants within the context of behavioural weight loss program, reinforcements and incentives have been used for encouragement. However, the approaches could be perceived by the participants as controlling; hence, their autonomous motivation to participate in the weight loss program would be undermined. The effect of incentives on motivation was initially examined by Crane et al. (2012). They investigated whether in a weight loss

program, autonomous versus controlled motivation differed between the individuals who were offered a financial incentive for losing weight compared to the participants who did not receive an incentive. For those participants who got an incentive after losing weight and the ones who did not receive any incentive, the same results were obtained. Data were analysed from 594 participants from Worksite Activities for You (WAY), which had been a worksite-based intervention trial for a year. The effects of a low-intensity weight loss program was compared to a similar program plus financial incentives (\$5.00 per percentage weight lost). During the study, the results between the groups demonstrated no significant difference. However, greater weight losses were connected to an increase in autonomous motivation. Autonomous motivation was not undermined, and the authors concluded that increases in controlled motivation did not result from the small incentives.

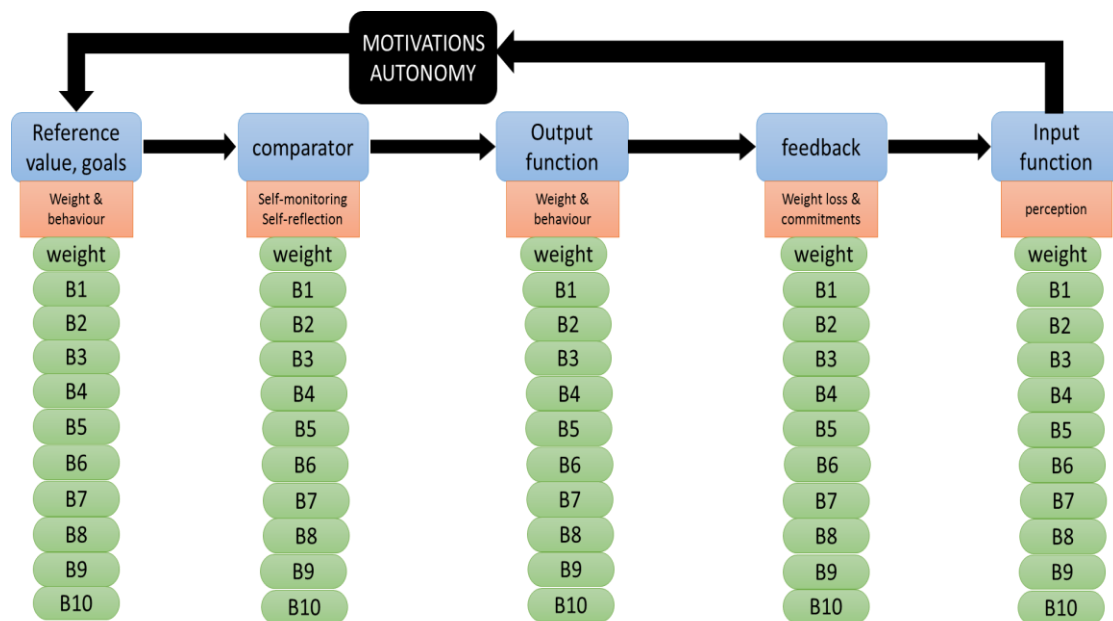


Figure 2.3: intervention concepts

Figure 2.3 explains the hierarchical organisation structure of goals (lower-level and higher level of goals). That is, in our intervention, the highest level goal was weight loss, and the lower levels goals were individual combinations of behaviours (1-10). The higher-level goal (weight loss) could be achieved through fulfilment of the lower level goals (commitment to the 10 commandments). In other words, attainment of the latter were requisite to—and intimately involved in—attainment of the former. Thus, achieving weight loss demonstrates why we need to commit ourselves to the ten behavioural commandments.



Weight loss and changes in eating behaviour are complex, and can be explained by hierarchies of a feedback loop. The hierarchical structure inherent in goal-related material helps individuals interpret and organize their eating behaviour in order to achieve significant weight loss. The “in-order-to” relation is an important factor in the hierarchical structure of goals as weight loss goals cannot be achieved before achieving necessary combinations of the eating behaviour. However, the lower level goals (commitment to commandments) are organised hierarchically and are based on individuals’ perception of barriers (e.g., someone might be more capable of reducing sugar intake than consumption of alcohol). At each level of the hierarchy, the results of the behaviour are presumably assessed by monitoring perceptual input information at the appropriate level of abstraction and by comparing it with reference values.

#### **2.2.1.4.2 Intervention tools:**

Previously we addressed the research areas that were included in our intervention. Now, we focus on what structure the intervention will have to have in order for the intervention to be accessible and usable to a wide range of intellectual abilities. It was imperative for us to provide the intervention tools in simple, short, colloquial language, and use an attractive design. Moreover, developing tools which integrate multiple behavioural change techniques and avoid time-consuming protocols which would need higher cognitive effort and time commitment might ensures that the intervention might affect food choices and lead to achievable, flexible but incremental changes in the eating behaviour. Thus, we decided to use 3 tools (laminated card, leaflet, compliance report) to address our interventional aims. The three tools are complementary to each other regarding their influence on eating behaviour and energy intake by combining the nutritional information with multiple behavioural techniques.

##### **2.2.1.4.2.1 Laminated card and leaflet:**

We intended to present the ten topics in the form of commandments form: both in long form as a written informational package (leaflet) and in slogan-like form (on a laminated card). We summarized our guidelines and other information on pages in a leaflet; each page contained the benefits of one commandment and its relationship to obesity. However, it was anticipated that slogan-like structures on a laminated card could be used as support for the reflective work and while shopping or eating. Because

they might be a useful tool to support the intervention, we produced a short version in the form of a laminated card. The two tools complement each other.

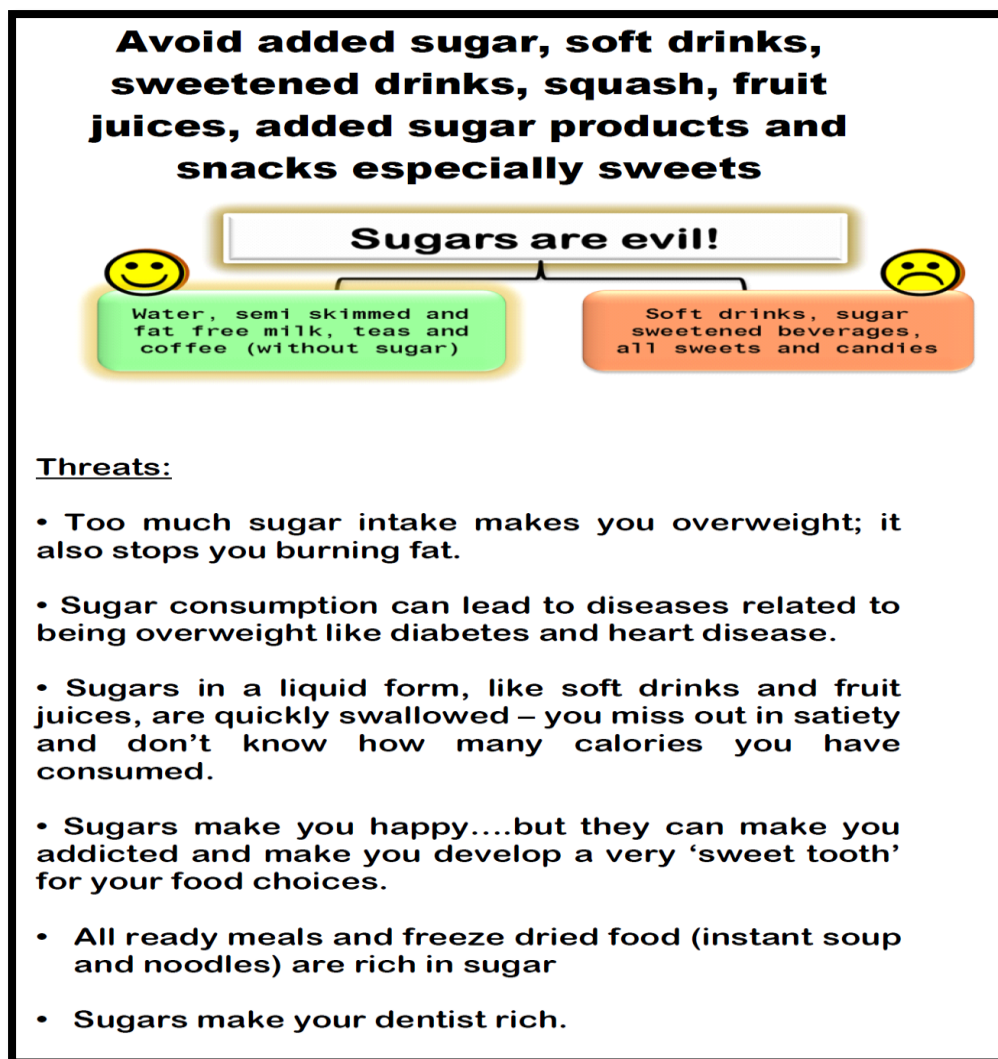
#### 2.2.1.4.2.1.a Leaflet

The leaflet contained the full version of the diet principles (table 2.3).

**Table 2.3** Commandment titles in leaflet

<b>Commandment titles</b>	
Topic 1	Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added sugar products and snacks, especially sweets
Topic 2	Eat at least half a kg of a variety of vegetables and fruits each day
Topic 3	Base your meals on fibre-rich foods
Topic 4	Eat fish and meat no more than twice a week
Topic 5	Eat food low in energy density
Topic 6	Choose low-salt products
Topic 7	Take your time and focus on your meal whilst eating
Topic 8	Have regular meal times
Topic 9	Be aware of your caloric needs and how much you eat
Topic 10	Limit calorie intake from alcohol and other drinks

It provided explanatory information regarding what the principles are and why they are important for weight loss and health. It consisted of ten pages (A6 size), with each page being related to one commandment. We also added a summary of the important health information related to healthy body weight in terms of threats, benefits, exceptions, and little helpers. We tried to render complex scientific information in simplified language to make it easy to understand. Also, we added a section on the laminated card that was related to each principle in order to simplify the process for the participants and make it easy for them to connect the laminated card and the leaflet. Figure 2.4 shows an example of the leaflet (for the complete form of the leaflet, see the appendix).



**Figure 2.4** an example of leaflet design

#### **2.2.1.4.2.1.b Laminated card**

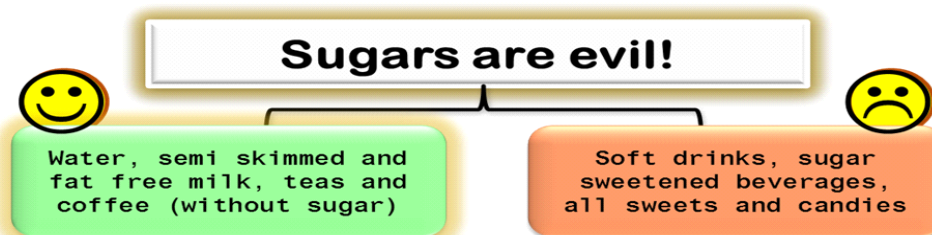
It is very important to have a tool within easy reach that could be used as a reference for our principles when making food choices. Thus, we decided to create a small laminated card into fit in a pocket, wallet, or handbag (A6 size). It contains a simple and short reminder of our ten nutritional principles. We used short memorable sentences (slogans) that could be easily planted in memory as a title for each commandment (Table 2.4).

**Table 2.4** Commandments title in laminated card

<b>Commandments title</b>	
Topic 1	Sugars are evil
Topic 2	Veg and fruit you need
Topic 3	Rich with fibres
Topic 4	Picky with the meat
Topic 5	Have a high with the low
Topic 6	Short of salt
Topic 7	Enjoy your food
Topic 8	Regular is better
Topic 9	Long ways to eat
Topic 10	No buzz with fizz

Cone (2008) defined a slogan as “a memorable phrase expressing an idea, purpose, or claim” (xiii). The main difference between the slogan and the body text is that the slogan appears alone (Fuertes-Olivera et al., 2007), which make it simple, easy to remember a product, and meaningful (Foster, 2001). Usually, slogans are short in length, written with three to five words (Dowling & Kabanoff, 1996). Slogans should be in a pivotal location and presented in a large font (Cone, 2008). Essentially, slogan can served as hooks or handles to capture the idea (Dahlén & Rosengren, 2005; Keller et al., 2008). In short, slogans should be memorable, simple, short, and meaningful.

We supported each commandment with two boxes: a green box to reflect a positive eating behaviour and a red box that provided examples of negative behaviours. Moreover, we added smiley and sad faces to green and red boxes, respectively, to confirm the notion of positive and negative behaviours. Figure 2.5 shows one commandment as an example (see the appendix for the entire laminated card content).



**Figure 2.5** sample of the commandment in laminated card.

Our choice of the red and green colours had a scientific basis. Colour classifications are perceptual classifications that are connected to the direct perception of colour stimuli (Belpaeme & Bleys, 2005). Colour classifications are identical across cultures (Belpaeme & Bleys, 2005; Regier et al., 2005). Colour conveys meaningful information that is relevant to how we think, feel, and behave (Elliot & Maier, 2007). Colour is a central component of primate vision; the perception of colour is crucial to scene identification, recognition, and visual memory (Gegenfurtner & Kiper, 2003; Hsu et al., 2011). It is believed that colours influence cognition and behaviour via their relevant meanings (Elliot et al., 2007). These meanings rely on learned associations and biological responses. The perception of the colour leads to an evaluative process that affects motivated behaviour. Colours that are often linked to negative associations, such as red, stimulate avoidance motivation, which means that individuals will become more aware of negative outcomes (Elliot & Maier, 2007; Elliot et al., 2007; Mehta & Zhu, 2009), which will thus make individuals more wary (Friedman & Förster, 2002, 2005; Koch & Holland, 2008). In contrast, colours with positive associations, such as green, may stimulate approach motivation, thus making individuals more aware of positive outcomes (Elliot & Maier, 2007; Mehta & Zhu, 2009). In this way, seeing a given colour is expected to stimulate a psychological response in accordance with its association (Soldat et al., 1997). Several studies have linked the red colour to dangers, mistakes, and the highest level of hazards (Braun & Silver, 1995; Williams & Noyes, 2007). In contrast, green is experienced as quieting, restful, and agreeable (Goldstein, 1942; Nakshian, 1964; Norman & Scott, 1952). Red is usually used to express avoidance information, while green is used to express positive information (Derefeldt et al., 2004; Moller et al., 2009).

We also added a smiley face and a sad face to the positive and negative boxes, respectively, as a support for the colours used. Rezabek and Cochenour (1998) stated that written communication can be supported by emoticons just as verbal communication is supported by body language (Braumann et al., 2010). According to Crystal (2001), “Written language has always been ambiguous, in its omission of facial expression, and in its inability to express all the international and other prosodic features of speech” (P. 38). Emoticons can give a written text an additional connotation or affirmation (Bódi & Veszelszki, 2006). Smiles and sad faces can thus reflect important information.

Subconscious stimuli (e.g. facial expression) can influence attitudes towards an object positively or negatively. Happy faces create positive attitudes, while negative attitudes are linked to sad and angry faces (Winkielman et al., 2005). Also, using face images (smiling and sad faces) has an impact on people's compliance. For instance, a study conducted in the US related to electricity use found that when face images were added to electronic bills to convey approval or disapproval of an individual's energy consumption, this had a meaningful effect. The study found a reduction in the energy consumption of people who received a sad face on their notice, while people who received a smiley face on their notice maintained their energy consumption level (Schultz et al., 2007). Studies have also illustrated that faces with a negative expression draw high levels of attention (Eastwood et al., 2003; Fenske & Eastwood, 2003; Zhang et al., 2005).

The importance of the laminated card is that it is small in size and the slogan-like versions of the commandments are made using a short memorable sentence, supported by healthy and unhealthy examples. The participants should have used it as a reference for their food decisions and shopping, which means that it should have a strong influence and direct their choices to healthy selections, curbing unhealthy behaviours. Additionally, the laminated card could be used directly after food intake as an analytical tool to determine whether the participants complied with the commandments or not, which ensures thinking about their consumed food, and may work as a warning tool to make them more aware of their next food decisions and choices.

Using this card every day, before and after food intake decisions, may create a positive and gradual change towards healthy eating. Additionally, this repeated daily cognitive analysis enabled the participants to improve their skills in filling out the compliance report at the end of each day (the third tool). The targeted behaviours and the used titles in leaflet and laminated card are presented in the table 2.5.

**Table 2.5** Targeted behaviour of the 10 commandments

	<b>Long version</b>	<b>Short version (slogans)</b>	<b>Targeted behaviour</b>
<b>B1</b>	Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added sugar products and snacks especially sweets	Sugars are evil!	Reduction of sugar intake
<b>B2</b>	Eat at least half a kg variety of vegetables and fruit a day	Veg and fruit you need!	Increase of fresh vegetable and fruit intake
<b>B3</b>	Base your meals on fibre-rich food	Rich with fibre!	Increase of fibre intake
<b>B4</b>	Eat fish and meat no more than twice a week	Picky with the meat!	Reduction of meat and fat intake
<b>B5</b>	Eat food low in energy density	Have a high with the low!	Reduction of high-calorie-density food intake
<b>B6</b>	Choose low-salt products	Short of salt!	Reduction of salt intake and ready meal consumption
<b>B7</b>	Take your time and focus on your meal whilst eating	Enjoy your food!	Reduction of intake velocity and increased awareness of food intake
<b>B8</b>	Have regular meal times	Regular is better!	Reduction of snacking and increased regular meal patterns
<b>B9</b>	Be aware of your caloric needs and how much you eat	Long ways to eat!	Awareness of an individual's caloric allowance and the understanding of caloric values (exercise conversion)
<b>B10</b>	Limit calorie intake from alcohol and drinks	No buzz with fizz!	Reduction of liquid calorie intake

#### **2.2.1.4.2.1.c Focus group**

Focus group interviews are becoming a popular method in health research for exploring study participants' beliefs, feelings and behaviours. They offer beneficial tools for including users in care management and strategy improvement needs, planning, and assessing the promotion of health and nutrition interventions (Duke et al., 1994; Kitzinger 1995; Richardson & Rabiee, 2001). The main purposes of the focus group interview are to learn about the perspectives, feelings and behaviours of participants with regard to products, and to explore their attitudes in a way that may not be feasible using other methods, such as one-on-one interviews (Kitzinger, 1995; Krueger, 2009). The focus group is a useful method when there are large differences between the participants and decision makers, and when one wishes to discover the degree of consensus on a particular issue (Morgan & Kreuger, 1993).

### **2.2.1.4.2.1.c.1 Methods**

Fifteen female volunteers were recruited for this focus group study, through advertisement boards and by word of mouth, as well as announcements in public places. We divided the participants into two focus groups. The moderated focus group interviews of 8 participants were conducted at the School of Sport, Health and Exercise Science, lasting one hour each. The moderator and assistant moderator were both researchers.

The participants who agreed to take part in the focus group were instructed to attend a short presentation of the research project before they signed the consent form. The main aims of the presentation were to give the potential participants a clear idea about the objectives of the project, and an overview about the developmental stages and interventional tools was provided. Moreover, the researchers listened to the focus group and realized the importance of their valuable opinions, which we were looking to simplify the project and ensure that all behavioural techniques used in the intervention were appropriate, and that our vision about the tools was correct. At the end of this presentation, we asked the participants about their willingness to join the focus group interviews, and to sign the consent form if they agreed to participate.

In the focus group interview, participants were reminded about our intentions, and they received a short explanation of the laminated card and leaflet. Then we discussed in general the idea behind these tools and participants' experiences with increased weight and weight loss. Following this introductory part, participants were guided and encouraged by the moderator to discuss their opinions and suggestions related to the tools:

#### 1-laminated card

##### a- Clarity in the meaning and wording:

- 1- What are your thoughts about the clarity of the diet commandments?
- 2- What are your thoughts about the negative and positive boxes under each commandment?

##### b- Appearance of the laminated card

- 1- Do you think the card size and lamination are suitable?
- 2- Do you feel the colour is bright enough? And is the font size readable with the colour selected?



## 2-leaflet

a- explanatory statement

- 1- Do you think that benefits of behaviours are well reflected in the explanations and is the wording clear?
- 2- Do you think that it complements the diet commandments on the laminated card?
- 3- Do you think that I need to add or remove some information on the leaflet?

During each focus group meeting, the moderator probed participants' responses and encouraged all members to participate. The assistant moderator took detailed notes and provided a summary at the end of the meeting, invited further discussion and elucidation of any misunderstandings with the participants. An audio-recorder was used.

### **2.2.1.4.2.1.c.2 Data analysis:**

An inductive approach to the qualitative analysis was employed, applying methods described by Krueger and Casey (2000). Following each focus group, and before transcription, a written summary was made independently by the assistant moderator. As advocated by Pope et al. (2000), systematic content analysis of the data from the focus group transcripts occurred concurrently with data collection in order to improve moderation techniques and maximize the information gained. The moderator read and re-read the discussion transcript in detail, identifying different meaningful responses that emerged regarding each concrete questions by highlighting sentences relevant to the intervention' tools (the leaflet and laminated card) (Debus, 1988). These quotes formed the basic meaning units for analysis, which were categorized through a process of comparing and contrasting. Preliminary themes were then identified in order to organize and understand the data (Scanlan et al., 1989).

### **2.2.1.4.2.1.c.3 Results**

Fifteen females aged 18-60 participated in two focus groups. Most of the participants were overweight or obese; however, a few were not struggling with a weight issue. As the main aim of our focus group was to determine the clarity of the intervention tools (leaflets and laminated cards) with regard to shape, size, colours and

language, we thought that there was no need to confine the focus group on obese and overweight individuals even if they would be the target of the intervention.

Identified concepts and ideas were represented in the main questions, thus the findings were integrated for analysis. Analysis of the two focus groups' data did not reveal any concepts or ideas additional to the original analysis, suggesting that theoretical saturation had been reached. However, these data allowed further development of the intervention tools through clarification of the existing tools. The following sections emerged from the analysis.

#### **2.2.1.4.2.1.c.3.a Laminated card:**

There was a general consensus on the clarity of the laminated card. They liked the slogans and they mentioned that it reflected the full commandments in the leaflet.

FG 1, P 5: "I liked it...the bold heading draws attention"

FG 2, P2: "Yah...it is eye catching"

Some of participants noted that the type of the font style in the slogan might need to be changed for clarity.

FG 1, P3: "It's clear, I think the font..[ ], over than that is fine."

FG 1, P 5: "I know it sounds silly but the font may be because (letter I) is not very clear on the whole thing"

FG 2, P 7: "I think it's fine. It's just the font itself (the issue)"

Additionally, some participants did not like the slogan "sugars are evil".

FG 1, P 1: "I don't think sugars are generally bad, it just depends on the type of sugar"

FG 2, P4; "Artificial sugars are obviously bad but natural sugars, in small dosage, wouldn't be so bad"

FG 2, P5: "They are good for training"

When it came to the colour of the boxes, and smiling and sad faces which we used to guide the participants to positive and negative behaviours, they mentioned that the idea was clear and they found the colour and face expressions to be meaningful.

FG 1, P2: "I think colours are fine....they stressed good and bad"

FG 2, P1: "I liked that you had a positive and a negative so you knew what should do and what you shouldn't"

Moreover, they frequently indicated that the size of the laminated card was appropriate for their handbags and easy to look at in the supermarket.

FG 1, P 7: "Yeah..it is fine"

FG 1, P 4: "I think it's big enough"

FG 2, P3: "It looks nice, and the size is good"

FG 2, P5 "It's good for wallets"

#### **2.2.1.4.2.1.c.3.b Leaflet:**

The majority of the participants mentioned that the leaflet was easy to understand, and they liked the idea of adding benefits and threats to some commandments.

FG 1, P 5: "I find it quite clear; easy to understand"

FG 1, P 6: "Yah.. it is clear I liked the font of the leaflet"

FG 2, P 6: "I find the idea of threats and benefits in some pages good"

They often stated that adding the laminated card images, which related to each individual commandment in the leaflet, made it easy to find the connection between the laminated card points and the leaflet. However, some participants mentioned that they preferred more explanations for some commandments to make them easier for the reader, for example.

FG 1, P 8: "Somebody might not know what high energy food is. May be have an example of how we calculate the food density"

FG 2, P 5: "Long ways to eat calculation is actually quite easy to do, but may be add an example shows how to work it out"

Finally, they indicated that we should remove the abbreviations (BMI, T2D) and correct some.

FG 1, P 8: "Sorry! It's not clear for me; what is BMI"

#### **2.2.1.4.2.1.c.4 Outcomes**

With the exception of the comments on "sugars are evil", which was decided to be important especially because it was controversially received, we produced the final version of our tools: leaflet and laminated card (see Appendix).

### 2.2.1.4.3 Reflection process

#### 2.2.1.4.3.a Reflection tools (daily compliance sheet).

Compliance sheets were used to reflect on participants' compliance with each of the 10 commandments. The reflective process consisted of two steps. First was a daily homework exercise in which, during meals, participants were asked to visualise which commandments they were breaking and which they were following. At the end of the day, participants reflected on their eating behaviour and effort throughout the day using the daily non-compliance sheet. They had to think about ways to avoid possible non-compliance events in the future. They ticked boxes describing their non-compliance, prompting analysis of their eating behaviour and commitment to the commandments (Figure 2.6).

- \* You need to fill in the reflection sheet before you go to bed
- \* Read the leaflet and plastic card carefully before you starting answer the reflection sheet
- \* Focus on the various commandments levels while reflecting about your day
- \* Remember your food intake and choices, read available food label with nutritional information
- \* Visualize which commandments you have broken and which you have followed
- \* Be aware that you may break several commandments with some types of food and drink
- \* Analysis your energy behaviour and shopping using the leaflet and plastic card
- \* Put (×) into the form for every commandment you have broken
- \* You may break one or other commandment overtime, don't dishearted by this

**Accuracy data is important**

When you ready;

**Could you, please, put a tick (√) if you have complied with the commandment and a cross (×) if you have not complied with the commandment**

	Days														Sum of (×)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Sugars are evil!															
Veg and fruit you need!															
Rich with fibres!															
Picky with the meat!															
Have a high with the low!															
Short of salt!															
Enjoy your food!															
Regular is better!															
Long ways to eat!															
No buzz with fizz!															

\* think about the non-complied point (×); why they happened  
\* have an eating plan for tomorrow

**Figure 2.6** compliance sheet

Note that the guidance (bullet point) in the reflection form is just a reminder. Participants have received a training reflection session containing two examples for a healthy and unhealthy meals and how they use the leaflet and laminated card to perform the reflection process (see training session section).

#### 2.2.1.4.3.b Reflection tools (Bristol online surveys).


The second step was to summarise their compliance over 14 days by answering a short questionnaire about the number of days on which they did not comply with individual commandments. Participants were approached via email. They then accessed Bristol Online Surveys (BOS) to fill out the electronic version of the 14 days non-compliance report (Figure 2.7).

How many days did you NOT comply with the following diet commandment in the last 14 days:

**Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added sugar products and snacks especially sweets**

○ 0   ○ 1   ○ 2   ○ 3   ○ 4   ○ 5   ○ 6   ○ 7   ○ 8   ○ 9   ○ 10   ○ 11   ○ 12   ○ 13   ○ 14

**Sugars are evil!**

 **Water, semi skimmed and fat free milk, teas and coffee (without sugar)**


 **Soft drinks, sugar sweetened beverages, all sweets and candies**

Figure 2.7 Bristol online surveys

The major aims of the non-compliance sheet and on-line report were: to support the reflective process, make them aware of their daily eating choices, monitor their progress, and to support the repetition of reflecting on their eating behaviour each day, which was intended to facilitate positive habit formation.

#### 2.2.1.3 Modelling process and outcomes

We linked behavioural determinants causally through behaviour to physiological variables and health outcomes, using a causal modelling approach suggested by Hardeman et al. (2005). Process and outcomes measures were mapped onto the causal pathway (Figure 2.8). The study outcomes assessed the effects of the

intervention on body weight measures, attitudes towards food, levels of food craving and improvement in obesity-related health risk. Changes in weight, BMI, body compositions, blood analysis highlighted improved health status outcomes. We identified changes in attitudes towards food and food craving that might determine improvement in the psychological measures.

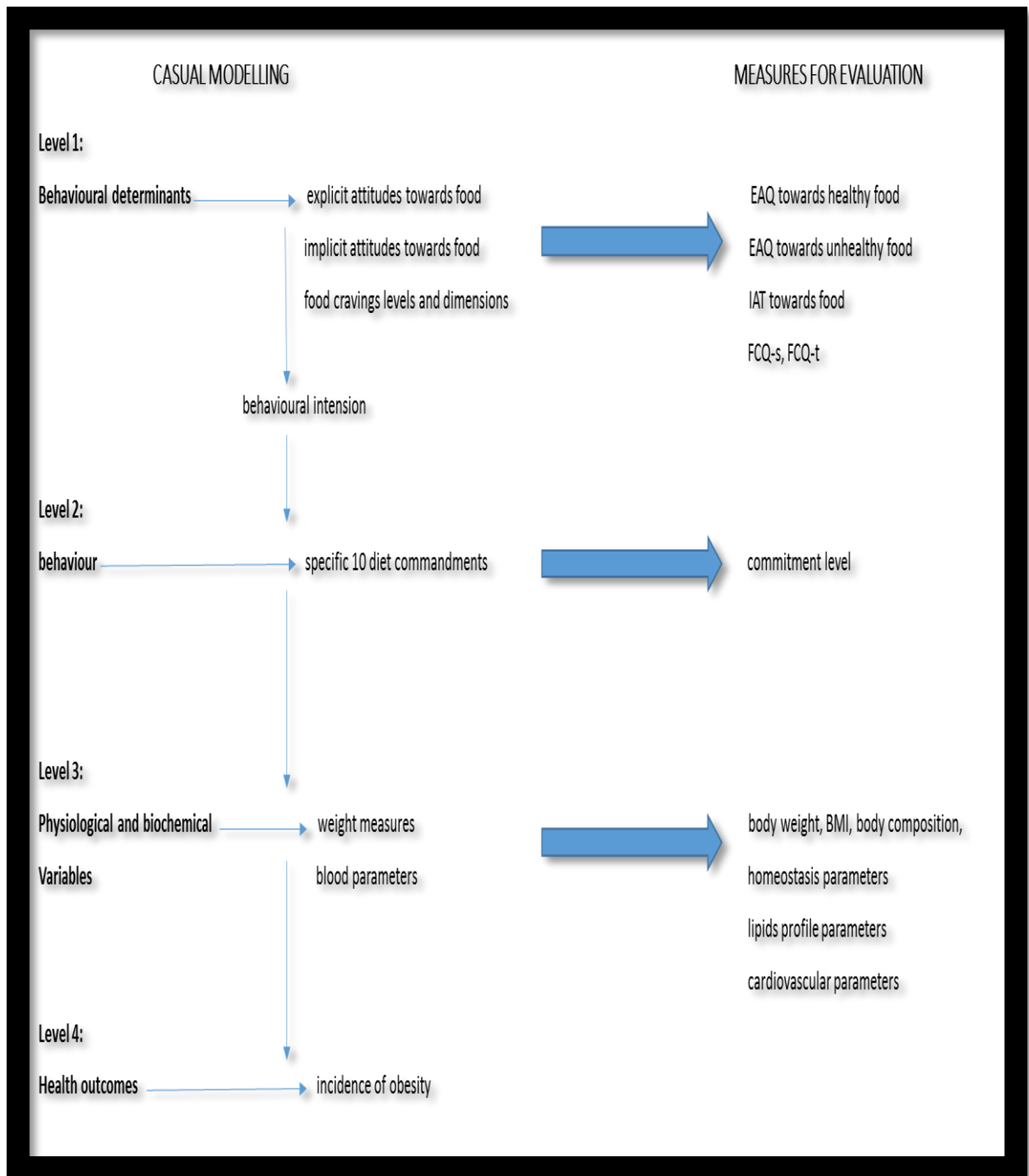


Figure 2.8 the causal pathway

The study focused on potential methods to improve long-term eating behaviour and enhance control over eating and food decisions and choices in overweight/obese individuals in the general public. The evidence base and theoretical findings informed the design of the new weight loss intervention that used reflective processes and 10 commandments based on current knowledge about nutritional and behaviour factors, and on eating behavioural strategies which are known to be beneficial for weight loss. The intervention was specifically designed to simplify and manage the changes in eating behaviour to what is healthy, establish a new healthy eating behaviour, raise awareness and knowledge about healthier eating and gradually build a strong basis for making healthy food choices and decisions. The intervention attempted to help the participants in terms of making wiser food choices and improving the ability of obese and overweight individuals to assess their food decisions and eating behaviours. The intervention structure was based on integration of the current nutritional/eating behavioural knowledge with techniques which are well-documented among the behaviour change literature and using reflective processes in daily eating behaviour. This combination guided us to produce three interventional tools (leaflet, laminated card and compliance report).

Potential participants (obese and overweight females) were invited to attend a training session, which was held a week prior to the expected starting date and aimed to enlighten participants about the nature of the study and familiarize them with the study' tools and guide them to the correct way of using the tools to achieve maximal benefits from the intervention. At the beginning of this session, they were introduced to the newly developed weight loss intervention and listened to a presentation related to our weight loss intervention tools. They were informed about the aims of our study, the development stages of the intervention tools, how the tools were designed, the object of every tool, and more precisely, how they should be used. Firstly, they received the leaflet and were asked to read through it. Then, they were informed about the aims and objectives of the leaflet in particular explaining the connection of long form of the commandments and health information in the leaflet. We tried to present this information in colloquial language to make it easier to understand. They were informed that the leaflet contained the long form of our commandments, and that each page of the leaflet was related to one commandment. The leaflet provided explanatory nutritional information about what the commandments were and why these were important for weight loss and health.

Secondly, the participants were given the laminated card and informed that the represented a concise copy of the leaflet. We explained that each slogan commandment reflected each original commandment; however, they were informed to always connect the slogan with the original (full) commandment in the leaflet. The participants were instructed to try to memorize the slogan versions of the commandments, and link these to the main information about them in the additional leaflet. They were also told that the green and red boxes, and smiley and sad faces under each slogan were a reflection of the examples of positive and negative behaviour. Additionally, they were told that they should think of more examples from their eating behaviours and link them to the positive and negative boxes based on the information in the leaflet and slogan-like versions. They were informed that the laminated card was made in a small size to enable them to carry it in a handbag, wallet or pocket to support them while shopping and eating. They were instructed to use the laminated card as an analytical tool for their eating behaviour and their compliance with the commandments after each meal.

Thirdly, regarding the compliance report, the study participants were instructed to fill out this form at the end of the everyday before they went to bed. Before they began to fill out the compliance form, they were instructed as follows:

- \* Read the leaflet and understand the underlying background of each commandment and why it is important for your health, and especially for your body weight.
- \* Read the laminated card and connect the slogan-like version to the full commandments in the leaflet.
- \* We assume that you, now, can remember all of the commandments' slogan versions on the laminated card.
- \* Remember that some commandments having different levels.
- \* Visualize your food intake and eating behaviours during this day, and how you are connected to the commandments.
- \* The compliance report is a summary of your compliance with the commandments supposedly done after each meal, by using the laminated card.
- \* Remember that eating one kind of food may lead to breaking more than one commandment, such as consuming sweetened beverages.
- \* Remember some commandments require looking into the whole food intake of the day, such as which foods are related to their daily caloric allowance.
- \* Have a plan for tomorrow's shopping and think about what you will eat.



To ensure that our intervention was completely understood by the participants, we used an example of one day of food intake, and how one can analyse the energy intake to find the compliance level with the commandments. Moreover, we gave the participants two examples of meals and asked them to write their compliance report. Each participant was asked individually to fill out the compliance report and explain his/her report to the researcher (see Appendix).

Describing the core components of an intervention helps to communicate its active components and increases the likelihood that it is replicable (NICE 2007; Michie & Johnston, 2012). Also, it is important to specify the reason why a given action in an intervention is expected to have a particular outcome (Campbell et al., 2000; Campbell et al., 2007; NICE 2007). In order to address these issues the intervention was described in terms of behavioural change techniques (Abraham & Michie, 2008). The following paragraphs are related to explaining the connection between the behaviour change techniques (BCTs) and our intervention tools.

**BCT 1:** Provide information on consequences of behaviour in general and information about the relationship between the behaviour and its possible or likely consequences in the general case.

Our leaflet explains the negative and positive consequences of health behaviours related to the particular commandments in precise statements with references to scientific work. The laminated card contains additional examples to enable subjects to connect possible food choices to the commandments and possible behavioural outcomes via the link between the short form on the card and larger explanations in the leaflet.

**BCT 2:** Provide information on the consequences of behaviour to the individual and information about the benefits and costs of action or inaction for the individual or tailored to a relevant group based on that individual's characteristics. This might include any costs/benefits and not necessarily those related to health, e.g. feelings.

The benefits and costs for the individual have been addressed in individual meetings – once a month where the participants came to be weighed and their individual problems and barriers for the individual health commandment being addressed.

**BCT 3:** Provide normative information about others' behaviour. this involves providing information about what other people are doing i.e. indicated that a particular behaviour or sequence of behaviours is common or uncommon amongst the population

or amongst a specified group. Presentation of case studies of a few others does not constitute normative information.

In the weighing sessions participants have been informed about the success of people taking part in the study and their weight loss.

**BCT 4:** Through goal setting (related to behaviour), the person is encouraged to make a behavioural resolution (e.g. take more exercise next week). This is directed towards encouraging people to decide to change or maintain change.

The participants were encouraged to set goals individually in terms of their circumstances (social, environmental, emotional) with respect to the ten commandments. The idea was for them to achieve flexible goal setting, which would enable them to experience achievements and improved planning for the next day/s. This would match their predicted circumstances and capability to follow commandments. For example, at a social event or while having dinner with friends, many commandments are broken inadvertently but if this is expected and included in the strategy for the next days it may not lead to frustration with accomplishing the task. The goal setting procedure was taught during the training session and discussed during weighing sessions. Participants could also ask questions between sessions via phone or email.

**BCT 5:** Through goal setting, the person is encouraged to set a specific goal that can be achieved by behavioural means but the outcomes of which was not defined in terms of behaviour (e.g. to reduce blood pressure or lose/maintain weight), as opposed to a goal based on changing behaviour per se. The goal, however, might be an expected consequence of one or more behaviours [see techniques (Goal setting – behaviour) and (Action planning)]. This technique might co-occur with the technique about setting goals for both behaviour and other outcomes.

Outcome related goals were discussed individually in the weighing sessions, and included such topics as whether or not participants were happy with the weight lost and how much they wanted to lose in the future.

**BCT 6:** Action planning involved detailed planning of what the person would do, including, as a minimum, when, in which situation and/or where to act. ‘When’ might describe frequency (such as how many times a day/week or duration (e.g. for how long). The exact content of action plans might or might not be described. The technique would be coded if it is stated that the behaviour is planned contingent on a specific situation or set of situations, even if exact details are not given.

Participants used the laminated card and commitment form to plan their future behaviour for complying with various sets of the commandments on a day-by-day basis. The commitment forms always included an analysis of the outcome of having planned a 14 day period. The participants would be able to self-monitor, analyse and plan ahead for the next 14 days maximally. Action plans could therefore be structured according their capability to foresee their circumstance in the time frame of 14 days. Planning strategies and the use of the tools (laminated card plus commitment form) were explained during the first training session and questions answered individually in the weighing sessions.

**BCT 7:** Barrier identification/problem solving is carried out as an initial plan for changing the behaviour. The person is prompted to think about potential barriers and to identify the ways of overcoming them. Barriers might include competing goals in specified situations. This might be described as ‘problem solving’. If it is problem solving in relation to the performance of a behaviour, then it counted as an instance of this technique. Examples of barriers may include behavioural, cognitive, emotional, environmental, social and/or physical barriers.

Support for barrier identification and problem solving has been achieved by the training practice where participants being informed that they need to plan and set their goals flexibly depending on expected barriers which might be related to situation/circumstances where they can’t show commitment to some of the goals. Consequently, participants should have various planning strategies for situations such as shopping, social events and the work place. Moreover, problem solving was facilitated by giving positive choices on the laminated card for finding alternatives for enhanced commitment to comply with the commandments. For example, people who go out for dinner knowing that they will drink alcohol on this occasion could chose a healthier meal and could avoid ordering a dessert.

**BCT 8:** Setting graded tasks involves breaking down the target behaviour into smaller, easier-to-achieve tasks which would enable the person to build on small successes in order to achieve the target behaviour. This might include either increments towards target behaviour or incremental increases from baseline behaviour. NB: The key difference between technique BCT 7 (Action planning) and BCT 8 lies in planning to perform a sequence of preparatory actions (e.g. remembering to take one’s gym bag to work), task components or target behaviours which are in a logical sequence or increase in difficulty over time as opposed to planning ‘if-then’ contingencies of

when/where to perform behaviours. General references to increasing physical activity as an intervention goal are not examples of this technique.

In contrast to other interventions, we emphasized that the goal of commitment to the commandments can be flexible and adjusted to circumstances, the environment and one's mood status (e.g. while in a training session or a weighing meeting). The concept of selecting out of a set of health behaviours and guidelines towards the goal of weight loss enabled the participants to set graded tasks and to use the commitment forms to visualize their progress in complying with the commandments over 14-day periods. This enabled them to see their successes (commitment and weight loss) in the context of their past commitment to the ten commandments. Focussing on a particular behaviour also enabled the participants to see small successes even if the commitment was to an easier goal. The laminated card and commitment form facilitated their choices and their monitoring of success. Their progress reports were also discussed in the weighing meetings in order for them to be reinforced for setting graded tasks.

**BCT 9:** Prompting review of behavioural goals involves reviewing or analysing the extent to which previously set behavioural goals (e.g. take more exercise next week) were achieved. In most cases, this follows previous goal setting (see BCT 5, 'goal setting-behaviour') and an attempt to act on the goals, followed by a revision or readjustment of goals, and/or means to attain them. NB: we also check whether there was any instance that also involved other techniques (goal setting – behaviour), (barrier identification/problem solving), (set graded tasks) or (prompt review of outcome goals).

Review of the behavioural goals was achieved by two strategies; firstly self-monitoring using the commitment form and laminated card enabled the participants to review their achieved goal directed behaviours over the period of 14 days when they needed to report the number of days committed to the various and to review their ongoing process over the 14 days while filling in the forms each day. 14-day periods were selected to enable them remember events which might have been critical for their success or failure. It was not expected that people could remember earlier events related to their eating behaviour. Secondly, weighing sessions were used to discuss their recent commitment (previous 14 days) and long-term commitment (the entire period of the intervention).

**BCT 10:** Prompting review of outcome goals involves a review or analysis of the extent to which previously set outcome goals (e.g. to reduce blood pressure or lose/maintain weight) were achieved. In most cases, this follows previous goal setting

(BCT on goal setting-outcome) and an attempt to act on those goals, followed by a revision of goals, and/or means to attain them. NB: we checked that any instance did not also involve techniques (goal setting – outcome), (barrier identification/problem solving), (set graded tasks) or (prompt review of behavioural goals).

Review of outcome goals were performed monthly in the weighing sessions and where weight loss and body composition changes have been recorded and discussed in the context of former values. Future expectations in weight loss were discussed for achieving realistic expectations about weight changes. Additionally, weight outcomes were discussed in relation to commitment performance.

**BCT 11:** Rewards are prompting contingent on effort or progress towards target behaviour. This involves the person receiving praise or rewards for attempts to achieve a behavioural goal. This might include efforts made towards achieving the behaviour or progress made in preparatory steps towards the behaviour, but not merely participation in the intervention. This could include self-rewards.

Weighing sessions were used to praise participants for achieving weight loss and to address reasons why weight loss might be below the targeted outcomes (if needed); encouragement was given to enforce commitment towards goals.

**BCT 12:** Prompting generalisation of target behaviour occurs once behaviour is performed in a particular situation. The person is encouraged or helped to try it in another situation. The idea is to ensure that the behaviour is not tied to one situation but becomes a more integrated part of the person's life that could be performed at a variety of different times and in a variety of contexts.

Throughout the intervention participants were encouraged to extend their commitment to an increasing number of commandments and interactions between behaviours. This was explained in the training session as well as in the weighing session in order to increase successful commitment success. For example, knowledge about macronutrient composition is difficult to achieve with take-away meals. This automatically leads to a breach of several commandments but could be avoided by cooking at home and a successful self- report later that day on the commitment form.

**BCT 13:** Prompting self-monitoring of behaviour involves the person being asked to keep a record of specified behaviour(s) as a method for changing behaviour. This should be an explicitly stated intervention component, as opposed to occurring as part of completing measures for research purposes. This could, e.g., take the form of

participants completing a diary or a questionnaire about their behaviour, in terms of type, frequency, duration and/or intensity.

A core principle of our intervention was to structure and facilitate self-monitoring of health behaviours related to eating by providing knowledge about the selected health behaviours in the form of commandments (using the leaflet and laminated card) and providing a technique for using the laminated card and commitment form for intensive self-monitoring. Self-monitoring was trained in the training session and support was also given in the weighing sessions where questions related to the techniques and tools could be addressed. Performance of self-monitoring was addressed, and successful continuation of monitoring practice was praised by reinforcing the behaviour.

**BCT 14:** Prompt self-monitoring of behavioural outcome occurs when the person is asked to keep a record of specified measures expected to be influenced by the behaviour change, e.g. blood pressure, blood glucose, weight loss, physical fitness. NB: It had to be reported as part of the intervention, rather than only as an outcome measure.

In the weighing sessions, the connection between commitment to self-monitoring and successful weight loss was emphasized and discussed using records (commitment records and weight changes) that participants had kept.

**BCT 15:** Prompting focusing on past success involves instructing the person to think about or list previous successes in performing the behaviour (or parts of it). NB: This is not just encouragement but a clear focus on the person's past behaviour. It is also not feedback because it refers to behaviour prior to the intervention.

Weighing sessions discussed performance/success during the past period (14 days) and also the whole of the intervention periods. To motivate subjects successes in the previous weighing periods were discussed and improvements pointed out.

**BCT 16:** Providing feedback on performance involves giving the participant results about their own recorded behaviour [(e.g. following BCT 14 (prompt self-monitoring of behaviour)] or commenting on a person's behavioural performance (e.g. identifying a discrepancy between behavioural performance and a set goal; see BCT 5 (Goal setting – behaviour) and BCT 6 (action planning) – or a discrepancy between the person's own performance in relation to others'.

Participants were given verbal feedback and were encouraged to observe their individual performance over the intervention period during the monthly weighing sessions. Participants were instructed to keep records about progress.

**BCT 17:** Providing information on where and when to perform the behaviour involves telling the person about when and where they might be able to perform the behaviour (e.g. tips on places and times participants could access local exercise classes). This could be in either verbal or written form.

Information about where and when particular health behaviour could be performed was given on the laminated card. Positive behavioural and food choice examples were shown in a colour coded form (green positive –red negative choice) and additionally enforced by smiley faces (sad and happy faces). This tool was used at least on a daily basis and also using the commitment forms or using it while shopping. Additionally training session explained with examples how to improve behavioural choices with regards to eating.

**BCT 18:** Providing instruction on how to perform the behaviour involves telling the person how to perform behaviour or preparatory behaviours, either verbally or in written form. Examples of instructions include; how to use gym equipment (without actually showing the participant), instruction on suitable clothing, and tips on how to take action by showing a person how to perform a behaviour

Instructions in how to perform a behaviour were given in the training session by demonstrating the self-monitoring process and analytical process using the intervention tools. Additionally, instruction in more complicated techniques (understanding caloric content of food and understanding caloric needs) were given in the leaflet and partially on the laminated cards for improved understanding and easier use.

**BCT 19:** The person is taught to use prompts/cues by identifying environmental prompts which can be used to remind them to perform the behaviour (or to perform an alternative, incompatible behaviour, in the case of behaviours to be eliminated). Cues might include times of day, particular contexts or technologies, such as mobile phone alerts, which prompted them to perform the target behaviour.

Another core principle/technique of our intervention was the use of slogans to depict health behaviour guidelines. We requested that participants to memorise the slogans and to use the laminated card in all possible situations (to make shopping decisions and plans for eating) and to use them for reflection and monitoring. The participants were taught how to use the tools in the training session, and questions could be asked in the weighing sessions. Environmental cues (such as seeing sugary foods in a shop) were connected to the short slogans on the card (sugars are evil) to

make sure that participants were reminded to perform the better behaviour if in situations of temptation or choice – avoiding buying and consuming sweets.

**BCT 20:** During prompted practice, the person rehearses and repeats the behaviour or preparatory behaviours numerous times. Note also includes components of the behaviour to be acquired, e.g. refusal skills in relation to unhealthy snacks. This could be described as ‘building habits or routines’, but it is still practice so long as the person is being prompted to try the behaviour (or parts of it) during the intervention or practice between intervention sessions, e.g. as ‘homework’.

Behavioural choices were trained by connecting short slogans describing the desired behaviours on laminated cards with the more complex situations in the real world described in the training sessions (a Power Point presentation during the training session). Additionally, participants were asked to learn the slogans and use them when they were in a situation of choice. Moreover, the examples on the laminated cards reinforced directions for the behaviours and choices.

**BCT 21:** Fear arousal involves presentation of risk and/or mortality information relevant to the behaviour as emotive images designed to evoke a fearful response.

On the laminated cards, we used colours (green and red), which expected to evoke a psychological response related to its association. Red colour were linked to dangers, mistakes, and the highest level of hazard, while green is experienced as quieting, restful, and agreeable. Moreover, we added a smiley face and a sad face to the positive and negative behaviour examples, to reinforce the colours used and to increase participant’ awareness of them. Also, in the leaflet we associated chronic diseases and some of the commandments.

### **2.2.1.3.a The study parameters:**

As this thesis aimed to develop a new weight loss intervention, we will examine the effectiveness of our intervention using psychological and physiological parameters. We decided to use measures selected based on their connection to behavioural theories and importance for eating behaviour as well as for physiological significance for health. Thus, we measured body weight (kg), BMI, waist-to-hip ratio, and body compositions, body fat mass, and skeletal muscle mass as important physiological parameters for obesity characterization. We also used metabolic blood parameters to investigate interventions’ influence on obesity-related health risks, especially risks which already known to be correlated with obesity, Type 2 diabetes, as well as cardiovascular



diseases. As psychological parameters, we measured attitudes, both explicit and implicit towards food, and various psychological aspects of food cravings of food cravings. The following subsections give an introduction and research background for these measures.

### 2.2.1.3.a.1 Body Mass Index (BMI)

Body mass index (BMI) is a simple indicator of weight in relation to height that is the most often used method for categorizing obesity in adults. BMI is the weight in kilograms divided by the square of height in meters (Kg/m). In 1995, the World Health Organization (WHO) accepted BMI as an adequate method for evaluating obesity and overweight severity (WHO, 1995). WHO defined obesity as a BMI  $\geq 30$  Kg/m (Table 2.6).

Table 2.6: Classification of overweight and obesity depending on BMI and risk of morbidities

CLASSIFICATION	BMI (Kg/m)	RISK OF CO-MORBIDITIES
UNDERWEIGHT	< 18.5	LOW
NORMAL WEIGHT	18.5-24.9	AVERAGE
OVERWEIGHT	25.0-29.9	MILDY INCREASED
OBESE	> 30	
CLASS 1	30.0-34.9	MODERATE
CLASS 2	35.0-39.9	SEVERE
CLASS 3 (MORBID OBESITY)	>40	VERY SEVERE

In addition, BMI can be used to gauge obesity prevalence among different population groups. BMI  $\geq 30$  (cut-off points) is viewed widely as an obesity indicator. However, some studies use another BMI cut-off point either above or below 30 (Kuczmarski et al., 1994). The BMI is highly correlated with degree of obesity, but is not used to measure body fat (VanItallie & Lew1992). There is another way of assessing obesity; waist circumference can be used to estimate the distribution of body fat. BMI and waist circumference can give a precise prediction of illness risk in populations (National Institutes of Health, 1998); however, BMI is beneficial measure to evaluate obesity prevalence from a public health perspective (Jeffery & Linde 2005).

#### **2.2.1.3.a.2 Waist to hip ratio (WHR), and waist-to-height ratio (WHtR)**

Waist-to-hip ratio is the most common means of measuring abdominal adiposity and fat distribution (Garrow et al., 2000). It provides an index of regional fat distribution and has proven valuable as a guide to health risks in epidemiological studies (Bray, 1996; WHO, 1997; WHO 1995). Many attempts have been made to establish adequate waist-to-hip ratio cut-off points. The risks of obesity increases quickly when WHR exceed 1 for men and 0.80 for women (Bjorntorp, 1985), 1 for men and 0.90 for women (Bray, 1987), 0.95 for men and 0.80 for women (Kanaley et al., 1993; Dennis & Goldberg, 1993), 0.94 for men and 0.88 for women (Lemieux et al., 1996). However, there is an increased risk of obesity in men when  $WHR > 0.90$ , while in women it is  $WHR > 0.80$  (Gray & Fujioka, 1991; Solomon & Manson, 1997). Lemieux et al. (1996) concluded that the cut-off point of waist circumference ought to be 100 cm for individuals  $\leq 40$  years, and 90 cm for individuals  $\geq 40$  years for both genders.

Waist-to-height ratio (WHtR) has been proposed as another rapid and simple screening tool for assessing obesity (Ashwell & Hsieh, 2005). WHtR values above 0.5 indicate increased risk and values above 0.6 indicate substantially increased risk (Ashwell & Gibson, 2009).

#### **2.2.1.3.a.3 Bioelectrical impedance**

Bioelectrical impedance is one of the most popular methods used to estimate body composition. It relies on variance in electrical conductivity in different kind of biological tissue. Fat mass had a lower electrical conductivity than lean body mass because lean body mass contains ions dissolved in water. Physical resistance to electrical currents correlates positively with a fat mass, Thus greater electrical resistance is caused by higher fat tissue and lower lean body mass (Baumgartner, 1996). Moyad (2004) stated that the measurement of electrical resistance is effective and simple. Measurement of body composition using bioelectrical impedance has many advantages, such as ease, safety, cost effectiveness and limited intrusiveness for subjects (Sun et al., 2003). Gray et al. (1989) found that there is great agreement of body composition when using bioelectrical impedance and underwater weighing methods.

#### **2.2.1.3.a.4 Obesity-related health risk parameters**

Obesity plays a central role in the insulin resistance syndrome which includes hypertension, Type 2 diabetes mellitus, and an increased risk of cardiovascular disease (Pinhas-Hamiel et al., 1996). Losing weight has favorable effects for overweight and obese individuals, and numerous reviews and studies have reported that achieving moderate weight loss, 5%-10% of initial body weight, is associated with strong improvements in obesity-related cardiovascular and metabolic abnormalities (Blackburn, 1995; Goldstein, 1992; Knowler et al., 2002; Williamson, 1997; Wing et al., 2011). Our study focus on 3 measures: Glucose Homeostasis: Fasting glucose (FG), Fasting insulin (FI), Glycosylated haemoglobin (HG.A1c), the Homeostasis Model for assessing beta cell function (HOMA B), the Homeostasis Model for assessing insulin sensitivity (HOMA S), and the Homeostasis Model for assessing insulin resistance (HOMA IR); Lipids Profile: High- Density Lipoprotein (HDL), Low-Density Lipoprotein (LDL), Total Cholesterol (TC), and Triglycerides (TG); and Cardiovascular Parameters: Blood Pressure-Systolic (PBS), Blood Pressure-Diastolic (PBS), and Resting Heart Rate (RHR).

#### **2.2.1.3.a.5 Attitudes**

It is understood that attitudes affect, direct and shape current behaviour (Kraus, 1995). The theoretical and empirical studies on attitudes about food indicate that affect choices (Hearty et al., 2007). People with positive attitudes towards healthy eating have been shown to comply better with nutrition guidelines than people with negative attitudes towards healthy eating. Studies of food choices have shown that obese individuals tend to consume food that is higher in sugar, fat and protein than their non-obese peers (McGloin et al., 2002; Nicklas et al. 2003). A likely explanation for this behavioural pattern might be people's attitudes toward food (Brug et al., 1998), as individuals with obesity could have greater desires about eating unhealthy food than individuals of normal weight. For example, many studies have found that eating high-fat foods is associated with weight gain (De Graaf, 2005; Davis et al, 2007; Drewnowski et al., 1996). The theoretical and empirical results indicate that implicit attitudes are predictors of spontaneous, involuntary behaviours, and explicit attitudes affect conscious decision-making and controlled actions (Deutsch & Strack, 2006; Perugini, 2005; Wilson et al., 2000). Recently, implicit attitude measures have been effectively utilised in research on health-risk behaviours by predicting different aspects

of addictive behaviours (Jajodia & Erleywine, 2003; Ostafin & Palfai, 2006; Wiers et al., 2006).

It is well known that attitudes are an important element of the theory of planned behaviour, which has showed marked success in predicting the intention to eat healthier (Armitage & Conner 1999; Oygard & Rise, 1996). Also, several eating behaviour studies have illustrated a moderate relationship between attitudes and behavioural intentions (Gummeson et al., 1997; Kassem et al., 2003; Oygard & Rise, 1996). Moreover, many studies also have showed moderate correlations between attitudes and eating behaviours (Stafleu et al., 1995; Verplanken & Faes, 1999). These previous studies have been based on explicit, self-reported questionnaires. According to their attitudes about food, obese individuals compared with normal-weight individuals have a positive attitude to unhealthy food. Studies have found that explicit attitudes about food comprise a number of dimensions linked to the different sensory, affective and cognitive aspects of particular food items (Aikman et al., 2006). Thus, explicit attitudes can be linked to the theory of planned behaviour, on which the present thesis research was in part based.

On the other hand, implicit attitudes have been shown to be connected to dieting-behaviour (Swanson et al. 2001), food choices (Karpinski & Hitto, 2001; Roefs & Jansen, 2002; Maison et al., 2001) and soft drink preferences (Maison et al., 2004). Individuals who overeat could be unaware that they have a high preference for unhealthy food, which could be having a clear impact on their eating behaviour and unintentionally result in overeating patterns (Aarts et al., 2008). Strong implicit liking of food could be an important reason behind the difficulty in resisting the tasty and seductive aspects of some food items. Most health-behaviour theories tend to assume that individuals think rationally about their behaviour. Rarely do theories, such as PRIME theory, take into account why individuals behave without thinking or with an intention. The PRIME (Plans, Responses, Impulses, Motives, Evaluations) theory of motivation states that the decision to cease behaviour is based on an individual's evaluative beliefs (either positive or negative), which influence the motive to either continue or quit. This motivation then interacts with internal tensions (impulses and urges to eat) and external triggers (e.g. cues in the environment), which can determine subsequent behaviour. Automatic processes that the theory describes do not require conscious awareness, although the resulting behaviour may be the object of reflection and form part of ongoing experience. Therefore, because our intervention is linked to

the PRIME theory, we decided to measure implicit attitudes about healthy and unhealthy food.

#### **2.2.1.3.a.6 Food craving measurement**

Food cravings have been associated with future food intake (Flint et al., 2000; Porrini et al., 1995); increased energy intake while snacking and weight concerns (Lafay et al., 2001); difficulty resisting eating (Gendall et al., 1997); external eating, emotional eating, susceptibility to hunger (Hill et al., 1991); and dropout from weight-loss treatment (Sutton, 1991). Craving is a somewhat vague term, and frequently individuals are required to refer on a one-item Likert scale how they yearn for or crave a particular food. However, an adequate assessment of craving should consist of a multidimensional questionnaire rather than a single question. So far, “subjective self-report seems the only viable assessment modality” (Shiffman, 2000, P. 171). Cepeda-Benito et al. (2000) developed and validated two self-report food craving questionnaires: a food cravings questionnaire for traits (FCQ-T) and a food cravings questionnaire for state (FCQ-S). The FCQ-T and FCQ-S, arguably among the most extensively validated multidimensional measures of craving, are available in English (Cepeda-Benito et al., 2000). The FCQ-S items were constructed to assess craving for a variety of foods, without assigning them to specific categories e.g., chocolate. Furthermore, the FCQ-S cover behavioural, cognitive and physiological aspects of food cravings. Finally, the FCQ-S combines two versions that measure current and habitual food cravings. As food cravings refer to an intense desire to eat food (Weingarten & Elston, 1990), this irresistible urge to eat a specific type of food has been implicated in loss of control over eating (Meule et al., 2012). Thus, the FCQ-S dimensions can reflect the level of self-control over emotional, cue-related, and cognitive factors which influences eating and result in overconsumption and an increase in body weight.

Changes in food cravings measured by the FCQ-s can help us to evaluate the control theory. The aim of improving self-control is to override desires that would interfere with goal-directed behaviour. Indeed, changes in food cravings can be considered as an outcome of self-monitoring, which is a significant component of the self-control process. Thus, self-control and monitoring are important in resisting craving for food. Additionally, the ability to enhance self-control is essential for successful reduction in food craving and body weight because cravings become an automatic part of eating behaviour. On the basis of PRIME theory, we assume that

reflective and automatic processes interact with each other in the control of overeating behaviour; the theory describes how these processes can promote addictive behaviours. On the FCQ-S, this interaction can be measured with certain subscales, such as “anticipation of positive reinforcement”, “cues that trigger cravings”, and “emotions”. Although food-craving questionnaires are based on self-reports which reflect conscious states, some dimensions of the questionnaires might also represent hedonic or subconscious aspects of food cravings.

## Chapter Three

### **Efficacy of a newly developed intervention on body weight based on 10 nutritional/behavioural commandments in overweight/obese females in UK**

#### **3.1 Introduction**

Obesity is recognised as the most widespread metabolic disease in most parts of the world. It affects children, adolescents and adults and has reached epidemic proportions in developed and developing countries (Tsigos et al., 2008). Obesity is often defined simply as the abnormal or excessive accumulation of fat in adipose tissue that can impair health (Garrow, 1988). It arises as a result of imbalance between energy intake and energy expenditure (energy balance dysregulation) (Gibney et al., 2009). Body mass index (BMI) is a simple indicator that is the most used method for measuring obesity in adults. BMI is a person's weight in kilograms divided by the square of the person's height in meters ( $\text{kg/m}^2$ ). In 1995, the World Health Organisation (WHO) accepted BMI as an adequate method for evaluating the severity of obesity and overweight (WHO, 1995), and it defines overweight as a BMI of 25–29.9  $\text{kg/m}^2$  and obesity as a BMI of  $\geq 30 \text{ kg/m}^2$ .

Epidemiological studies have proven that the prevalence of obesity has increased sharply in Great Britain. According to the Health Survey for England (HSE), between 1993 and 2009, the percentage of adults with a normal, healthy BMI (18.5–25) fell from 41% to 32% in men and 49.5% to 40.8% in women, while there was no significant change in the overweight population. A Foresight report on obesity predicted that, if left unchecked, the prevalence of obesity in England will reach 36% of males and 28% of females by 2015, 47% of males and 36% of females by 2025 and 60% of males and 50% of females by 2050 (McPherson et al., 2007). Allender and Rayner (2007) estimated the direct and indirect costs of treating the obese and overweight are £ 3.2 billion, which equals 5% of NHS expenditures.

Obesity leads to very high levels of morbidity, mortality, disabilities and quality life impairment (Adams et al., 2006; Flegal et al., 2007; Renehan et al., 2008; Tsigos et al., 2008). Weight loss is the major goal in the management of obesity (Maria & Evagelia, 2009). There is strong evidence that weight loss also reduces risks of mortality and morbidity related to obesity. In several studies, a loss of 5%–10% of initial body weight has been related to notable reductions in type 2 diabetes,

hypertension and cardiovascular disease (Anderson & Konz, 2001; Vidal, 2002; Tuomilehto et al., 2001).

Although obesity is a major, growing public health problem in many countries, there are no effective and satisfactory treatments for it (Byrne et al., 2004). Weight-loss medications, such as orlistate and sibutramine, have resulted in modest weight loss; unfortunately, weight relapse occurs simultaneously with terminating use of the obesity medication (Aronne, 2002a; Hollander, 2007; Sjostrom et al., 1998), as well, surgery is available for only a small number of individuals with severe obesity (Balsiger et al., 2000; Kral, 1989). The most used strategy for weight loss is reducing energy intake and increasing exercise (Kruger et al., 2004). However, numerous studies have reported high rates of relapse (about 85%) in which the initial body weight is even exceeded after 3 to 5 years of successful weight loss (Barte et al., 2010; Jeffery et al., 2000; Wadden & Frey, 1997). Two meta-analyses found that the combination of changes in diet and physical activity achieved modest weight loss in the short term (Miller et al., 1997; Wing, 1999) but is not sufficient to result in constant weight loss or to maintain the achieved weight loss (Westenhofer et al., 2001). Diet interventions usually rely on dramatically reducing caloric intake to initiate weight loss but neglect to achieve modification of eating behaviour in the long term (Mann et al., 2007).

Maintaining achieved weight loss in the long term is a challenge (Elfhag & Hongu et al., 2011; Rossner, 2005; Sciamanna et al., 2011). Most people fail to maintain the changes in eating behaviour required to prevent subsequent weight regain (Cooper et al., 2010; Cooper & Fairburn, 2002; Perri & Corsica, 2002). Thus, for individuals who want to achieve sustainable weight loss, it is necessary to make changes into a habit or a lifestyle (Hollis et al., 2008; Kruger et al., 2006; Phelan et al., 2006). Recently, lifestyle modification programmes such as cognitive-behavioural therapy (CBT) have increasingly been applied for weight loss in obese patients and appear to be effective (Cooper et al., 2010; Mefferd et al., 2007; Munsch et al., 2007). CBT is not a specific intervention but rather a set of techniques and principles to assess individuals' ability to modify their eating habits and achieve weight loss (Franson & Rossner, 1994; Foreyt & Poston, 1998). The main three principles of CBT are that cognitions influence behaviour, cognitions can be changed, and cognitive change can affect behaviour change (Dobson & Dozois, 2001; Dobson, 2009). CBT is considered the most effective nonsurgical strategy in the treatment of overweight and obesity (Avenell et al., 2004). Despite its effectiveness, widespread implementation of it has been hindered because,



among various reasons, it requires specialised skills, is time consuming and costly (Lally et al., 2008) and demands a high level of adherence which some clients are not willing to invest in treatment (Verheijden et al., 2007).

The remarkable recent increase in body weight could be attributed primarily to energy intake, rather than energy expenditure (Swinburn et al., 2009). Many reasons underlie this claim. Several researches state that modern food has become more tempting (high in sugar, fat and salt) and accessible (vending machines, restaurants, and ready-made meals), which has increased snacking behaviour (Brownell et al., 2009b; Geier et al., 2006; Kessler, 2010). Recently, experts have paid increasing attention to eating behaviours because they might reflect the joint effect of a number of foods and nutrients and, thus, increase the likelihood of finding a link to obesity (Rodriguez & Moreno, 2006). Eating behaviours influence energy intake through choices about when and where to eat, the types and amounts of foods chosen and when to start and stop eating (Blundell & Cooling, 2000; Blundell et al., 2005). Moreover, if eating behaviour is found to be linked to increased body weight, it might be a universal indicator of obesogenic lifestyles (Mesas et al., 2012) and support more practical strategies for preventing a higher rate of obesity than the common strategies (eating less and exercising more). Behaviours related to eating are affected by different factors, for instance, food characteristics, cognitions, attitudes, cravings and individuals' previous experiences (Wardle, 2007).

Attitudes play an important role in the adoption and maintenance of a variety of health and nutritional habits (Turconi et al., 2008). Several obesity and food-choice studies have shown that obese individuals tend to consume more food high in sugar and fat compared with peers with a normal body weight (McGloin et al., 2002; Nicklas et al., 2003). That is, obesity is partially a result of the behavioural pattern of unhealthy eating (Craeynest et al., 2005; Craeynest et al., 2007). This behavioural pattern could be explained by obese attitudes towards food (Brug et al., 1995). Two kinds of attitudes influence behaviour: explicit and implicit (Fazio, 1990). Explicit attitudes guide behaviour through a thoughtful, conscious analysis of the pros and cons of a given behaviour, while implicit attitudes automatically bypass balancing the benefits and costs of a behaviour. Indeed, attitude is one element of the Ajzen model of behaviour. The Theory of Planned Behaviour (TPB) model suggests that attitudes are factors which drive intentions towards a specific behaviour as well as they interact with subjective norms; their relative contribution to predict behaviour leads to the importance of

measuring attitudes for the assessment of intervention success even if behaviour can't be monitored directly in the follow-up period. Moreover, Oygard and Rise (1996) found that attitudes were the strongest predictors of intention to eat healthier food compared to other elements of the TPB model.

Food cravings are well recognized as common in participants suffering obesity (Delahanty et al., 2002; White et al., 2002) and have been reported to have a function with increased food intake and weight gain (Forman et al., 2007, Moreno et al., 2008, Steel et al., 2006), quitting obesity treatment (Lim et al., 2009; Moreno et al., 2008; Sitton, 1991) and setbacks in successful weight loss (Forman et al., 2007; Hill 2007, Jakubowicz et al., 2012; Lowe, 2003). Regarding a relationship between weight loss and cravings, research has produced a diversity of results supporting the view that food cravings are an obstacle to weight loss. Some studies have stated that cravings decrease with weight loss (Alberts et al., 2010; Jakubowicz et al., 2012; Lim et al., 2009; Martin et al., 2006), while others have reported increased cravings with dieting (Massey & Hill, 2012) and even stabilisation of cravings with weight loss (Gilhooly et al., 2007). Until now, there has been no consensus on whether weight loss is linked to increased or decreased food cravings and whether interventions that successfully decrease body weight are associated with greater reduction in food cravings.

Clearly, obesity has increased rapidly worldwide, and individuals urgently need an effective obesity-management intervention which is simple, inexpensive, does not rely on the assistance of health professionals and benefits individuals who cannot make hospital appointments. Therefore, we developed a weight-loss intervention that uses reflective processes which uses 10 behavioural commandments based on the current knowledge about nutritional and eating behavioural strategies beneficial for weight loss from recent literature and the design and concepts based on behavioural change theories (see chapter 1 and 2). The main aims of the present study were to examine the effectiveness of the developed intervention and to identify which commandments and combinations of commandments have the strongest influence on physiological elements (body weight measures, body characteristics) and psychological elements (food cravings, explicit and implicit attitudes), which are elements for predicting behavioural change. The intervention was performed in the Bangor area, UK, with overweight/obese females for 3 months and 6 months intervention period, and 3 months follow-up period.

## **3.2 Hypothesis**

We hypothesized that 3 and 6 months after the intervention, body weight, food cravings and explicit attitude towards unhealthy food would be significantly reduced, while implicit attitude and explicit attitude towards healthy food would be significantly increased. Moreover, we assumed that three months after the end of the intervention, the achieved weight loss, food cravings, explicit attitudes towards unhealthy food and increased explicit attitudes towards healthy food would be maintained. In addition, we hypothesised that the estimated commitment to these interventional rules during the follow-up period and the maintained weight loss would be correlated.

In addition, we hypothesised that commitment to the commandments and achieved weight loss would correlate with achieved changes in food cravings and implicit and explicit attitudes. Identifying the strongest influencers of weight-loss and food-craving decline among the 10 commandments could enable us to produce a model with the most effective combination of the commandments. Furthermore, expected changes in attitudes and food cravings as well as their association to commitment levels to the commandments should support the interventional design based on behavioural change theories.

## **3.3 Methods**

### **3.3.1 Participants**

Female participants in this study were recruited through official advertising channels (Bangor University email system, discussion forums). Advertisements were also posted on notice boards at Bangor University (schools, halls) and in the surrounding community (supermarket, public places). Further recruitment was carried out using poster advertisements in general practitioner (GP) clinics and general libraries. Participants were recruited according to the following criteria: healthy, overweight/obese women, ages 18 and 60 with a BMI of  $\geq 25$  kg/m<sup>2</sup>. Healthy was defined as not diagnosed with any chronic medical condition and not taking any prescription medications, with the exception of oral contraceptive pills (Martins et al., 2010). Participants who were not engaging in any stringent exercise schedule or dieting were included. Exclusion criteria were the presence of pregnancy or chronic health conditions such as cancer, heart disease, liver disease and gastrointestinal disorders. Participants were also excluded if they were taking psychiatric medications or other

medications known to have an effect on body weight and metabolism, such as sibutramine and orlistat.

Participants were sent a written study information sheet by e-mail before agreeing to take part in the study. The information sheet (see the appendix) outlined all that was expected of the participants and provided contact information if they had any questions. The outline included the study procedures, measurements and number of expected visits to our laboratory. Potential participants were invited to attend a session at which all their questions were answered. The study intervention was also described in detail, and participants practised using the study tools and two examples of popular meals (see the appendix). This practise ensured that participants became adept at and familiar with using the tools. At the end of the session, all participants were asked whether they had any further questions about the study and then to sign the informed consent form if they agreed to take part. Informed consent was obtained by the principal researcher, and all participants were aware that taking part was completely voluntary and that they were free to withdraw at any time without giving a reason. Written, informed consent was obtained before enrolling participants in the study. Potential participants were screened by pre-study and medical questionnaires which evaluated their medical conditions and use of any medications that could prevent them from participating in the weight loss programme.

### **3.3.2 Ethics**

This study followed all regulations concerning the ethical use of volunteers. All procedures of the study received approval from the Ethics Committee of the School of Sport, Health and Exercise Sciences at Bangor University (Ethical No. s/PhD-11/12).

### **3.3.3 Intervention**

The main purpose of the study was to help overweight and obese individuals to lose weight through a cognitive training programme using 10 nutritional and behavioural commandments (see chapter one). The targeted behaviours of the 10 commandments are presents in Table 3.1.

**Table 3.1** The targeted behaviours in the 10 commandments

	<b>short version (slogans)</b>	<b>Targeted behaviour</b>
<b>B1</b>	Sugars are evil!	Reduction of sugar intake
<b>B2</b>	Veg and fruit you need!	Increase of fresh vegetable and fruit intake
<b>B3</b>	Rich with fibre!	Increase of fibre intake
<b>B4</b>	Picky with the meat!	Reduction of meat and fat intake
<b>B5</b>	Have a high with the low!	Reduction of high caloric density food intake
<b>B6</b>	Short of salt!	Reduction of salt intake and ready meal consumption
<b>B7</b>	Enjoy your food!	Reduction of intake velocity; increased awareness of food intake
<b>B8</b>	Regular is better!	Reduction of snacking; increase of regular meal patterns
<b>B9</b>	Long ways to eat!	Awareness of individual's caloric allowance and understanding of caloric values (exercise conversion)
<b>B10</b>	No buzz with fizz!	Reduction of liquid calorie intake

To achieve the study aims, we used 3 tools. First, a small laminated card contained a slogan-like version of the nutritional and behavioural commandments supported by positive and negative examples. Participants were to carry this card in their handbag or pocket to support themselves during shopping and eating. They were to try to memorise the short versions of the commandments and link them to the main information about the commandments in the second tool, an additional leaflet. The leaflet gave explanatory information about the commandments and why they are important for weight loss and health. The third tool was a non-compliance report (cognitive training) in which participants recorded their compliance with each commandment at the end of every day. Non-compliance reports are expected to have a role in commitment enhancement. Participants' level of compliance was discussed in the next month's visit. They were assisted in identifying the connection between their weight change and day-to-day eating behaviour, where they prompting review of their behavioural and outcomes goals (see BCT 9 and BCT 10, page 114-115). The compliance report aimed to help the participants be aware of their daily eating-behaviour choices and to support their reflection as well as monitor their progress.

### **3.3.4 Measures**

All measurements and questionnaires were completed by participants at baseline, after the 3-month and 6-months of study intervention, and 3 months after the end of the intervention (follow-up).

#### **3.3.4.1 Height and body weight and composition.**

Height was measured using a wall-mounted stadiometer (Bodycare Products, Southam, United Kingdom). Participants were measured barefoot with their backs positioned against a wall. A digital scale (Seca, Vogel & Halke, Humburg, Germany) was used to measure body weight, while body composition was measured with a bioimpedance analysis (BIA) (Inbody 230, biospace co., Ltd, Korea). Participants were weighed in a non-fasting state, wearing minimal, lightweight clothes. The same digital scale was used at each time-point. Waist and hip circumferences were measured using a tape measure.

#### **3.3.4.2 Reflection on commitment.**

In the current study, Participants were asked to reflect on their compliance with the 10 diet commandments. The reflective process consisted of 2 steps. First was a daily homework exercise in which, during meals, participants visualised which commandments they were breaking and which they were following. At the end of the day, participants reflected on their eating behaviour and effort throughout the day using the daily non-compliance sheet and had to think about ways for avoidance of possible non-compliance events in the future. They ticked boxes describing their compliance, prompting analysis of their eating behaviour and commitment to the commandments. The second step was to summarise their compliance over 14 days by answering a short questionnaire about the number of days on which they did not comply with individual commandments. Participants were approached via email and then accessed Bristol Online Surveys (BOS) to fill out the electronic version of the 14 days non-compliance report. However, the participants have not been aware about the follow-up phase of this study and they were instructed to stop submitting the compliance reports. Thus, we developed a questionnaire which aimed to estimate their compliance with the study' commandments over the follow-up period considering the limitation of retrospective records.

### **3.3.4.3 Food craving questionnaires.**

Food cravings were assessed using the food craving questionnaire (FCQ), both the state and the trait version (Cepeda-Benito et al., 2000; Moreno et al., 2008). FCQ is considered the best measure for food cravings in general (Christensen, 2007). Cepeda-Benito et al. (2000) developed and validated two versions of the self-report FCQ: Food Cravings Questionnaire–Traits (FCQ-T) and Food Cravings Questionnaire–State (FCQ-S). The FCQ-T is intended to evaluate food cravings as steady traits and thus measures aspects of food cravings that are steady across time and situations within particular populations or participants. The FCQ-T has 39 items and 9 scales: positive reinforcement, negative reinforcement, cue-dependent eating, feeling of hunger, preoccupation with food, intention to eat, lack of control, emotions, and guilt feeling. The FCQ-T asks participants how frequently each statement is true for them measured on a 6-point Likert scale, ranging from 1 (never) to 6 (always). Participant responses were gathered, and a high score indicated a high level of a food craving trait.

The FCQ-S assesses state-dependent cravings, i.e., whether food cravings are experienced in response to specific, instantaneous cases or to psychological and physiological states. The FCQ-S has 15 items and a 5-point scale: positive reinforcement, negative reinforcement, preoccupation and lack of control over eating, intense desire to eat, and feeling of hunger. The FCQ-S asks participants to indicate their level of agreement with each statement. As in FCQ-T, the FCQ-S is measured by a 5-point Likert scale, ranging from 1 (strongly agree) to 5 (strongly disagree). Participants' responses were added, and a low score indicated a high level of a food craving state. Both food craving scales have been shown to have good internal consistency ( $\alpha > 0.9$ ) (Cepeda-Benito et al., 2000a, 2000b), satisfactory test-retest stability and appropriate construct and discriminant validity (Cepeda-Benito et al., 2000).

### **3.3.4.4 Implicit and explicit attitudes towards healthy and unhealthy food.**

Attitudes towards healthy and unhealthy food were assessed using an implicit association test (IAT) and explicit attitudes questionnaire (EAQ). As the terms 'healthy' and 'unhealthy' are vague, we used 'healthy' as non-specific terms to describe foods which are fresh, low in sugar and fat and rich in fibre and 'unhealthy' as a non-specific term to refer to foods low in fibre, high in fat and sugar and not fresh in the EAQ.

### **3.3.4.4.a Implicit attitudes.**

Implicit attitudes were measured by IAT, considered the best method for this purpose (Greenwald et al., 1998). The IAT was developed by Greenwald et al. (1998) and modified by Dr David Markland at Bangor University to assess implicit attitudes towards food. To validate the modified version of the IAT, pictures were selected from online public-domain sources, and positive and negative terms were standardised for testing. A group of undergraduate and Msc students (lean, overweight, obese) were asked to sort the selected pictures into categories of healthy or unhealthy according to low or sugar, fat and fibre content and the standardised words into categories of good or bad. Lean and obese participants had significantly different attitudes towards healthy and unhealthy food. Therefore, the modified version showed satisfactory validity (Francesco et al., 2011).

In the present study, participants were asked to use two response keys (E and I) to categorise the stimulus (picture or word, see the appendix) shown in the middle of the computer screen into one of two contrasting target concept categories (healthy and unhealthy) and one of two contrasting attribute concept categories (good or bad). Following established protocol (Greenwald et al., 1998), participants completed seven blocks of trials (Table 3.2). As the IAT is designed to measure the strength of association between concepts by indirectly observing response latencies in computer paradigm categorisation tasks, the crucial blocks were block four, with the category labels of healthy food, good, unhealthy food, and bad food), and block seven, with the category labels of unhealthy food, good, healthy food, and bad food). The IAT measure is calculated as the difference between the averages of the relative response latencies in these two blocks. The IAT is based on the assumption that, if the target concept (e.g., healthy food) and attributed dimension (e.g., good) are cognitively related and share the same response key (e.g., E), the categorisation task will be easy and quick when the two concepts; these are called congruent trials. If the concepts conflict cognitively, however, responding to them is more difficult, and reaction time should increase; this is called an incongruent trial. The IAT is a computer-based, reaction-time measure that evaluates the relative strength of association between two concept categories. This method measures implicit attitudes, so it is tough for participants to regulate their responses (Steffens, 2004).



**Table 3.2** IAT Sequences

<b>Block</b>	<b>Trial</b>	<b>E-key items</b>	<b>I-key items</b>
1	Practice	Healthy food images	Unhealthy food images
2	Practice	Good words	Bad words
3	Practice	Healthy food images, good words	Unhealthy food images, bad words
4	Incongruent	Healthy food images, good words	Unhealthy food images, bad words
5	Practice	Unhealthy food images	Healthy food images
6	Practice	Unhealthy food images, good words	Healthy food images, bad words
7	Incongruent	Unhealthy food images, good words	Healthy food images, bad words

#### **3.3.4.4.b Explicit attitudes.**

Explicit attitudes towards food items (healthy and unhealthy) were measured with the explicit attitudes questionnaires (EAQ), developed by Courneya and Bobick (2000) and modified by Dr. Markland (Bangor University). Participants were asked to indicate their agreement with 8 elements (enjoyable/not enjoyable, harmful/beneficial, useful/useless, boring/interesting, pleasant/unpleasant, stressful/relaxing, wise/foolish, and bad/good) based on a 7-point bipolar Likert scale ranging from 1 (extremely enjoyable) to 7 (extremely unenjoyable). The 7-point Likert scale displayed satisfactory internal consistency ( $\alpha=0.89$ ). Participants' responses were gathered. A high score for a healthy food indicated a high, positive, explicit attitude towards healthy food items, and a high score negative explicit attitudes towards unhealthy food items.

#### **3.3.4.5 Data collection and analysis**

The collected data were analysed using Statistical Package for Social Sciences (SPSS ver. 20). Descriptive statistics (i.e., mean and standard deviation [SD]) were applied. T-tests between baseline and 3 months after the intervention were conducted. The Pearson's correlation coefficients ( $r$ ) between study variables were calculated. Furthermore, one way repeated ANOVA was conducted to find the differences between levels of commitment of the commandments. P-values were considered significant at  $<0.05$ .

### 3.4 Design and procedure

The study consisted of eight visits. Body weight, BMI, waist-to-hip ratio (WHR) and body composition were assessed at each visit. Moreover, participants were requested to complete a FCQ, EAQ and IAT at baseline (first visit), 3 months after the intervention (fourth visit), 6 months after the intervention (seventh visit), and 3 months after ending the intervention, follow-up period, (eighth visit). Figure 3.1 shows the study design, procedure and measures. Note that we did not offer any support to the participants during the follow-up period. This design was chosen for the follow-up study to decrease the influence of external control which may lead to higher commitment. This design may reflect more accurately the effectiveness of the intervention, as the participants were unaware that they would be invited back three months after the end of the interventional period.

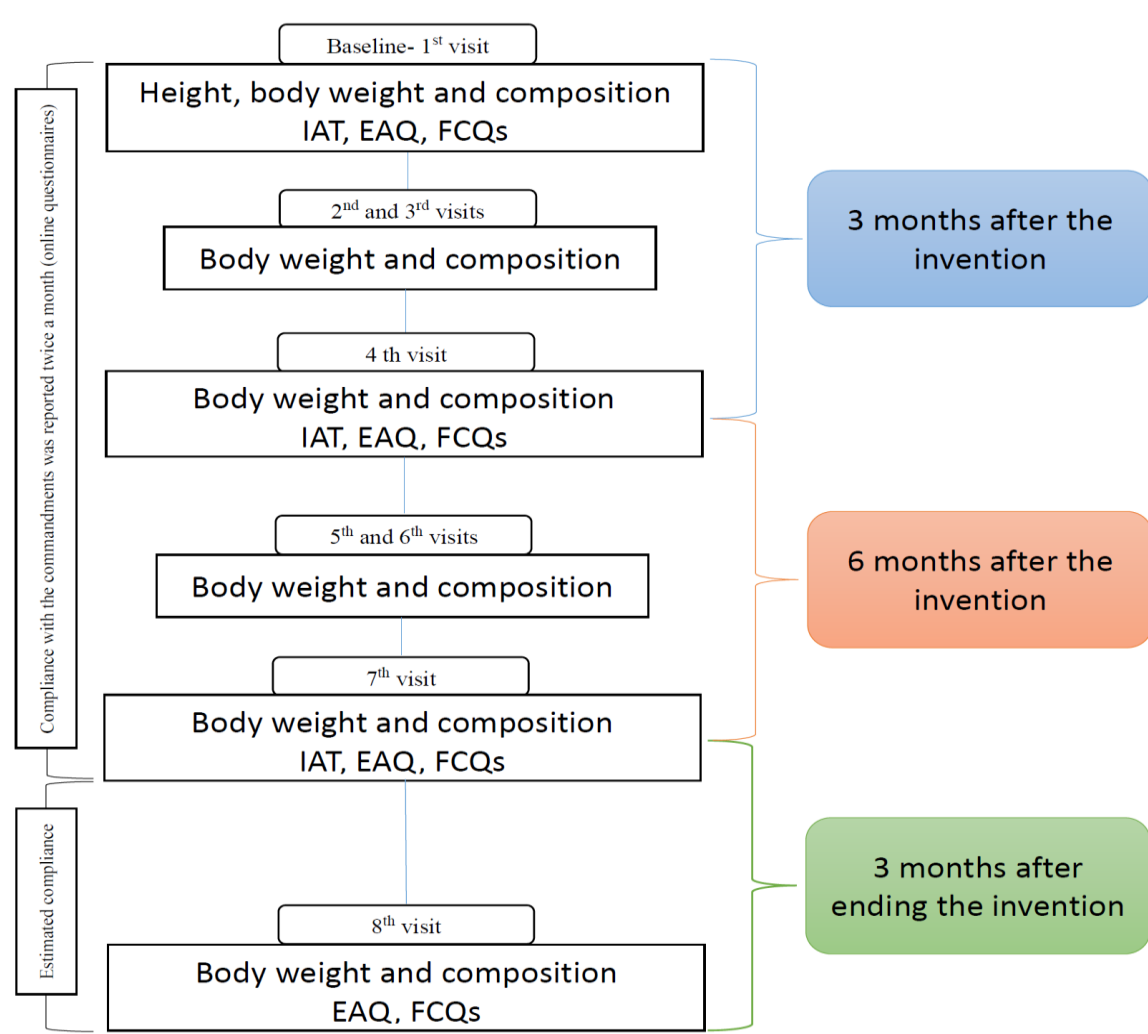


Figure 3.1 the study design diagram

## **3.5 Result**

### **3.5.1 The result report of 3 months after the intervention**

Thirty-five (age  $37.6 \pm 14.79$ , BMI  $32.08 \pm 5.16$ ) (52.2%) of the 67 overweight and obese female participants who enrolled in this study completed the 3-month period of using the tools and being committed to the study. This section presents the findings from the analysis undertaken to determine the effectiveness of the study intervention (10 diet commandments based on cognitive process using self-reflection) at influenced body weight and composition, food cravings and implicit and explicit attitudes. We also show the relationship between the main outcomes and finally identify the predictors of achieved weight loss and food craving reduction.

#### **3.5.1.1 Commitment to the 10 commandments**

The mean and SD of the commitment level for each commandment during the study period (3 months) are shown in Table 3.3, along with the commandment headings used on the leaflets and laminated cards and the acronym for each commandment (B1–B10). Although the level of commitment to the diet commandments varied, this variation was relatively small. B6 had the highest level of commitment ( $68.49 \pm 14.18$ ), while B1 had the lowest level ( $55.66 \pm 15.79$ ).

**Table 3.3** Level of commitment to commandments

Diet Commandment Headings			Commitment (day/84)
In leaflet	In laminated card	symbol	Mean±SD
Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added-sugar products and snacks, especially sweets	Sugars are evil!	B1	55.66±15.79
Eat at least a half kilogram of a vegetables and fruit a day	Veg and fruit you need!	B2	67.95±10.88
Base your meals on fibre-rich foods	Rich with fibre!	B3	65.45±11.68
Eat fish and meat no more than twice a week	Picky with the meat!	B4	65.74±17.98
Eat food low in energy density	Have a high with the low!	B5	63.34±10.05
Choose low-salt products	Short of salt!	B6	67.71±13.40
Take your time, and focus on your meal whilst eating	Enjoy your food!	B7	68.49±14.18
Have regular meal times	Regular is better!	B8	67.23±17.47
Be aware of your caloric needs and how much you eat	Long ways to eat!	B9	62.85±13.62
Limit calorie intake from alcohol and drinks	No buzz with fizz!	B10	62.08±17.32
Total commitment			646.51±105.17

Moreover, one-way repeated measure was conducted to compare the levels of the participants' commitment to the commandments. We found that the level of commitment to the following commandments, B2 'vegetables and fruit you need', B3 'rich with fibres', B6 'short of salt', B7 'enjoy your food', B8 'regular is better', were significantly higher than the commitment to B1 'sugars are evil' (Table 3.4). With the exception of these commandments, no significant difference was found between the levels of the commitments to the commandments.

**Table 3.4** Significant differences between the levels of the commitments to the commandments

	<b>Mean difference</b>	<b>P value</b>
B1-B2	-12.29±1.9	<b>0.000</b>
B1-B3	-9.8±1.92	<b>0.001</b>
B1-B6	-12.01±1.87	<b>0.000</b>
B1-B7	-12.83±2.91	<b>0.005</b>
B1-B8	-11.57±2.94	<b>0.017</b>

p value<0.05

### 3.5.1.2 Body characteristics.

#### 3.5.1.2.a Body characteristics in dropout group and the completion group

An independent t-test was conducted to compare the body weight and composition of the dropout group and the completion group. Table 3.5 illustrates the baseline characteristics of the study participants (recruited, dropped out, and completed). The baseline dropout group and baseline completion group had significant differences in age and waist-to-hip ratio (WHR). The age mean of the dropout group ( $28.97 \pm 11.4$ ) was younger than that of the completion group ( $37.6 \pm 14.79$ ), while students comprised the majority of the dropout group. In other words, younger participants were more likely to withdraw from the study compared to older participants. Conversely, older participants showed more willingness to commit themselves to the study intervention. In addition, the WHR was higher in the dropout group ( $0.887 \pm 0.06$ ) compared with the completion group ( $0.86 \pm 0.052$ ).

In short, the body characteristics for recruited participants for the dropout and completion groups were similar, except for WHR and age. WHR was higher in the dropout group, whose participants were students and thus younger than participants in the completion group.

**Table 3.5** Baseline characteristics of the study participants (recruited, dropout, and completed groups)

Characteristics	Baseline— recruited (n=67)	Baseline— drop out (n=32)	Baseline— completion (n=35)	Difference	P value
Age (year)	33.47±13.88	28.97±11.4	37.6±14.79	-8.63±3.25	<b>0.010<sup>+</sup></b>
Height (cm)	164.5±6.5	165.28±6.27	163.83±6.74	1.45±1.59	0.366
Weight (kg)	85.7±15.29	84.75±12.93	86.57±17.33	-1.82±3.76	0.631
BMI (kg/m <sup>2</sup> )	31.56±4.78	30.99±4.34	32.08±5.16	-1.08±1.17	0.358
Waist-c (cm)	98.07±11.94	98.59±10.6	97.59±13.18	1.01±2.94	0.732
Hip-c (cm)	112.76±11.81	111.42±11.33	114±12.27	-2.56±2.89	0.379
WHR	0.870±0.0586	0.887±0.06	0.86±0.052	0.031±0.014	<b>0.027<sup>+</sup></b>
WHtR	0.596±0.069	0.597±0.064	0.6±0.07	0.0019±0.017	0.913
FM (%)	36.32±10.59	35.19±9.58	37.35±11.49	-2.16±2.59	0.409
SMM (%)	27.36±4.04	27.51±3.48	27.22±4.54	0.286±0.99	0.774

Waist-c: waist circumference, Hip-c: hip circumference, WHR: waist to hip ratio, WHtR: waist to height ratio: FM: fat mass, SMM: skeletal muscle mass. <sup>+</sup>: p value<0.05

### 3.5.1.2.b Body characteristics in the completion group.

We hypothesized that the intervention would result in weight loss and changes in the body composition. An independent t-test was performed to identify changes of body weight and characteristics in the completion group 3 months after the intervention (n=35, age 37.6±14.79, BMI 32.08±5.16), as shown in Table 3.6. All body characteristics posted highly significant differences (p<0.0005) between baseline and 3 months after the intervention. The net weight change for individuals was (-5.5±3.77) kg, and the change in BMI was (-2.0±1.27) kg/m<sup>2</sup>. The reductions in waist circumference (waist-c) was reduced by (5.6) cm, hip circumference (hip-c) by (4.2) cm, body fat mass (FM) by (4.1%), and skeletal muscle mass (SMM) by (0.59%)

**Table 3.6** Changes in body characteristics in participants completing the 3-Month Intervention

<b>Body characteristics</b>	<b>Baseline</b>	<b>3 months after the intervention</b>	<b>Difference</b>	<b>P value</b>
Weight (kg)	86.57±17.33	81.03±16.31	-5.5±3.77	<b>0.000*</b>
BMI (kg/m <sup>2</sup> )	32.08±5.16	30.08±4.86	-2±1.27	<b>0.000*</b>
Waist-c (cm)	97.59±13.18	92±12.59	-5.6±3.22	<b>0.000*</b>
Hip-c (cm)	114±12.27	109.76±11.41	-4.23±3.37	<b>0.000*</b>
WHR	0.86±0.052	0.84±0.056	-0.019±0.018	<b>0.000*</b>
WHtR	0.6±0.07	0.56±0.07	-0.034±0.02	<b>0.000*</b>
FM (%)	37.35±11.49	33.22±10.92	-4.13±2.9	<b>0.000*</b>
SMM (%)	27.22±4.54	26.63±4.42	-0.59±1	<b>0.001<sup>^</sup></b>

Waist-c: waist circumference, Hip-c: hip circumference, WHR: waist to hip ratio, WHtR: waist to height ratio: FM: fat mass, SMM: skeletal muscle mass. \*: p value<0.0005. ^ p<0.01

### **3.5.1.2.c Relationship between commitment and change in body weight measures.**

We hypothesized that higher commitment to the commandments would be negatively correlated with weight loss. Pearson correlation was computed to assess the relationship between participants' commitment to the commandments and achieved reduction of weight and BMI. Table 3.7 shows the correlations between commitment to the commandments and the change in BMI and weight loss values. There was a highly significant correlation between BMI change and the commandments B3 'rich with fibres', B8 'regular is better', and B1 'sugars are evil' (p<0.01) and a significant correlation with the commandments B9 'long ways to eat', B2 'veg and fruit you need', B6 'short of salt' and B10 'no buzz with fizz' (p<0.05). These correlations were negative, which means that high commitment to diet will result in high reduction of BMI over 3 months. Again this was supported by the correlation between commitment to the commandments and weight loss which reported a significant negative correlation between achieved weight loss and commitment to B3 'rich with fibres'

In short, while weight loss appeared to correlated negatively with B3 only, the reduction in BMI was correlated negatively and significantly with seven commandments, ranked by correlations strength: B3 'rich with fibres', B8 'regular is

better', B1 'sugars are evil', B9 'long ways to eat', B2 'veg and fruit you need', B6 'short of salt' and B10 'no buzz with fizz'.

**Table 3.7** Pearson correlations between commandments and change in body weight

Commandment	BMI change	Weight change
	r	r
B1	<b>-0.464<sup>^</sup></b>	-0.317
B2	<b>-0.405<sup>+</sup></b>	-0.292
B3	<b>-0.62<sup>*</sup></b>	<b>-0.513<sup>^</sup></b>
B4	-0.271	-0.148
B5	-0.293	-0.159
B6	<b>-0.4<sup>+</sup></b>	-0.173
B7	-0.312	-0.214
B8	<b>-0.516<sup>^</sup></b>	-0.324
B9	<b>-0.409<sup>+</sup></b>	-0.279
B10	<b>-0.347<sup>+</sup></b>	-0.254
Total	<b>-0.564<sup>*</sup></b>	<b>-0.374<sup>+</sup></b>

\*: p value<0.0005, ^ p<0.01, + p<0.05

### 3.5.1.3 Food Cravings

#### 3.5.1.3.a Baseline difference between dropout and completion groups.

An independent t-test was performed to determine whether the food craving dimensions of the dropout and completion groups differed. The FCQ-S and FCQ-T found no significant differences between the groups (Tables 3.8 and 3.9). Therefore, food cravings were not the main reason for dropping out of the present study.



**Table 3.8** FCQ-S baseline differences between dropout and completion groups

<b>FCQ-S</b>	<b>Baseline—dropout (n=32)</b>	<b>Baseline— completion (n=35)</b>	<b>Difference</b>	<b>P value</b>
Intent	10.66±2.96	9.94±3.85	0.71±0.84	0.401
ANT+	10.75±2.65	10.14±4.19	0.61±0.87	0.486
ANT-	9.97±3.49	9.54±3.76	0.43±0.89	0.634
Control	10.59±3.21	10.23±3.70	0.37±0.85	0.669
Hunger	10±3.18	9.69±3.89	0.31±0.87	0.720
Total	51.97±12.23	49.54±17.12	2.43±3.67	0.510

Intent=an intense desire to eat; ANT+=anticipation of positive reinforcement that may result from eating; ANT-=anticipation of relief from negative states and feelings as a result of eating; Control=lack of control over eating and thoughts or preoccupation with food; Hunger=craving as a physiological state

**Table 3.9** FCQ-T baseline differences between dropout and completion groups

<b>FCQ-T</b>	<b>Baseline—dropout (n=32)</b>	<b>Baseline—completion (n=35)</b>	<b>Difference</b>	<b>P value</b>
ANT+	17.26±5.73	18.56±4.27	1.31±1.24	0.298
ANT-	9.68±3.98	10.94±3.56	1.25±0.93	0.181
Intent	11.71±3.92	11.75±3.24	0.036±0.88	0.968
Cues	17.8±4.66	17.56±5.45	-0.24±1.24	0.848
Thoughts	20.43±9.46	22.81±10.10	2.38±2.39	0.322
Hunger	14.74±4.35	15.84±4.38	1.1±1.07	0.306
Control	23.31±6.95	22.63±8.45	-0.69±1.88	0.716
Emotions	16.09±5.83	16.88±6.28	0.79±1.48	0.596
Guilt	12.29±3.97	11.94±4.45	-0.35±1.03	0.736
Total	143.3±38.07	148.91±38.36	5.59±9.35	0.552

ANT+=anticipation of positive reinforcement that may result from eating; ANT-=anticipation of relief from negative states and feelings as a result of eating; Intent=intention and plan to consume food; Cues=cues that may trigger food cravings; Thoughts=thoughts or preoccupation with food; Hunger=craving as a physiological state; Control=lack of control over eating; Emotions=experience of emotions before or during food cravings or eating; Guilt=guilt from food cravings and/or for giving into them

### 3.5.1.3.b Change in cravings.

We hypothesized that the intervention would reduce food cravings, both state and trait. An independent t-test was performed to calculate the change of food cravings in the completion group 3 months after the intervention. There were significant differences between craving subscale scores (baseline and 3 months after the intervention) on both FCQ-S (Table 3.10) and FCQ-T (Table 3.11). Participants reported significantly lower levels of food cravings 3 months after the intervention. Significant changes in the total food craving score and subscale scores were found for both; states (state-dependent food cravings) and traits (state independent craving trait intensity). These changes might reflect the effectiveness of the study intervention in the physiological and psychological dimensions of cravings.

**Table 3.10** Changes in food Craving state

<b>FCQ-S</b>	<b>Baseline</b>	<b>3 months after the intervention</b>	<b>Difference</b>	<b>P value</b>
Intent	9.94±3.85	12.26±2.57	2.31±3.11	<b>0.000*</b>
ANT+	10.12±4.19	12.26±3.34	2.11±3.7	<b>0.002^</b>
ANT-	9.54±3.76	11.71±3.12	20.17±2.92	<b>0.000*</b>
Control	10.23±3.7	12.71±2.98	2.49±3.72	<b>0.000*</b>
Hunger	9.69±3.89	11.46±3.02	1.77±3.45	<b>0.005^</b>
Total	49.54±17.12	60.40±12.39	10.86±13.74	<b>0.000*</b>

\*: p value<0.0005, ^ p<0.01. Note that increases in the change score reflect decreases in food-craving state.

**Table 3.11** Changes in food craving trait

FCQ-T	Baseline	3 months after the intervention	Craving loss	P value
ANT+	17.26±5.73	13.83±5.37	-3.43±5.1	<b>0.000*</b>
ANT-	9.68±3.98	7.23±3.1	-2.46±3.41	<b>0.000*</b>
Intent	11.71±3.92	8.8±3.38	-2.91±3.48	<b>0.000*</b>
Cues	17.8±4.66	13.46±4.66	-4.34±4.71	<b>0.000*</b>
Thoughts	20.43±9.46	14.4±6.03	-6.03±7.13	<b>0.000*</b>
Hunger	14.74±4.35	12.43±4.08	-2.31±4.31	<b>0.003^</b>
Control	23.31±6.95	16.86±5.58	-6.46±6.76	<b>0.000*</b>
Emotions	16.09±5.83	11.8±4.6	-4.29±5.61	<b>0.000*</b>
Guilt	12.29±3.97	11.29±3.77	-1±2.7	<b>0.035+</b>
Total	143.3±38.07	110.09±29.41	-33.29±34.29	<b>0.000*</b>

\*: p value<0.0005, ^ p<0.01, + p<0.05. Note that decreases in the change score reflect decreases in food craving traits.

### 3.5.1.3.c Correlation between craving dimension and body weight.

It was hypothesised that the dimension of food craving would be correlated with lower weight and BMI. Pearson's correlations were calculated for baseline scores and changed scores for cravings in relation to changes in weight and BMI. These correlations are presented in Table 3.11 (FCQ-S) and Table 3.12 (FCQ-T).

The Pearson's correlations between the BMI reduction and both the baseline and change values of the food craving states (FCQ-S) were not significantly correlated, except for the 'an intense desire to eat' subscale change value ( $p<0.05$ ), which correlated negatively with BMI change (Table 3.12). This indicates that a greater score for 'an intense desire to eat' was associated with a higher reduction in BMI. As a higher score depicted a low craving state, that correlation means that a decrease in 'intention and planning to consume food' was positively associated with BMI reduction. In the same vein, 'the anticipation of relief from the negative states' subscale change score had a trend value (0.076), meaning that the reduction in 'anticipation of relief from negative states and feelings as a result of eating' was positively associated with greater BMI reduction.

**Table 3.12** Pearson correlations between BMI reduction, weight change and craving state subscales

FCQ-S	BMI change	Weight change
	r	r
Baseline—intent	0.269	0.181
Baseline—ANT+	0.134	0.110
Baseline—ANT-	0.208	0.126
Baseline—control	0.078	-0.011
Baseline—hunger	0.239	0.222
Baseline—total	0.210	0.143
Change—intent	<b>-0.350+</b>	<b>-0.344+</b>
Change—ANT+	-0.083	-0.124
Change—ANT-	-0.304	-0.292
Change—control	-0.263	-0.225
Change—hunger	-0.265	-0.321
Change—total	-0.304	-0.315

+  $p < 0.05$ ; note that negative correlation is mean that BMI change is associated with increased change in FCQ-s, however, increased change in FCQ-S is depicting increase the score, and increase the score is mean a reduction in the level of FCQ-S.

Baseline FCQ-T was correlated negatively with weight change, but not significantly, and it was found to be low in strength, which means that the food cravings level (FCQ-T) at baseline did not have a strong influence on subsequent BMI change (Table 3.13). In other words, no matter what food craving trait level the participants started with, they still had a good chance of losing weight by using the study’s intervention method. Changes in FCQ-T subscales were positively correlated with weight change such that greater reductions in FCQ-T were associated with greater BMI reduction. The significant, positive correlations between weight, BMI reduction and FCQ-T reduction were present in two subscales (‘the anticipation of positive reinforcement that might result from eating’ and the ‘emotions that might be experienced before or during food cravings or eating’). In addition, there were trend values with the hunger subscale (0.057) and the total FCQ-T score (0.054).

In short, reduction in weight and BMI was correlated positively with the reduction in the ‘intense desire to eat’ dimension of FCQ-S and with three FCQ-T dimensions: ‘anticipation of positive reinforcement that might result from eating’, ‘craving as a physiological state’ and ‘emotions that might be experienced before or during food cravings or eating’.

**Table 3.13** Pearson correlations between BMI reduction, weight change and craving trait subscales (baseline and changes)

FCQ-T	BMI change	Weight change
	r	r
Baseline—ANT+	-0.331	-0.226
Baseline—ANT-	-0.254	-0.163
Baseline—intent	-0.068	0.015
Baseline—cues	-0.186	-0.194
Baseline—thoughts	-0.183	-0.105
Baseline—hunger	-0.209	-0.162
Baseline—control	-0.141	-0.064
Baseline—emotions	-0.229	-0.093
Baseline—guilt	0.058	0.078
Baseline—Total	-0.23	-0.136
Change—ANT+	<b>0.414<sup>+</sup></b>	<b>0.362<sup>+</sup></b>
Change—ANT-	0.154	0.096
Change—intent	0.074	0.013
Change—cues	0.266	0.268
Change—thoughts	0.262	0.142
Change—hunger	0.325	<b>0.34<sup>+</sup></b>
Change—control	0.282	0.178
Change—emotions	<b>0.373<sup>+</sup></b>	0.242
Change—guilt	-0.065	-0.11
Change—Total	0.328	0.24

+  $p < 0.05$ ; Note that negative correlation reflecting increase BMI change is associated with decrease FCQ-T change

#### 3.5.1.3.d Correlation between and craving dimensions and commandments' commitment.

We hypothesised that reductions in food craving trait dimensions would be correlated with commitment to the commandments. A Pearson correlation was computed to assess the relationship between participants' commitment to the commandments and changes in the FCQ-T subscales. Changes on the FCQ-T

(subscales and total scores) were not correlated significantly with total commitment to the 10 commandments (see Table 3.14).

**Table 3.14** Pearson correlations between craving state subscales and total Commitment to the commandments

FCQ-T	Total commitment	
	r	p
Change—ANT+	-0.24	0.165
Change—ANT-	0.002	0.993
Change—intent	-0.248	0.151
Change—cues	-0.246	0.151
Change—thoughts	-0.209	0.227
Change—hunger	-0.234	0.177
Change—control	-0.093	0.596
Change—emotions	-0.128	0.465
Change—guilt	0.141	0.42
Change-total	-0.196	0.26

However, the change in FCQ-T (subscale and total) was found to have some significant correlations with commitment to specific commandments (see Table 3.15). Increased commitment to the B1 ‘sugars are evil’ commandment clearly correlated negatively with the total FCQ-T score reduction and the score reductions in the following FCQ-T dimensions: ‘intent to consume food’, ‘cues that trigger craving’, ‘thoughts or preoccupation with food’ and ‘craving as hunger’. Thus, an increased commitment to the commandment that aims to reduce sugar intake (B1, ‘sugars are evil’) is associated with a decrease in total FCQ-T, and it correlated specifically and strongly with four food craving trait dimensions: ‘intention and plan to consume food’, ‘cues that might trigger food craving’, ‘hunger as craving’ and ‘thoughts about food’. In contrast, commitment to the B7 ‘enjoy your food’ commandment was correlated positively with change in ‘guilt from cravings’ dimension scores; thus, increased commitment to the B7 ‘enjoy your food’ commandment correlated with increased feelings of guilt about food cravings. In addition, for the score of the trait dimension of ‘thoughts or preoccupation with food’ was correlated negatively with the commitment to B10 ‘no buzz with fizz’ commandment. Participants who successfully committed

themselves to the B10 ‘no buzz with fizz’ commandment achieved a greater impact on ‘preoccupation with food’ food-craving dimension.

In short, the more a participant committed to the B1 ‘sugars are evil’, B7 ‘enjoy your food’ and B10 ‘no buzz with fizz’ commandments, the more significant a reduction was achieved in specific FCQ-T subscales (‘intention and plan to consume food’, ‘cues that might trigger food craving’, ‘hunger as craving’ and ‘thoughts about food’).

**Table 3.15** Correlations between craving trait subscales and commitment to the commandments

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
<b>Change</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>
ANT+	-0.324	-0.239	-0.144	-0.162	0.032	-0.092	-0.112	-0.218	-0.098	-0.249
ANT-	-0.075	-0.011	0.021	-0.173	0.088	0.104	0.127	-0.056	0.191	-0.099
Intent	<b>-0.422+</b>	-0.19	-0.166	-0.232	-0.17	-0.16	-0.021	-0.076	-0.061	-0.239
Cues	<b>-0.386+</b>	-0.256	-0.142	-0.165	-0.268	-0.055	-0.177	-0.058	-0.093	-0.25
Thoughts	<b>-0.465<sup>^</sup></b>	-0.323	0.189	-0.18	-0.079	-0.134	0.223	-0.035	0.12	<b>-0.438<sup>^</sup></b>
Hunger	<b>-0.399+</b>	-0.32	-0.222	-0.306	-0.094	-0.132	0.106	-0.059	0.022	-0.272
Control	-0.233	-0.127	0.153	-0.159	-0.032	-0.042	0.061	-0.036	0.165	-0.113
Emotions	-0.193	-0.103	-0.129	-0.151	-0.021	-0.037	0.183	-0.222	0.104	-0.281
Guilt	-0.036	0.000	0.137	-0.096	0.222	0.116	<b>0.516<sup>^</sup></b>	0.179	0.299	-0.142
Total	<b>-0.379+</b>	-0.241	-0.163	-0.227	-0.061	-0.077	0.112	-0.098	0.086	-0.31

<sup>^</sup> p<0.01, + p<0.05

### 3.5.1.4 Attitude variables

#### 3.5.1.4.1 Implicit association test.

##### 3.5.1.4.1.a Baseline difference between dropout and completion groups.

We hypothesized that dropout group’s implicit attitudes towards healthy and unhealthy food differed from those of the completion group. An independent t-test was conducted to compare the groups’ implicit attitudes towards healthy and unhealthy food. Table 3.16 shows the difference in IAT baseline between the groups. There is no significant difference in the groups’ implicit attitudes to healthy and unhealthy foods.

**Table 3.16** Baseline difference between dropout and completion groups

	<b>Baseline—dropout (n=32)</b>	<b>Baseline—completion (n=35)</b>	<b>Difference</b>	<b>P value</b>
IAT	1.054±0.297	1.139±0.262	0.084±0.068	0.224

**3.5.1.4.1.b Change in IAT.**

The present study hypothesized that the intervention would improve individuals' implicit attitudes towards healthy and unhealthy food and used the IAT (Greenwald et al., 1998) to assess those attitudes. There was no difference in IAT scores from baseline and after 3 months of the intervention (see Table 3.17). This result might indicate that the intervention had no effects on implicit attitudes towards healthy and unhealthy food among the participants. However, the small change in IAT could be attributed to the high score at baseline (1.138).

**Table 3.17** Change in IAT scores

	<b>Baseline</b>	<b>3 months after the intervention</b>	<b>Difference</b>	<b>P value</b>
IAT	1.138±0.236	1.145±0.27	0.00686±0.21	0.85

**3.5.1.4.1.c Correlation between implicit attitudes and body weight measures.**

We hypothesised that weight loss and BMI reduction would be correlated negatively with increased scores of implicit attitudes which reflecting increase attitudes towards healthy foods. A Pearson's correlation was calculated for the relationship between the change in IAT score and achieved weight loss and BMI reduction. Table 3.18 shows the correlation between IAT (baseline and change) and BMI (baseline and change).



**Table 3.18** BMI and weight correlation with IAT, both baseline and change

IAT	Baseline		Change	
	BMI	weight	BMI	Weight
	r	r	r	r
Baseline—IAT	0.249	0.351+	-0.147	-0.101
Change—IAT	-0.196	-0.288	-0.044	0.005

+ p&lt;0.05

Baseline IAT was positively correlated with baseline BMI but not significantly. In addition, increased IAT scores were negatively but not significantly correlated with BMI reduction. In short, there was no significant correlation between IAT change and BMI and weight change.

#### **3.5.1.4.1.d Correlation between implicit attitude and commandments' commitment.**

The study hypothesised that implicit attitudes might support participants' commitment to the intervention as it is known that implicit attitudes are important in eating behaviour (Papies et al., 2009, Aarts et al., 2008). Thus, the Pearson's correlation was computed for the relationship between participants' commitment to the commandments and IAT score. Table 3.19 presents the correlation of commitment to diet commandments and baseline and change IAT scores. Commitment to most commandments was correlated positively with baseline IAT scores; in other words, participants with high baseline IAT scores showed higher levels of commitment to the diet commandments. However, the change in IAT score did not shown any significant correlation with the level of commitment to the commandments. In short, there were no correlations between commitment to the commandments and IAT score change.

**Table 3.19** Correlation of commitment to commandments with baseline and change IAT

	<b>Baseline—IAT</b>	<b>IAT change</b>
	<b>r</b>	<b>r</b>
Sugars are evil	<b>0.415<sup>+</sup></b>	-0.278
Veg and fruit you need	<b>0.409<sup>+</sup></b>	-0.202
Rich with fibre	<b>0.430<sup>+</sup></b>	-0.213
Picky with the meat	-0.121	-0.102
Have High with the low	<b>0.365<sup>+</sup></b>	-0.134
Short of Salt	0.277	-0.224
Enjoy your food	0.118	-0.260
Regular is better	<b>0.499<sup>^</sup></b>	-0.165
Long ways to eat	0.327	-0.329
No buzz with fizz	0.358	-0.181
Total commitment	0.418	-0.315

<sup>^</sup> p<0.01, + p<0.05

### 3.5.1.4.2 Explicit attitudes

#### 3.5.1.4.2.a Baseline difference between dropout and completion groups.

An independent t-test was performed to determine whether the dropout group's explicit attitudes towards healthy and unhealthy food differed from those of the completion group. At baseline, there were significant differences in the groups' explicit attitudes towards healthy and unhealthy food (see Table 3.20). Compared with completion group, the dropout group had lower explicit attitudes towards healthy food (-3.06±1.28) and higher explicit attitudes towards unhealthy food (3.07±1.28). In short, there were significant differences in the dropout and completion groups' explicit attitudes towards healthy and unhealthy food.

**Table 3.20** Baseline difference between dropout and completion groups

<b>EAQ</b>	<b>Baseline—dropout</b>	<b>Baseline— completion</b>	<b>Difference</b>	<b>P value</b>
Explicit—healthy	42.28±5.47	45.34±4.99	-3.06±1.28	<b>0.020+</b>
Explicit—unhealthy	32.63±5.60	29.43±5.52	3.07±1.28	<b>0.022+</b>

+ p<0.05

#### 3.5.1.4.2.b Changes in explicit attitudes towards healthy and unhealthy food.

We hypothesised that the study intervention would increase explicit attitudes towards healthy food and inhibit explicit attitudes towards unhealthy food. A paired-sample t-test found a significant difference ( $p < 0.01$ ) in explicit attitudes towards healthy and unhealthy food at baseline and 3 months after the intervention (see Table 3.21). Explicit attitudes towards healthy food had increased, and explicit attitudes towards unhealthy food had decreased.

**Table 3.21** Change in explicit attitudes

EAQ	Baseline	3 months after the intervention	Difference	P value
Explicit-healthy	45.34±4.99	49.26±4.65	3.91±4.45	<b>0.000*</b>
Explicit-unhealthy	29.43±5.52	24.4±6.94	-5.03±7.37	<b>0.000*</b>

\*: p value < 0.0005

#### 3.5.1.4.2.c Correlation between explicit attitudes and body weight measures.

The study hypothesised that improvements in explicit attitudes towards healthy and unhealthy food would be correlated with weight loss. The Pearson's correlation was calculated for the relationship between participants' explicit attitudes towards healthy and unhealthy food and their body weight and BMI (baseline and loss). Table 3.22 shows the correlations between scores for explicit attitudes towards healthy and unhealthy food (baseline and changes) and BMI and weight (baseline and changes). There are no significant correlations found between the changes in body weight measurements and the changes in the explicit attitudes towards healthy and unhealthy food. However, a negative correlation was found between the baseline score for explicit attitudes towards unhealthy food and the change in BMI and weight, meaning that participants with higher scores for explicit attitudes towards unhealthy food had a smaller BMI change. Moreover, there was positive correlation between the baseline of BMI and the change in explicit attitudes towards healthy food; in other words, participants with greater BMI at baseline showed higher subsequent change in their explicit attitudes towards healthy food.

In short, changes in explicit attitudes towards healthy and unhealthy food were not correlated with BMI reduction and weight loss.

**Table 3.22** BMI and weight correlation with EAQ, both baseline and change

EAQ	Baseline		Change	
	BMI	Weight	BMI	Weight
	r	r	r	r
baseline-H-food	-0.253	-0.280	-0.002	0.080
baseline-UNH-food	0.144	0.163	<b>-0.337<sup>+</sup></b>	<b>-0.358<sup>+</sup></b>
Change-H-food	<b>0.355<sup>+</sup></b>	0.322	-0.206	-0.219
Change-UNH-food	-0.123	-0.118	0.278	0.284

+  $p < 0.05$ , EAQ; explicit attitudes questionnaires, H: healthy food; UNH: unhealthy food

#### 3.5.1.4.2.d Correlation between explicit attitudes and commitment to commandments.

We hypothesised that improvement in explicit attitudes towards healthy and healthy food would be correlated with commitment to the commandments. A Pearson's correlation was computed for the relationship between participants' commitment to the commandments and explicit attitudes towards healthy and unhealthy food. Table 3.23 shows these correlations. There was no significant correlation between commitment to diet commandments and change in explicit attitudes towards healthy and unhealthy foods. There was a significant correlation between baseline scores and commitment to the commandment B7, meaning that participants with higher baseline scores on explicit attitudes towards healthy foods showed greater commitment to 'enjoy your food' commandment. In short, improvement in explicit attitudes towards healthy and unhealthy food was not shown to be correlated with commitment to the commandments.

**Table 3.23** Correlation of commitment with explicit attitudes towards food

commandments	Baseline		change	
	H	UNH	H	UNH
	r	r	r	r
Sugars are evil	-0.034	-0.028	0.106	-0.058
Veg and fruit you need	-0.184	0.110	0.237	0.064
Rich with fibre	-0.060	0.211	0.231	0.108
Picky with the meat	0.296	-0.145	-0.179	0.2
Have High with the low	-0.011	-0.161	0.240	0.005
Short of Salt	0.074	-0.069	0.240	-0.014
Enjoy your food	<b>0.495<sup>^</sup></b>	0.2	-0.285	0.224
Regular is better	0.209	0.159	0.048	0.132
Long ways to eat	0.144	0.055	0.108	0.061
No buzz with fizz	-0.215	-0.110	0.257	0.029
Total commitment	0.117	0.042	0.090	0.118

<sup>^</sup> p<0.01

In fact, this study found positive correlations between changes in the implicit-association test (IAT) score and the explicit attitudes towards unhealthy food change score ( $r=0.40$ ,  $p=0.016$ ). This positive correlation means that an increase in the implicit attitudes towards healthy food is associated with an increase in the explicit attitudes towards unhealthy food. To ensure the validity of our result, we performed two partial correlations. In the first analysis, we controlled the IAT baseline and found a continuation of the significant positive correlation ( $r=0.41$ ,  $p=0.015$ ). We also observed a continuation for the significant positive correlation when we controlled the baseline for the explicit attitudes towards unhealthy food ( $r=0.476$ ,  $0.004$ ).

### 3.5.2 The result report of 6 months after the intervention

Twenty-six (74.3%) of the 35 overweight and obese female participants who enrolled in this study completed the 6-month period of using the tools and being committed to the target. This section presents the findings from the analysis to determine the effectiveness of the study intervention (10 diet commandments based on a cognitive behavioural intervention) on body weight and composition, food cravings

and implicit and explicit attitudes. We also show the associations among the main outcomes. Additionally, we identify the predictors of achieved weight loss.

### 3.5.2.1 Commitment to the 10 commandments

Table 3.24 shows the means and SD of commitment to the commandments over the first 3 months, final 3 months and whole study period of 6 months. The level of commitment to the diet commandments varies over 6 months. B8 ‘regular is better’ had the highest level of commitment (135.38±35.02), and B1 ‘sugars are evil’ the lowest level (110.04±31.63). Comparing the levels of commitment to the commandments in first and last 3 months shows is a strong, significant ( $p < 0.0005$ ) reduction in the commitment to B2 ‘veg and fruit you need’ commandment (-8.38±9.59) and a significant reduction in the commitment to B5 ‘have a high with the low’ (-6.58±12.99). Generally, there was a significant decline in total commitment to the commandments (-39.71±88.37). Notably, the reductions in commitment to three commandments (B1 ‘sugars are evil’, B4 ‘picky with the meat’, and B9 ‘long ways to eat’) were obtained trend values (see Table 3.24).

**Table 3.24** Level of commitment to commandments in the first and last 3 months

Commandments	First 3 months (day/84 days)	Last 3 months (day/84 days)	Difference	P value	Total 6 months (day/168days)
B1	57.81±15.16	52.54±18.48	-4.99±13.38	0.082	110.04±31.63
B2	69.58±9.93	61.58±15.69	-8.38±9.59	<b>0.000*</b>	131.54±24.59
B3	66.92±10.9	62.88±16.78	-3.38±14	0.250	129.13±24.76
B4	65.77±20.26	60±19.29	-4.33±10.85	0.063	124.33±38.25
B5	63.50±10.54	56.42±17.53	-6.58±12.99	<b>0.021+</b>	119.42±26.05
B6	68.11±14.48	64.71±16.24	-2.67±10.85	0.241	132.08±29.16
B7	68.35±14.49	65.04±20.76	-0.33±14.48	0.271	133.42±33.28
B8	68.23±17.82	67.79±18.28	0.21±10.71	0.925	135.38±35.02
B9	62.73±16.84	56.46±21.21	-5.17±14.09	0.086	118.08±35.84
B10	62.27±18.97	60.21±19.62	-1.13±12.91	0.673	121.54±36.73
Total commitment	653.27±106.47	607.63±140.58	-39.71±88.37	<b>0.038+</b>	1254.96±235.34

\*p value<0.05; +p value<0.05

### 3.5.2.2 Body Characteristics

#### 3.5.2.2.a Body characteristics in dropout and completion Group.

An independent t-test was conducted to compare the body weight and composition of the dropout and completion groups. Table 3.25 displays the baseline characteristics of the study participants (dropout and completion groups). The groups had no significant differences.

**Table 3.25** Baseline characteristics in the study participants (recruited, dropout, and completed groups)

Characteristics	3months— Dropout (n=9)	Baseline— Completion (n=26)	Difference	P value
Age (year)	35.44±13.28	38.35±15.45	-2.9	0.619
Height (cm)	165.56±7.38	163.23±6.55	2.3	0.38
Weight (kg)	89.97±16.86	86.71±17.99	3.26	0.638
BMI (kg/m <sup>2</sup> )	33±6.1	32.15±5.01	0.85	0.682
Waist-c (cm)	98.06±13.32	98.06±13.39	-0.002	1
Hip-c (cm)	115.83±13.13	114.23±12.07	1.6	0.739
WHR	0.85±0.04	0.86±0.05	-0.01	0.575
WHtR	0.59±0.09	0.6±0.07	-0.01	0.821
FM (%)	39.7±12.01	37.41±11.85	2.29	0.622
SMM (%)	27.89±5.21	27.25±4.34	0.64	0.721

†: p value<0.05

#### 3.5.2.2.b body characteristics in completion group.

The completion group's body characteristics and composition at baseline, 3 months after the intervention, and 6 months after the intervention (n=26, age 38.35±15.45, BMI 32.15±5.01) are presented in Table 3.326.

**Table 3.26** Mean and SD of body characteristics

<b>Characteristics</b>	<b>Baseline M±SD</b>	<b>3 months after the intervention M±SD</b>	<b>6 months after the intervention M±SD</b>
Weight (kg)	85.4±17.7	79.6±16.3	77.6±15.9
BMI (kg/m <sup>2</sup> )	31.8±4.9	29.7±4.5	28.9±4.4
Waist-c (cm)	97.4±13.4	91.6±12.8	89.3±12.8
Hip-c (cm)	113.4±12.2	108.6±10.9	107±11.4
WHR (cm)	0.86±0.05	0.84±0.06	0.83±0.06
WHtR	0.6±0.07	0.56±0.07	0.6±0.07
Body Fat (%)	36.5±11.4	32.6±10.7	29.9±10.8
SMM (kg)	27±4.4	26.2±4.2	26.5±4.3

Over 6 months, the intervention achieved improvement in all body characteristics, including reductions in body weight (-7.8 kg), BMI (-2.9), SSM (-0.5 kg), body fat (6.2%), waist-c (-8.4 cm), hip-c (6.1 cm), WHR (0.03 cm) and WHtR (0.05 cm). A one-way repeated measures analysis of variance (ANOVA) was performed to determine whether the body characterises variables changed within the study sample. The outcomes are displayed presented in Table 3.27. Mauchly's test showed that the sphericity assumptions were met ( $p > .05$ ) for the variables of weight, WHR, and SMM, but violated for the BMI, waist-c, hip-c, WHtR and body fat. The ANOVA results revealed significant differences in all variables at the three points of measurement. In short, the intervention achieved changes in all body characteristics over the study period.



**Table 3.27** Results of one-way repeated measures ANOVA for body characteristics

Characteristics	SS	df	MS	F	P value	Partial $\eta^2$
Weight	856.19	2	428.094	41.52	<b>0.000*</b>	0.624
	515.48	50	10.31			
BMI	114.83	1.46	78.57	49.89	<b>0.000*</b>	0.666
	57.55	36.54	1.58			
Waist-c	489.44	1.31	647.55	74.09	<b>0.000*</b>	0.771
	252.23	28.86	8.74			
Hip-c	487.18	1.6	305.17	41.79	<b>0.000*</b>	0.665
	256.49	35.12	7.30			
WHR	0.010	2	0.005	30.32	<b>0.000*</b>	0.579
	0.007	44	0.000			
WHtR	0.033	1.3	0.025	81.83	<b>0.000*</b>	0.788
	0.009	28.88	0.000			
Fat%	450.08	1.55	291.33	47.49	<b>0.000*</b>	0.683
	208.49	33.99	6.13			
SMM	7.31	2	3.66	5.54	<b>0.007^</b>	0.201
	29.02	44	0.778			

\*p value<0.05; ^p value<0.01

In Table 3.28, the Bonferroni comparison showed that, 3 months after the intervention, all body characteristics had significantly decreased from baseline, which supported the hypothesis. The comparison of 6 months and 3 months after the intervention found (significant reduction in BMI, waist, WHR, WHtR and body fat. Six months after the intervention, the Bonferroni comparison detected significant reductions in all body characteristics variables compared to baseline, except for SMM. In short, over 3 months, the intervention resulted in a reduction of all body characteristics, while after 6 months, its influence remained for all characteristics except SMM.

**Table 3.28** Pairwise comparison of mean scores for body characteristics

Variable	Time	Mean	Pairwise	Mean difference	P value
Weight	T1	85.39	T2-T1	-5.83	<b>0.000*</b>
	T2	79.56	T3-T1	-7.8	<b>0.000*</b>
	T3	77.59	T3-T2	-1.97	0.121
BMI	T1	31.76	T2-T1	-2.04	<b>0.000*</b>
	T2	29.72	T3-T1	-2.89	<b>0.000*</b>
	T3	28.87	T3-T2	-0.85	<b>0.019+</b>
Waist-c	T1	97.65	T2-T1	-5.8	<b>0.000*</b>
	T2	91.85	T3-T1	-8.39	<b>0.000*</b>
	T3	89.26	T3-T2	-2.59	<b>0.000*</b>
Hip-c	T1	113.13	T2-T1	-5	<b>0.000*</b>
	T2	108.13	T3-T1	-6.12	<b>0.000*</b>
	T3	107.02	T3-T2	-1.11	0.324
WHR	T1	0.862	T2-T1	-0.017	<b>0.001^</b>
	T2	0.845	T3-T1	-0.029	<b>0.000*</b>
	T3	0.833	T3-T2	-0.012	<b>0.002^</b>
WHtR	T1	0.599	T2-T1	-0.036	<b>0.000*</b>
	T2	0.563	T3-T1	-0.052	<b>0.000*</b>
	T3	0.547	T3-T2	-0.016	<b>0.000*</b>
Body fat (%)	T1	36.02	T2-T1	-4.02	<b>0.000*</b>
	T2	31.99	T3-T1	-6.16	<b>0.000*</b>
	T3	29.86	T3-T2	-2.12	<b>0.001*</b>
SMM	T1	27.04	T2-T1	-0.787	<b>0.005*</b>
	T2	26.25	T3-T1	-0.504	0.273
	T3	26.53	T3-T2	0.283	0.551

\* $p < 0.0005$ ; ^  $p < 0.01$ ; +  $p < 0.05$ ; WHR: waist to hip ratio, WHtR: waist to height ratio, SMM: skeletal muscle mass

Body weight and BMI declined steadily. The means of weight loss and BMI reduction after 3 months were -5.83kg and -2.04 kg/m<sup>2</sup>, respectively, and their means after 6 months were greater than at the first visit, -7.8kg and -2.89 kg/m<sup>2</sup>, respectively.

### 3.5.2.2.c Relationship between commitment and change in body weight measures.

Table 3.29 shows the correlations between commitment and change in BMI and weight loss over 6 months. BMI change had a highly significant correlation to commitment to the B1 ‘sugars are evil’, B5 ‘have a high with the low’, B8 ‘regular is better’ and B10 ‘no buzz with fizz’ commandments ( $p < 0.01$ ) and a significant correlation with the B9 ‘long ways to eat’, B2 ‘veg and fruit you need’ and B3 ‘rich with fibres’ commandments ( $p < 0.05$ ). These correlations were negative, which means that increased commitment to the commandments resulted in a reduction of body weight measures over 6 months. In short, correlations were observed between weight loss and commitment to all commandments, except for B4 ‘picky with the meat’, B6 ‘short of salt’ and B10 ‘no buzz with fizz’.

**Table 3.29** Correlations between commitment to commandments and weight Change over 6 months

Commandments	BMI Change		Weight Change	
	r	P value	r	P value
B1 6 months	-0.591	<b>0.002</b> <sup>^</sup>	-0.596	<b>0.002</b> <sup>^</sup>
B2 6 months	-0.455	<b>0.025</b> <sup>+</sup>	-0.451	<b>0.027</b> <sup>+</sup>
B3 6 months	-0.498	<b>0.013</b> <sup>+</sup>	-0.471	<b>0.020</b> <sup>+</sup>
B4 6 months	-0.218	0.306	-0.212	0.319
B5 6 months	-0.522	<b>0.009</b> <sup>^</sup>	-0.531	<b>0.008</b> <sup>^</sup>
B6 6 months	-0.375	0.071	-0.350	0.094
B7 6 months	-0.719	<b>0.000</b> <sup>*</sup>	-0.697	<b>0.000</b> <sup>*</sup>
B8 6 months	-0.497	<b>0.013</b> <sup>+</sup>	-0.465	<b>0.022</b> <sup>+</sup>
B9 6 months	-0.642	<b>0.001</b> <sup>^</sup>	-0.629	<b>0.001</b> <sup>^</sup>
B10 6 months	-0.176	0.411	-0.207	0.331
Total B 6 months	-0.720	<b>0.000</b> <sup>*</sup>	-0.712	<b>0.000</b> <sup>*</sup>

\* $p < 0.0005$ ; <sup>^</sup>  $p < 0.01$ ; <sup>+</sup>  $p < 0.05$

### 3.5.2.3 Food Cravings

#### 3.5.2.3.a Change in food craving state.

An independent t-test found no significant differences in the food cravings of the dropout and completion groups (see Table 3.30). Therefore, cravings were not the main reason for dropping out of the present study.

**Table 3.30** FCQ-S baseline for dropout and completion groups

<b>FCQ-S</b>	<b>Baseline—drop out (n=9)</b>	<b>Baseline—completion (n=26)</b>	<b>Difference</b>	<b>P value</b>
intent	10±3.94	10.04±3.94	-0.04	0.98
ANT+	10.11±3.86	10.23±4.45	-0.12	0.94
ANT-	9.33±2.96	9.73±4.07	-0.4	0.79
Control	10.56±32.8	10.12±3.96	0.44	0.76
Hunger	10.11±2.85	9.65±4.32	0.46	0.77
Total	50.11±14.89	49.77±18.43	0.34	0.96

The mean and SD of FCQ-S at baseline, 3 months after the intervention, and 6 months after the intervention are presented in Table 3.31. FCQ-S scores over increased over 6 months, which reflects decreases in the craving-state levels.

**Table 3.31** Mean and SD of FCQ-S

<b>FCQ-S</b>	<b>Baseline M±SD</b>	<b>3 months after the intervention M±SD</b>	<b>6 months after the intervention M±SD</b>
Intent	9.92±3.89	12.42±2.4	12.81±2.74
ANT+	10.15±4.38	13±2.69	13.31±2.96
ANT-	9.62±4.05	12.15±3.04	13.08±2.53
Control	10.12±3.96	13.23±2.21	13.31±2.39
Hunger	9.54±4.24	11.35±3.07	12.15±3.17
Total	49.35±18.1	62.15±11.53	64.65±11.68

Over 6 months, the intervention achieved improvement in all FCQ-S dimensions, including in intense desire to eat (-2.9), anticipation of positive reinforcement that might result from eating (-3.2), anticipation of relief from negative states and feelings as a result of eating (-3.5), lack of control over eating and thoughts or preoccupation with food (-3.2) and cravings as a physiological state (-2.6)

One-way repeated measures ANOVA was used to examine whether the FCQ-S subscales scores changed within the study sample over time. The outcomes are presented in Table 3.32. Mauchly's test showed that the sphericity assumptions were met ( $p > .05$ ) for the ANT+ and hunger subscales but violated for the intent, ANT- and control subscales. The ANOVA results revealed significant differences in all FCQ-S subscales between the 3 times of measurement. In short, the study intervention achieved change in FCQ-S dimension over the study period.

**Table 3.32** Results of one-way repeated measures ANOVA for FCQ-S

FCQ-S	SS	df	MS	F	P value	Partial $\eta^2$
Intent	127.56	1.64	78.04	12.53	<b>0.000*</b>	0.334
	254.44	40.86	6.23			
ANT+	157.23	2	78.62	11.19	<b>0.000*</b>	0.309
	351.44	50	7.03			
ANT-	167.08	1.41	118.78	17.15	<b>0.000*</b>	0.407
	243.59	35.165	6.93			
Control	172.49	1.51	113.93	13.58	<b>0.000*</b>	0.352
	317.51	37.85	8.39			
Hunger	93.26	2	46.63	7.24	<b>0.002^</b>	0.225
	322.08	50	6.44			

**P<0.0005; ^ p<0.01**

Table 3.33 presents the Bonferroni comparison which found that, 3 months after the intervention, all FCQ-S subscales had decreased significantly from baseline, which supports the hypothesis. No significant difference in any FCQ-S was detected between three and 6 months after the intervention. However, all FCQ-S subscales showed significant reductions 6 months after the intervention compared to baseline, according to the Bonferroni comparison. In short, the intervention resulted in the reduction of all

FCQ-S dimensions over the first 3 months and overall 6 months but not in the final 3 months of the study.

**Table 3.33** Pairwise comparison of mean FCQ-S scores

<b>Variable</b>	<b>Time</b>	<b>Mean</b>	<b>Pairwise</b>	<b>M difference</b>	<b>P value</b>
Intent	T1	9.92	T2-T1	2.5	<b>0.003<sup>^</sup></b>
	T2	12.42	T3-T1	2.89	<b>0.001<sup>^</sup></b>
	T3	12.81	T3-T2	0.385	1
ANT+	T1	10.15	T2-T1	2.85	<b>0.001<sup>^</sup></b>
	T2	13	T3-T1	3.15	<b>0.004<sup>^</sup></b>
	T3	13.31	T3-T2	0.308	1
ANT-	T1	9.62	T2-T1	2.54	<b>0.000<sup>*</sup></b>
	T2	12.15	T3-T1	3.46	<b>0.000<sup>*</sup></b>
	T3	13.08	T3-T2	0.923	0.153
Control	T1	10.12	T2-T1	3.12	<b>0.001<sup>^</sup></b>
	T2	13.23	T3-T1	3.19	<b>0.003<sup>^</sup></b>
	T3	13.31	T3-T2	0.077	1
Hunger	T1	9.54	T2-T1	1.81	<b>0.04<sup>+</sup></b>
	T2	11.35	T3-T1	2.62	<b>0.013<sup>+</sup></b>
	T3	12.15	T3-T2	0.808	0.515

\*p<0.0005; ^ p<0.01; + p<0.05

### 3.5.2.3.b Change in food craving trait.

An independent t-test was conducted to compare the baseline characteristics of the dropout and completion groups in terms of FCQ-T (see Table 3.34). There were no significant differences between the groups, so food cravings do not seem to be the main reason for dropping out of the study.

**Table 3.34** FCQ-T baseline characteristics of dropout and completion groups

<b>FCQ-T</b>	<b>Baseline— drop out (n=9)</b>	<b>Baseline— completion (n=26)</b>	<b>Difference</b>	<b>P value</b>
ANT+	19.11±6.23	16.5±5.7	2.61	0.256
ANT-	10.78±3.6	9.31±4.1	1.47	0.347
Intent	10.89±3.02	12.12±4.01	-1.23	0.409
Cues	15.78±5.09	18.12±4.68	-2.34	0.216
Thoughts	17.33±4.58	21.5±5.1	-4.17	0.216
Hunger	14.67±3.32	14.58±4.81	0.09	0.959
Control	22.56±6.52	23.65±7.03	-1.1	0.684
Emotions	16.56±5.7	15.96±5.9	0.59	0.795
Guilt	12.22±3.42	12.23	-0.009	0.996
Total	139.89±31.02	143.96±41.6	-4.07	0.79

The means and SD of FCQ-T at baseline, 3 months after the intervention and 6 months after the intervention are presented in Table 3.35. FCQ-T scores decreased over 6 months. Note that the decline in scores reflects a decrease in the FCQ-T level.

**Table 3.35** Mean and SD of FCQ-T

<b>FCQ-T</b>	<b>Baseline</b> <b>M±SD</b>	<b>3 months</b> <b>after the intervention</b> <b>M±SD</b>	<b>6 months</b> <b>after the intervention</b> <b>M±SD</b>
ANT+	16.62±5.53	13.27±5.56	12.62±6.27
ANT-	9.31±4.1	6.81±2.94	6.96±3.68
Intent	12±4.2	9±3.67	8.73±3.84
Cues	18.5±4.39	13.69±4.76	12.96±5.21
Thoughts	21.5±10.51	14.81±6.59	14.42±7.04
Hunger	14.77±4.72	12.31±4.18	11.27±4.24
Control	23.58±7.19	16.92±6.12	17.12±8.32
Emotions	15.92±5.97	11.35±4.52	12±5.76
Guilt	12.31±4.21	11.46±3.91	11.65±4.04
Total	144.5±40.71	109.62±31.13	107.73±39.63

Over 6 months, the intervention achieved improvement in all FCQ-T dimensions, except for guilt from eating. Reductions were realised in the anticipation of positive reinforcement that might result from eating (-4), anticipation of relief from negative states and feelings as a result of eating (-2.4), intention and plan to consume food (-3.3), cues that might trigger food cravings (-5.5), thoughts or preoccupation with food (-7.1), cravings as a physiological state (-3.5), lack of control over eating (-6.5) and emotions that might be experienced before or during food cravings or eating (-3.9).

One-way repeated measures ANOVA was performed to determine whether the FCQ-T subscales changed within the study sample over time. The outcomes of one-way repeated measures ANOVA for body characteristics variables over time are presented in Table 3.36. Mauchly's test showed that the sphericity assumptions were met ( $p > .05$ ) for emotions subscales but violated for the remaining FCQ-T subscales. The ANOVA results revealed significant differences in all FCQ-S subscales between the 3 times of measurement. In short, the study intervention achieved change in all FCQ-T dimensions over the study period, except for the guilt dimension.



**Table 3.36** Results of one-way repeated measures ANOVA for FCQ-T

FCQ-T	SS	df	MS	F	P	Partial $\eta^2$
ANT+	239.41	1.5	159.74	8.46	<b>0.002<sup>^</sup></b>	0.253
	707.26	37.47	18.88			
ANT-	102.08	1.43	71.18	7.98	<b>0.003<sup>^</sup></b>	0.242
	319.92	35.85	8.92			
Intent	171.26	1.32	129.84	11.98	<b>0.001<sup>^</sup></b>	0.324
	357.41	32.98	10.84			
Cues	470.8	1.39	338.86	21.61	<b>0.000<sup>*</sup></b>	0.464
	544.54	34.73	15.68			
Thoughts	823.49	1.17	705.31	14.44	<b>0.000<sup>*</sup></b>	0.366
	1425.85	29.19	48.85			
Hunger	168.03	1.56	107.59	8.75	<b>0.002<sup>^</sup></b>	0.259
	479.97	39.05	12.29			
Control	745.87	1.43	520.28	18.74	<b>0.000<sup>*</sup></b>	0.428
	994.8	35.84	27.76			
Emotions	318.64	2	159.32	10.25	<b>0.000<sup>*</sup></b>	0.291
	777.36	50	15.55			
Guilt	10.23	1.55	6.6	0.827	0.417	0.032
	309.1	38.76	7.98			

\* $p < 0.0005$ ; <sup>^</sup>  $p < 0.01$

Table 3.37 presents a Bonferroni comparison which showed that, 3 months and 6 months after the study intervention, all FCQ-T subscales, except for the guilt subscale, had decreased significantly from baseline, which supports the hypothesis. No significant differences in all FCQ-T measures were found when comparing three and 6 months after the intervention.

In short, the intervention resulted in a significant reduction in all FCQ-T dimensions over the first 3 months but not the later 3 months.

**Table 3.37** Pairwise comparison of mean FCQ-T scores

<b>Variable</b>	<b>Time</b>	<b>Mean</b>	<b>Pairwise</b>	<b>M difference</b>	<b>P value</b>
ANT+	T1	16.62	T2-T1	-3.35	<b>0.004<sup>^</sup></b>
	T2	13.27	T3-T1	-4	<b>0.016<sup>+</sup></b>
	T3	12.62	T3-T2	-0.654	1
ANT-	T1	9.31	T2-T1	-2.5	<b>0.002<sup>^</sup></b>
	T2	6.81	T3-T1	-2.35	<b>0.042<sup>^</sup></b>
	T3	6.96	T3-T2	0.154	1
Intent	T1	12	T2-T1	-3	<b>0.001<sup>^</sup></b>
	T2	9	T3-T1	-3.27	<b>0.006<sup>^</sup></b>
	T3	8.73	T3-T2	-0.269	1
Cues	T1	18.5	T2-T1	-4.81	<b>0.000<sup>*</sup></b>
	T2	13.69	T3-T1	-5.54	<b>0.000<sup>*</sup></b>
	T3	12.96	T3-T2	-0.731	0.741
Thoughts	T1	21.5	T2-T1	-6.69	<b>0.000<sup>*</sup></b>
	T2	14.81	T3-T1	-7.08	<b>0.004<sup>^</sup></b>
	T3	14.42	T3-T2	-0.385	1
Hunger	T1	14.77	T2-T1	-2.46	<b>0.019<sup>+</sup></b>
	T2	12.31	T3-T1	-3.5	<b>0.008<sup>^</sup></b>
	T3	11.27	T3-T2	-1.04	0.380
Control	T1	23.58	T2-T1	-6.65	<b>0.000<sup>*</sup></b>
	T2	16.92	T3-T1	-6.46	<b>0.001<sup>^</sup></b>
	T3	17.12	T3-T2	0.192	1
Emotions	T1	15.92	T2-T1	-4.58	<b>0.000<sup>*</sup></b>
	T2	11.35	T3-T1	-3.92	<b>0.014<sup>+</sup></b>
	T3	12	T3-T2	0.654	1
Guilt	T1	12.31	T2-T1	-0.846	0.348
	T2	11.46	T3-T1	-0.654	1
	T3	11.65	T3-T2	0.192	1

\*p<0.0005; <sup>^</sup> p<0.01; <sup>+</sup> p<0.05

### 3.5.2.3.c Correlations between FCQ-T and change in body weight measures.

Table 3.38 shows the correlations between the FCQ-T subscales and change in BMI and body weight. There were significant correlation between BMI reduction and two subscales of FCQ-T: anticipation of positive reinforcement that might result from eating ‘anticipation of positive reinforcement that may result from eating’ and craving as a physiological state ‘craving as a physiological state’. These two correlations were moderate, so BMI reduction is correlated with the reduction in ‘anticipation of positive reinforcement that may result from eating’ and ‘craving as a physiological state’ subscale scores. In short, BMI reduction was correlated with only two out of nine FCQ-T dimensions, namely ANT+ and hunger.

**Table 3.38** Correlations between FCQ-T and weight change over 6 months

FCQ-S	6 months after the intervention			
	BMI change		W change	
	r	p	r	p
Change—ANT+	0.399	<b>0.043</b> <sup>+</sup>	0.406	<b>0.04</b> <sup>+</sup>
Change—ANT-	0.304	0.131	0.316	0.116
Change—intent	0.347	0.083	0.386	0.052
Change—cues	0.278	0.17	0.271	0.18
Change—thoughts	0.138	0.5	0.146	0.476
Change—hunger	0.411	<b>0.037</b> <sup>+</sup>	0.405	<b>0.04</b> <sup>+</sup>
Change—control	0.246	0.227	0.253	0.212
Change—emotions	0.116	0.572	0.123	0.549
Change—guilt	-0.059	0.775	-0.05	0.807
Change—total	0.281	0.164	0.290	0.15

<sup>+</sup> p<0.05

### 3.5.2.3.d Correlations between FCQ-T and commandments’ commitments

Table 3.39 shows the correlations between the FCQ-T subscales and commitment to the commandments. Commitment to the B1 commandment ‘sugars are evil’ was correlated negatively with four dimensions of FCQ-T: ‘anticipate of positive reinforcement that may result from eating’, ‘intention and plan to consume food’, ‘thoughts or preoccupation with food’, and ‘lack of control over eating’. Commitment to the B4 commandment ‘picky with the meat’ was also correlated with the guilt

subscale. In addition, the intent subscale was correlated with commitment to the B5 ‘have a high with the low’ commandment. Finally, commitment to the B10 commandment ‘no buzz with fizz’ was correlated with thoughts. All of these correlations were negative such that greater reductions of FCQ-T subscale were correlated with higher reductions of BMI.

**Table 3.39** Correlations between commitment to the commandments and FCQ-T

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Change	r	r	r	r	r	r	r	r	r	r
ANT+	<b>-0.415</b>	-0.238	-0.354	-0.024	-0.282	-0.124	-0.284	-0.152	-0.2	-0.211
ANT-	-0.37	-0.185	-0.255	-0.066	-0.325	-0.025	-0.109	-0.122	-0.107	-0.220
Intent	<b>-0.527</b>	-0.395	-0.391	-0.037	<b>-0.437</b>	-0.274	-0.145	-0.1	-0.186	-0.347
Cues	-0.269	-0.005	-0.031	-0.174	-0.055	0.083	-0.187	-0.02	0.116	-0.138
Thoughts	<b>-0.489</b>	-0.297	-0.304	-0.233	-0.199	-0.207	-0.015	-0.055	-0.023	<b>-0.436</b>
Hunger	-0.377	-0.307	-0.307	-0.230	-0.222	-0.071	-0.173	-0.107	-0.161	0.202
Control	<b>-0.446</b>	-0.239	-0.212	-0.194	-0.229	-0.132	-0.149	-0.056	-0.021	-0.161
Emotions	-0.25	-0.008	-0.128	0.082	-0.142	0.057	-0.098	-0.032	0.079	-0.138
Guilt	-0.121	-0.027	0.074	<b>-0.437</b>	0.014	0.148	0.188	0.072	0.231	-0.129
Total	<b>-0.442</b>	-0.231	-0.261	-0.169	-0.244	-0.089	-0.131	-0.076	-0.038	-0.273

p<0.05

### 3.5.2.4 Implicit and explicit Attitudes

#### 3.5.2.4.a Changes in explicit and implicit attitudes

An independent t-test was conducted to compare the body weight and composition of the dropout and completion groups. Table 3.40 illustrates the baseline characteristics of the participants in these groups. There were no significant differences between the baseline dropout group and the baseline completion group.

**Table 3.40** Mean and SD of explicit attitudes towards healthy and unhealthy food

	<b>Baseline—drop out (n=9)</b>	<b>Baseline— completion (n=26)</b>	<b>Difference</b>	<b>P value</b>
IAT	1.07±0.26	1.15±0.27	-0.08	0.46
EAQ—healthy	46.33±6.46	44.96±4.46	1.37	0.485
EAQ— unhealthy	30.89±6.11	28.88±5.33	2	0.356

The mean and SD of the implicit and explicit attitudes towards healthy and unhealthy food at baseline, 3 months after the intervention and 6 months after the intervention are presented in Table 3.41.

**Table 3.41** Means and SDs of the attitudes

<b>Attitudes</b>	<b>Baseline M±SD</b>	<b>3 months after the intervention M±SD</b>	<b>6 months after the intervention M±SD</b>
IAT	1.162±0.264	1.196±0.236	1.094±0.373
Healthy	45±4.48	48.85±4.82	49.5±5.09
Unhealthy	28.92±5.33	24.38±6.88	22.81±6.83

Over 6 months, the intervention achieved improvement in explicit attitudes towards healthy and unhealthy foods but did not seem to affect implicit attitudes. The intervention increased explicit attitudes towards healthy food by 4.5 and decreased explicit attitudes towards unhealthy foods by 6.1. One-way repeated measures ANOVA was used to examine whether implicit and explicit towards healthy and unhealthy food changed within the study sample over time. The outcomes are presented in Table 3.42. Mauchly's test showed that the sphericity assumptions were met ( $p > .05$ ) for explicit attitudes towards healthy and unhealthy food but violated for implicit attitudes. The ANOVA results revealed significant differences in implicit and explicit attitudes towards healthy and unhealthy food between the 3 times of measurement. In short, the study intervention achieved improvements in explicit attitudes towards healthy and unhealthy food over the study period.

**Table 3.42** Results of one-way repeated measures ANOVA for attitudes

Attitudes	SS	df	MS	F	P value	Partial $\eta^2$
IAT	0.141	1.22	0.115	1.19	0.297	0.045
	2.98	30.58	0.097			
Healthy	307.41	2	153.71	14.99	<b>0.000*</b>	0.375
	512.59	50	10.25			
Unhealthy	524.018	2	262.09	12.3	<b>0.000*</b>	0.330
	1065.82	50	21.32			

\*  $p < 0.0005$ 

Table 3.43 presents the Bonferroni comparison which showed that, from baseline to 3 months after the intervention, implicit attitudes did not change significantly, while explicit attitudes did change significantly. From 3 months after the intervention to 6 months after the intervention, there were no significant differences in all implicit and explicit attitudes. The Bonferroni comparison of baseline and 6 months after the intervention found significant change in explicit attitudes towards healthy and unhealthy food but not in IAT scores. In short, over first 3 months, the intervention produced improvements in explicit attitudes towards healthy and unhealthy food, while in the last 3 months, its influence continued only on explicit attitudes towards healthy food.

**Table 3.43** Pairwise comparison of mean scores for attitudes

Variable	Time	Mean	Pairwise	M difference	P value
IAT	T1	1.16	T2-T1	0.034	0.865
	T2	1.19	T3-T1	-0.068	1
	T3	1.09	T3-T2	-0.102	0.571
EAQ—healthy	T1	45	T2-T1	3.85	<b>0.001<sup>^</sup></b>
	T2	48.85	T3-T1	4.5	<b>0.000*</b>
	T3	49.5	T3-T2	0.654	1
EAQ—unhealthy	T1	28.92	T2-T1	-4.54	<b>0.014<sup>+</sup></b>
	T2	24.38	T3-T1	-6.12	<b>0.000*</b>
	T3	22.81	T3-T2	-1.58	0.376

\* $p < 0.0005$ ; <sup>^</sup>  $p < 0.01$ ; <sup>+</sup>  $p < 0.05$

### 3.5.2.4.b Correlation between attitudes and body weight measures

Table 3.44 shows the correlation between the change in BMI and weight loss values and in implicit and explicit attitudes towards healthy and unhealthy food. There was significant negative correlation between BMI loss and baseline explicit attitudes towards unhealthy food, in which participants with greater explicit attitude towards unhealthy food scores at baseline experienced smaller subsequent weight change. On other hand, there was a positive correlation between the explicit attitude towards unhealthy food change score and BMI loss, such that a greater reduction in explicit attitudes towards unhealthy food was associated with greater weight change. In short, BMI reduction was correlated with a change in explicit attitudes towards unhealthy food.

**Table 3.44** Correlations between attitudes and weight change over 6 months

	<b>6 months after the intervention</b>			
	BMI change		Weight change	
	r	p	r	p
Pre-IAT	-0.223	0.274	-0.268	0.186
Change-IAT	0.176	0.391	0.206	0.312
Pre-healthy	-0.212	0.297	-0.132	0.520
Change healthy	-0.252	0.215	-0.286	0.157
Pre-unhealthy	-0.409	<b>0.038<sup>+</sup></b>	-0.399	<b>0.044<sup>+</sup></b>
Change unhealthy	0.424	<b>0.031<sup>+</sup></b>	0.438	<b>0.025<sup>+</sup></b>

+ p<0.05

Table 3.45 shows the correlations between implicit and explicit attitudes towards healthy and unhealthy food and commitment to the commandments.

**Table 3.45** Correlations between commitment to the commandments and attitudes to foods

	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
<b>Change</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>
IAT	<b>-0.504</b>	-0.273	-0.312	0.024	<b>-0.564</b>	<b>-0.425</b>	-0.156	-0.339	-0.207	-0.288
EAQ-h	<b>0.481</b>	0.261	0.250	-0.091	0.343	0.217	-0.07	0.061	0.165	0.383
EAQ-unh	-0.094	-0.157	-0.115	0.048	-0.09	0.146	-0.138	0.010	-0.067	0.074

+ p<0.05

The IAT change score was correlated negatively with commitment to three commandments: B1 ‘sugars are evil’, B5 ‘have a high with the low’ and B6 ‘short of salt’. However, the change in IAT was too small and correlated with some commandments, so we performed a partial correlation between IAT change scores and commitment to the three commandments while controlling for the baseline IAT score. The results show no correlation between IAT and the commitment (see Table 3.46), meaning that higher commitment did not change the implicit attitudes score. However, this result can be explained by the high IAT score at baseline, which makes increasing the score exceedingly difficult.

The commitment to the B1 commandment ‘sugars are evil’ was correlated positively with EAQ-h, such that increased commitment to this commandment was associated with greater EAQ-h change.

**Table 3.46** Partial correlation between IAT score and commitments to B1, B5, B6

Correlations			SUM.B1	SUM.B5	SUM.B6	IAT.pre.to.6
Control Variables	SUM.B1	Correlation	1.000	.791	.687	-.391
		Significance (2-tailed)	.	.000	.000	.065
		df	0	21	21	21
	SUM.B5	Correlation	.791	1.000	.780	-.319
		Significance (2-tailed)	.000	.	.000	.138
		df	21	0	21	21
	SUM.B6	Correlation	.687	.780	1.000	-.305
		Significance (2-tailed)	.000	.000	.	.157
		df	21	21	0	21
	IAT.pre.to.6	Correlation	-.391	-.319	-.305	1.000
		Significance (2-tailed)	.065	.138	.157	.
		df	21	21	21	0

In short, higher explicit attitudes towards healthy food were correlated with commitment to the B1 commandment, which emphasises improving control of intake of food and drinks high in sugar.



### **3.5.3 The results report after 3 months of ending the intervention (follow-up)**

The current study aimed to examine the lasting effects of our intervention, three months after the end of the intervention. In order to achieve this aim, the participants were not made aware of the follow-up when they have been recruited for the intervention. The participants were asked to stop submitting their reflection forms and try to follow the 10 commandments in the future, relying on their learned skills. Three months after their last measurement session, the participants were contacted and invited to come over to the laboratory at department of school of sport, health and exercise (SSHE), once, to re-measure the study variables, where the body weight, BMI and body composition were assessed. Thirteen (BMI  $28.61 \pm 4.6$ ) participants, 50% of the participants taken part for 6 months intervention period, replied to our emails and agreed to come to our lab to retake their measurements three months after the last measurement session at the end of the intervention. Body weight and composition, food cravings and implicit and explicit attitudes were measured and compared with the outcomes at the end of the intervention. We also evaluated the relationship between the main outcomes.

#### **3.5.3.1 Commitment to the 10 commandments**

The mean and SD of the estimated commitment level for each commandment, three months after the end of the intervention, are shown in Table 3.47, along with the commandment headings used on the leaflets and laminated cards and the acronym for each commandment (B1 - B10). Although the level of commitment to the diet commandments varied, this variation was relatively small. B8 had the highest level of commitment ( $7.5 \pm 2.9$ ), while B10 had the lowest level ( $5.5 \pm 3.1$ ).

**Table 3.47** Level of commitment to commandments.

Diet Commandment Headings			Commitment
In leaflet	On laminated card	Symbol	(rate/10) Mean±SD
Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added-sugar products and snacks, especially sweets	Sugars are evil!	B1	5.6±2.8
Eat at least a half kilogram of a vegetables and fruit a day	Veg and fruit you need!	B2	7.4±2.1
Base your meals on fibre-rich foods	Rich with fibre!	B3	6.8±2.3
Eat fish and meat no more than twice a week	Picky with the meat!	B4	5.5±2.5
Eat food low in energy density	Have a high with the low!	B5	6.1±2.3
Choose low-salt products	Short of salt!	B6	7±2.8
Take your time, and focus on your meal whilst eating	Enjoy your food!	B7	7.3±2.8
Have regular meal times	Regular is better!	B8	7.5 ±2.9
Be aware of your caloric needs and how much you eat	Long ways to eat!	B9	6.7±2.8
Limit calorie intake from alcohol and drinks	No buzz with fizz!	B10	5.5±3.1

We compared the level of the commitment to the commandments over the follow-up period, and determined that there were no significant differences between the levels of commitment to the 10 diet commandments.

### 3.5.3.2 Body characteristics

We hypothesized that three months after end of the intervention the achieved weight loss and changes in the body composition would be sustained. An independent t-test was performed to identify changes in body weight and characteristics three months after disuse of the intervention (see Table 3.48). All body characteristics showed no significant differences ( $p > 0.05$ ) between the end of the intervention and

three months after the end of the intervention. The net weight change for the individuals was  $-0.41 \pm 3.46$  kg, and the change in BMI was  $-0.08 \pm 1.2$  kg/m<sup>2</sup>. The body fat mass (FM) was reduced by  $-0.04$  %, and the skeletal muscle mass (SMM) by  $-0.27$  %. Although there were no significant differences, all of the body characteristics showed small reductions during the follow-up period.

**Table 3.48** Changes in body characteristics at the end of the intervention and follow-up period.

	<b>End of intervention</b>	<b>Follow-up</b>	<b>Change</b>	<b>P value</b>
Weight	76.49±16.03	76.08±15.28	-0.41±3.46	0.679
BMI	28.61±4.6	28.52±4.45	-0.08±1.2	0.804
FM	30.4±9.67	30.36±8.96	-0.04±2.9	0.963
SMM	25.36±4.57	25.09±4.89	-0.27±1.09	0.389

### **3.5.3.2.a Relationship between commitment and change in body weight measures**

We hypothesized that higher commitment to the commandments would be negatively correlated with weight loss. The Pearson correlation was computed to assess the relationships between the participants' commitment to the commandments and achieved reduction of weight and BMI. Table 3.49 shows the correlations between the commitment to the commandments and the change in BMI and weight loss values. There were significant negative correlations between the BMI change and the commitment to the B1 "Sugars are evil!" commandment ( $r = -0.573$ ) and B10 "No buzz with fizz!" commandment ( $r = -0.563$ ).

**Table 3.49** Pearson correlations between commandments and change in body weight.

Commandments	BMI change		Weight change	
	r	p	r	p
<b>B1</b>	-0.573	<b>0.041</b>	-0.555	<b>0.049</b>
<b>B2</b>	-0.443	0.129	-0.442	0.130
<b>B3</b>	-0.442	0.130	-0.445	0.127
<b>B4</b>	0.276	0.361	0.253	0.405
<b>B5</b>	-0.290	0.336	-0.280	0.355
<b>B6</b>	-0.301	0.318	-0.302	0.315
<b>B7</b>	-0.419	0.154	-0.420	0.153
<b>B8</b>	-0.378	0.203	-0.379	0.202
<b>B9</b>	-0.334	0.264	-0.321	0.284
<b>B10</b>	-0.563	<b>0.045</b>	-0.563	<b>0.045</b>

### 3.5.3.3 Food cravings

#### 3.5.3.3.a Change in cravings

We hypothesized that three months after the end of the intervention, the achieved reduction in food cravings (both state and trait) would be maintained. An independent t-test was performed to calculate the change in food cravings in the completion group three months after the intervention. There were significant differences between the craving subscale scores (at the end of the intervention and follow up period of three months) in both the FCQ-S (Table 3.50) and FCQ-T (Table 3.51). Three months after the end of the intervention, the participants reported no significant changes in the levels of food cravings in both state and trait.

**Table 3.50** Changes in food craving state.

FCQ-S	End of intervention	Follow-up	Difference	P value
Intent	12.69±2.36	13.38±2.72	0.69	<b>0.31</b>
ANT+	13.23±1.92	12.92±2.81	-0.31	<b>0.59</b>
ANT-	13.15±1.99	12.92±2.96	-0.23	<b>0.7</b>
Control	14.08±1.04	13.46±2.15	-0.62	<b>0.12</b>
Hunger	11.92±2.63	12.62±2.6	0.69	<b>0.41</b>
Total	65.08±7.32	65.31±11.46	0.23	<b>0.92</b>

\*: p value < 0.0005, ^ p < 0.01. Note that increases in the change score reflect decreases in food-craving state.

**Table 3.51** Changes in food craving trait.

FCQ-T	End of intervention	Follow-up	Craving change	P value
ANT+	12.38±4.4	12.5±3.3	0.15±5.03	0.914
ANT-	6.5±2.9	6.8±2.9	0.31±3.5	0.758
Intent	8.3±2.5	8.3±3.1	0.00±1.8	1
Cues	13.1±4.5	13.6±2.7	0.54±3.3	0.568
Thoughts	12.2±4.2	12.3±5.4	0.08±3.3	0.933
Hunger	11.1±2.7	11.9±3.1	0.85±2.9	0.315
Control	15.1±5.3	15.5±5.2	0.46±4.8	0.736
Emotions	11±3.9	12±3.7	1±4.5	0.436
Guilt	12.2±3.5	13±4	0.85±2.4	0.223
Total	101.8±18.04	106±21.3	4.2±22.7	0.514

\*: p value < 0.0005, ^ p < 0.01, + p < 0.05. Note that decreases in the change score reflect decreases in food craving traits.

### 3.5.3.3.b Correlation between FCQ-T and change in body weight measures

The current study hypothesised that the food craving trait subscales would be correlated negatively with lower weights and BMIs in the follow-up period. Pearson's correlations were calculated for the changed scores for the cravings in relation to the changes in weight and BMI three months after ending the intervention. There was no significant correlation between the weight change in the follow-up period and the changes in the FCQ-T subscale (Table 3.52).

**Table 3.52** Pearson correlations between body weight change and craving traits.

FCQ-t	BMI change		Weight change	
	r	p	r	p
Change-ANT+	0.4	0.176	0.379	0.201
Change-ANT-	0.259	0.393	0.270	0.373
Change-Intent	0.008	0.980	0.011	0.972
Change-Cues	0.355	0.235	0.352	0.238
Change-Thoughts	0.482	0.095	0.488	0.091
Change-Hunger	0.456	0.117	0.431	0.142
Change-Control	0.239	0.432	0.235	0.439
Change-Emotions	0.180	0.556	0.171	0.576
Change-Guilt	0.109	0.723	0.084	0.785
Change-total	0.407	0.168	0.396	0.180

### 3.5.3.3.c Correlation between FCQ-T and commandments' commitment

We hypothesised that the reductions or maintaining the achieved reductions in the food craving trait dimensions would be correlated with commitment to the commandments in the follow-up period. A Pearson correlation was computed to assess the relationship between the participants' commitment to the commandments and the changes in the FCQ-T subscales (Table 3.53). The changes in some FCQ-T subscales had significant negative correlations with certain commandment commitments. Increased commitment to the B1 “Sugars are evil!” and B10 “No buzz with fizz!” commandments clearly correlated negatively with the “cues that trigger craving” subscale of the FCQ-T. Also, an increased commitment to the commandment which aims to increase fibre intake (B3, “Rich with fibres!”) was associated with a decrease in the “thoughts or preoccupation with food”.

**Table 3.53** Correlations between craving state subscales and commitment to the commandments.

	<b>B1</b>	<b>B2</b>	<b>B3</b>	<b>B4</b>	<b>B5</b>	<b>B6</b>	<b>B7</b>	<b>B8</b>	<b>B9</b>	<b>B10</b>
<b>Change</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>	<b>r</b>
ANT+	-0.196	-0.122	-0.226	-0.464	-0.119	-0.173	-0.272	-0.103	-0.238	-0.163
ANT-	-0.399	-0.547	-0.492	-0.421	-0.339	-0.385	-0.435	-0.458	-0.453	-0.403
Intent	-0.116	0.131	0.020	-0.277	0.083	0.000	-0.181	0.193	-0.05	0.261
Cues	<b>-0.638</b>	-0.279	-0.353	0.151	-0.140	-0.146	-0.232	-0.111	-0.250	<b>-0.556</b>
Thoughts	-0.415	-0.411	<b>-0.562</b>	-0.177	-0.456	-0.296	-0.481	-0.446	-0.426	-0.433
Hunger	-0.171	-0.190	-0.265	-0.033	-0.252	-0.186	-0.165	-0.246	-0.281	-0.292
Control	-0.428	-0.196	-0.266	-0.083	-0.011	0.012	-0.139	-0.037	-0.142	-0.339
Emotions	0.073	-0.183	-0.048	-0.507	-0.05	-0.148	-0.177	-0.173	-0.166	0.049
Guilt	-0.209	-0.495	-0.401	-0.248	-0.418	-0.494	-0.277	-0.506	-0.507	-0.359
Total	-0.388	-0.355	-0.399	-0.341	-0.247	-0.264	-0.360	-0.286	-0.377	-0.359

### 3.5.3.4 Explicit Attitudes

#### 3.5.3.4.a Changes in explicit attitudes towards healthy and unhealthy food

We hypothesised that the effect of the study intervention would be sustained in terms of achieved improvement in the explicit attitudes towards healthy and unhealthy food. A paired-sample t-test found no significant differences ( $p < 0.01$ ) in the explicit attitudes towards healthy and unhealthy food at the end of the intervention and three months afterwards (see Table 3.54).

**Table 3.54** Change in explicit attitudes.

	<b>End of intervention</b>	<b>Follow-up</b>	<b>Change</b>	<b>P value</b>
Explicit-healthy	50.2±4.3	49.5±4.4	-0.62±4.6	0.389
Explicit-unhealthy	25.4±4.2	26.3±4.5	0.92±3.7	0.384

#### 3.5.3.4.b Correlation between explicit attitudes and body weight measures

This study hypothesised that the achieved alteration in explicit attitudes towards healthy and unhealthy food during the follow-up period would be correlated with maintained weight loss. Pearson's correlation was calculated for the relationship between the change in the participants' explicit attitudes towards healthy and unhealthy food and their body weight and BMI changes during the follow-up period (see Table 3.55). There was no correlation between the change in explicit attitudes towards healthy and unhealthy food and the changes in body weight and BMI during the follow-up period.

**Table 3.55** BMI and weight correlation with EAQ during follow up period.

<b>Explicit</b>	<b>BMI change</b>		<b>Weight change</b>	
	<b>r</b>	<b>p</b>	<b>r</b>	<b>p</b>
Change-exp-H	-0.167	0.585	-0.137	0.656
Change-exp-UNH	0.330	0.271	0.371	0.212

### **3.6 Discussion:**

#### **3.6.1 Body characteristics**

##### **3.6.1.a Dropout group versus completion Group**

Like most obesity trials, our study in the first phase (3 months) experienced a high dropout rate (approximately 48%). It is well known that the dropout rate is one of the main obstacles in studies related to obesity and can lead to failure (Finley et al., 2007). Obesity interventions have reported attrition rates between 10% and 80% (Richman et al., 1992). However, our study found no difference in the body characteristics of the dropout and completion groups, except for age. We found that younger participants were more likely to drop out, especially that high rate of the study participants were students. One study has suggested that younger age and lower BMI are predictors for withdrawal from a study (Clark et al., 1996). However, Honas et al. (2003) found that BMI has no influence on the dropout rate. In fact, this study intervention is needed daily commitment to perform the reflection work (the compliance with the commandments). It, also, demands improving one's regular lifestyle and health behaviour. These characteristics could result in a higher dropout among students because their lifestyle is irregular. In addition, some participants in the dropout group expressed that it required too much effort because they had a full-time job. This finding was supported by Inelmen et al. (2005), who stated that having a full-time job appears to be an important predictor of early dropout.

Although food cravings have been associated with dropping out from weight-loss treatment (Sitton, 1991), our study shows that dropout and completion participants had similar psychological factors (food cravings, implicit attitudes). The only difference was in explicit attitudes towards both healthy and unhealthy food. Participants in the dropout group had lower explicit attitudes towards healthy food and higher explicit attitudes towards unhealthy food.

However, in the second phase of the study (6 months), of the 35 participants who enrolled in the second phase of the current study, only 9 withdrew. The study thus experienced a low dropout rate (approximately 25%). Although the groups had no significant differences in body weight and characteristics, food cravings and attitudes towards foods, the mean of age in the dropout and completion groups were ( $35.4 \pm 13.3$ ) and ( $38.4 \pm 15.5$ ), respectively. This result confirms the finding in the first study that participant age (younger participants) was the main reason underlying the high dropout



rate. The results also corroborates the findings of Clark et al. (1996) that younger age acts as a predictor of withdrawal from a study.

### **3.6.1.b Effectiveness of study intervention on body weight characteristics**

This study aimed to assess the effectiveness of our developed intervention on weight loss at 3 different time points; 3 months after the intervention, 6 months after the intervention, and follow-up (3 months after the end of the intervention). This study showed that the mean weight loss mean 3 months after the intervention (4th visit) was 5.5 kg, or 6.4% of baseline body weight. Various studies have reported that loss of 5%–10% of initial body weight is associated with significant improvement of obesity-related comorbidities (Blackburn, 1995; Dattilo & Kris-Etherton, 1992; Goldstein, 1992; Wing et al., 1998). Achieved weight loss resulted in a significant reduction of the initial body weight. In addition to weight loss, our intervention significantly reduced BMI, waist-c, hip-c, WHR, WHtR and body fat percentage. This study's findings for weight loss and body composition were higher than those obtained by several previous studies. For example, a study by Tsiros et al. (2008) on a 20-week CBT programme reduced body weight by 4.3 kg, BMI by 1.6, waist-c by 5.9 and fat mass by 3.5%. Our 12-week study intervention achieved better results, reducing body weight by 5.5 kg, BMI by 2, waist-c by 5.6, and fat mass by 4.1%. In addition, the achieved weight loss of our study intervention was higher than that of diet-only interventions. For example, after 12 weeks, women participants in high-carbohydrate (CHO)/high-glycaemic index (GI), high-CHO/low-GI and high-protein/low-GI diets lost 3.1 kg, 4.8 kg and 3.5kg, respectively (McMillan-Price et al., 2006).

Kruger et al. (2004) suggested that the most widely used strategy for weight loss is reducing energy intake and increasing exercise. The mean weight losses after a 10-week treatment programme of diet and exercise and of diet alone were (-9.3) kg and (-5.6) kg, respectively (Wing et al., 1988). A meta-analysis of studies conducted from 1969 and 1994 found that a 15-wk diet and a diet-plus-exercise programme produced weight loss of approximately 11 kg (Miller et al., 1997). There are several possible explanations for the differences between the results of our study intervention and previous studies on diet and exercise programmes. Firstly, it is well known that weight gain and loss are functions of energy balance; therefore, weight loss can be obtained by a decrease in energy intake and an increase in physical activity level (Fogelholm & Kukkonen-Harjula, 2000). Exercise can add an additional negative value to the energy

balance; therefore, the expected weight loss with the combination of diet and exercise should be higher than the current study's outcomes. Secondly, many obesity treatment options are effective as long as individuals continue to participate in the program (Werrij et al., 2009), so they are effective in the short-term and they seem to be ineffective in the long-term. The inability to achieve constant or maintained weight loss could be attributed to the lack of long-term modification of eating behaviours (Mann et al., 2007). Thirdly, it is possible that achieved changes in the craving traits could result in a greater opportunity to maintain weight loss in the long-term, as food cravings are more connected to a relapse in weight loss and they are considered to be a barrier to maintaining weight loss (Budak & Thomas, 2009; Fabbricatore et al., 2011; Kaplan et al., 2011). This means that achieving a significant reduction in the craving trait with moderate weight loss might be sustainable over the long-term in comparison to achieving great weight loss with a minimal change in the craving trait, which may result in being prone to relapsing with regard to the achieved weight loss over the long-term. Finally, another explanation for the differences is that other interventions concentrate on diet composition and adherence to a strict diet and a regular exercise regime, while the current study's intervention place an emphasis on changing eating behaviours and cognitions towards food.

The outcomes of the second phase of the study (6-month) give more evidence of the effectiveness of the intervention. After 6 months of intervention, we achieved reductions in weight (7.8 kg, ~9.1% of initial body weight), BMI (~-3), waist-c (8 cm), hip-c (6.4 cm), WHR (0.03), body fat (6.6%) and SMM (0.5 kg). Moreover, we found some significant difference between the first phase of the study (3 months) and second phase of the study (6 months) with regard to BMI, waist-c, WHtR, and body fat mass, but there was no significant difference in the change in body weight.

Our finding was higher than those obtained by several studies on weight loss. For example, Shai et al. (2008) compared 3 diet interventions and found achieved weight losses of (6.5) kg in a low-carbohydrate diet and (4.5) kg in a low-fat diet and a Mediterranean diet. The mean weight losses in 4 commercial diet were (6) kg (Atkins diet), (6.6) kg (Weight Watchers), (4.8) kg (Slim Fat) and (6.3) kg (Rosemary diet) (Truby et al., 2006). In addition, numerous studies have reported that diet interventions have been effective at achieving weight loss at 6 months but produced varied outcomes: losses of (4.6) kg (Bacon et al., 2002), (2.7)kg (Manning et al., 1998) and (4.3) kg (Trials of Hypertension, 1997). McManus et al (2001) compared 2 diet programmes

(moderate-fat diet vs. low-fat diet) and found that, after 6 months, both programmes have achieved reductions in weight (4.9 kg, 5.1 kg), BMI (2, 1.9 kg/m<sup>2</sup>), body fat (3%, 2%), waist-c (6 cm, 5.1 cm) and WHR (-0.02, -0.01 cm) that were lower than our findings.

In addition, various studies have investigated the effectiveness of diet-plus-exercise programmes on weight loss over 6 months and found different results: losses of 7 kg (Diabetes Prevention Programme [DPP], 2002), 8 kg (Harvey-Berino et al., 2002) and 7.6 kg (Harvey-Berino et al., 2004). A meta-analysis suggested that exercise interventions obtain minimal weight loss (~2.4 kg) compared to diet interventions (~4.9 kg) and exercise plus diet interventions (~7.9kg) over a 6-month period in overweight and obese individuals (Franz et al., 2007). In fact, our findings are superior compared to previous mentioned studies. Numerous studies obtained high weight loss through diet-plus-exercise interventions, for example losses of (9) kg (Jeffery et al., 2003), (10.2) kg (Jakicic et al., 1999), (9.6) kg (Leermakers et al., 1999) and (10.9) kg (Perri et al., 1997). However, it is well documented that weight loss achieved by diet-plus-exercise interventions is not sustainable because the literature also reported high rates of weight relapse (approximately 75%) (Befort et al., 2007; Stevens et al., 2006; Wing & Hill, 2001). Our findings on weight loss were higher than the 4 kg achieved through online behavioural therapy over 6 months (Tate et al., 2001) and similar to the 7.8 kg achieved by CBT plus a Mediterranean diet over 8 months. Moreover, our findings were lower than the weight loss of (11.3) kg achieved through a low-energy diet plus sibutramine over 6 months. Unfortunately, weight relapse tends to occur concurrently with terminating use of obesity medications (Aronne, 2002a; Hollander, 2007; Sjostrom et al., 1998). Those who follow diet-only, exercise-only, diet-plus-exercise and diet-plus-medication interventions often suffer weight regain (Anderson et al., 2001), which might be because they did not successfully change unhealthy eating behaviours or acquire behavioural and cravings traits which usually resist and prevent a high rate of weight relapse and help maintain modest weight loss (Fabbriatore et al., 2012).

At the follow-up period, the study aimed to assess the lasting effectiveness of our developed intervention on weight loss beyond the end of the intervention (three months). The outcomes showed that the participants maintained the obtained reduction in their body weight, BMI, body fat % and skeletal muscle mass. Actually, these parameters tend to be reduced as the means of the reductions in weight was 0.41 kg, in BMI was 0.08 kg/m<sup>2</sup>, in body fat percentage was 0.04 %, and in SMM was 0.27 kg. The

outcomes of the current follow-up study are similar to the follow-up studies of other interventions. For example, Lutes et al. (2008) found that across a three-month follow-up period of using the ASPIRE program (participant-chosen change in diet and physical activity), the participants were able to maintain their achieved improvements in weight. In Lutes' study, the mean weight post-treatment was 85.8 kg, and after three months became 86.2 kg, which means it increased by about 0.4 kg. However, the follow-up of our study illustrated that the weight change three months after the end of the intervention showed further reductions. Moreover, the outcomes of the current study seem more effective because of further weight loss in the Saudi study than some diet interventions in the follow-up period. For instance, a study conducted by Vogels and Westerp-Plantenga (2007) to examine weight-loss maintenance during a two-year follow-up after using the very low calorie diet (VLCD) program, found that the weight and BMI at end of the intervention were 84.75 kg and 29.7 kg/m<sup>2</sup>, respectively, and after three months of follow-up the participants maintained their achieved weight loss with a mean weight of 84.95 kg and BMI of 29.75 kg/m<sup>2</sup>.

In conclusion, the study intervention have showed significant reduction in body weight measures after three and six months of the intervention. Moreover, the intervention at the follow-up period (3 months after the end of the intervention seem to have promising outcomes as it maintains the achieved weight loss.

### **3.6.1.c Body weight measures and commitment to the commandments**

This study hypothesized to find correlations between achieved reduction in BMI and commitment to the commandments at the three phases of the study. Seven of the 10 commandments were shown to be related significantly to BMI reduction in the first 3 months of the intervention; B1 'sugars are evil', B2 'veg and fruit you need', B3 'rich with fibres', B6 'short of salt', B8 'regular is better', B9 'long ways to eat', and B10 'no buzz with fizz'. However, after 6 months, there are continuation effects of B1, B2, B3, B8, and B9. In other words, controlling consumption of sugary food and drinks, basing daily meals on foods rich in fibre, eating vegetables and fruits on daily base, not skipping breakfast, eating regular meals and avoiding eating snacks between meals, and watching calories intakes and aware of your daily needs are the strongest influences on reduced BMI and weight loss.

These findings are consistent with those of other studies on the connection between body weight and commitment to these commandments. For example, with

regards to fibre intake, several epidemiological studies have shown that a high-fibre diet has a role in controlling body weight (Liu, 2002; Ludwig et al., 1999; Roberts & Heyman, 2000). As well, in several observational studies, intake of dietary fibre has been shown to be independently and negatively linked with obesity measurements (Howarth et al., 2005; Liese et al., 2005; Liu et al., 2003; Sasaki et al., 2003; Spencer et al., 2003). A longitudinal study on young adults showed that fibre intake was inversely related to BMI (Ludwig et al., 1999). Du et al. (2010) concluded that higher intake of dietary fibre aids in preventing gains in body weight and waist-c. Additionally, eating more portions of fruits and vegetables has a role in increasing the consumption of dietary fibre and decreasing the risk of obesity. Fruit and vegetables have lower energy density (0.4–2.0kJ/g) because of their high water content (Drewnowski, 2003). Therefore, higher consumption of fruit and vegetables is related to a lower gain in BMI (Newby et al., 2003). He et al. (2004) indicated that increasing consumption of fruits and vegetables could reduce the long-term risk of obesity.

Our study outcomes demonstrated a correlation between BMI and commitment to the B8 ‘regular is better’ commandment, which emphasises eating regular meals and avoiding snacking. This outcome is supported by many previous researches which linked the regularity of meals with body weight. For example, Halberg (1989) stated that specific eating behaviours, such as the time of ingestion, could have significant consequences for weight control. Keim et al. (1997) compared the consumption of a large meal in the morning with the consumption of a large meal eaten later in the day. They found that consuming a large meal in the morning resulted in just a little more weight loss than when a large meal was consumed later in the day, but they found that consuming a large meal later in the day resulted in better maintenance of fat-free mass. In addition, they concluded that consuming meals (very low diet) in the evening could permanently promote fat oxidation (Keim et al., 1997).

Arble et al. (2009) pointed out that behaviour modifications, such as the timing of food intake, could be an important factor in slowing the high increase in the prevalence of obesity. The B8 ‘regular is better’ commandment emphasises eating breakfast regularly and avoiding late dinners. Many studies have shown that ingesting a single daily meal (2000 kcal) in the evening induces an increase in weight, while it induces a reduction in weight when ingested in the morning (Halberg et al., 1974; Hirsch et al., 1975; Jacobs et al., 1975). When skipping breakfast, people tend to later select calorie-dense foods compared to those who regularly eat breakfast (Morgan et

al., 1986; Schlundt et al., 1989). Those who eat breakfast consistently have sufficient micronutrient intakes (Nicklas et al., 1998; Morgan et al., 1986; Ruxton & Kirk, 1997) and lower proportions of calories from fat (Ruxton & Kirk, 1997). Most studies suggest that eating breakfast is linked to the reduction in the body weight and BMI. For instance, Ma et al. (2003) found that the risk of obesity is 4.5 times higher among those who skip breakfast than those who eat breakfast. BMI has been found to be higher in individuals who skip breakfast (Cho et al., 2003). Among women, there is an inverse relationship between breakfast consumption and BMI (Song et al., 2005).

Regular meals is a beneficial factor in long-term weight loss (Westenhoefer et al., 2004), and regularly eating breakfast has been overwhelmingly reported among individuals who successfully maintained their weight (Kayman et al., 1990; Wyatt et al., 2002). Schlundt et al. (1992) suggested that eating breakfast is an important part of weight loss because it helps to reduce dietary fat and snacking intake. Many studies have shown that consumption a single daily meal (2,000 kcal) in the evening causes an increase in weight, but consumption in the morning causes weight loss (Halberg et al., 1974; Hirsch et al., 1975; Jacobs et al., 1975). In addition, Armstrong (1980) suggested that the timing of meals is a very important contributor to the degree of weight loss.

In recent years, eating food between main meals, usually called snacking behaviour, has increased and is considered a contributing factor in higher rates of overweight and obesity (Savigne et al., 2007). Over the past two decades, caloric intakes have increased, and beverages and snacks account for the vast majority of this increase (Duffey & Popkin, 2007; Nielson et al., 2002a). Many epidemiologic studies have stated that snacks have an aetiological role in body weight gain and obesity (Basdevant et al., 1993; Takahashi et al., 1999). An increase in the frequency of eating, especially of snacks, plays a main role in the increased prevalence of obesity in children and adults (Manson & Bassuk, 2003; Serdula et al., 1993). Snacks account for a larger proportion of total daily energy and macronutrient intake than in the late 1970s (Cleveland et al., 2005; Nielsen et al., 2002b). The rise in consumption of snacks is frequently posited to be one factor in changing dietary patterns and possibly in the increased prevalence of obesity (Jahns et al., 2001; Zizza et al., 2001). French et al. (2001b) found that the number of meals eaten has decreased and the number of snacks eaten has increased, especially away from home, simultaneous with the rise in the prevalence of obesity. Among young adults, there has been a clear increase in energy intake from snacks (Rolls et al., 2002; Rolls et al., 2004a; Rolls et al., 2004b). Bertéus Forslund et al.

(2005) concluded that obese individuals consume more snacks than lean individuals. Studies have suggested that snacking likely has importance for energy regulation (Forslund et al., 2005; Howarth et al., 2007). Two studies investigating the association between snacks and nutrient intake showed that snacks reduce the total nutrient density in a diet (Bigler-Doughten & Jenkins, 1987; Ovaskainen et al., 2006). According to Sebastian et al. (2008), snacks exceed the number of calories from sugar and fat that individuals estimate snacks to have. In addition, consuming snacks regularly has an impact on the intake of macronutrients and several micronutrients (Sebastian et al., 2008).

The current study found an association between body weight and the commandment related to controlling intake of food and drinks high in sugar. This result corroborates the findings of much earlier work on the relationship between increased weight and a high-sugar diet (Drewnowski & Bellisle, 2007; Johnson, 2009; Mattes et al., 2011; Vartanian et al., 2007). Sugary food and drinks are well known to be a crucial factor in rapid increased body weight and obesity. For example, in the United States, the estimated mean of added-sugar consumption accounts for 15.8% of total energy intake (Guthrie & Morton, 2000). The relationship between sugar and body weight has been confirmed in many studies. For example, a meta-analysis of controlled trials suggested that increasing or decreasing intake of dietary sugar in adults is associated with corresponding changes in body weight in adults (Te Morenga et al., 2012). The most obvious mechanism by which increased sugar consumption promotes weight gain is by increasing energy consumption to an extent that exceeds energy output and distorts the energy balance.

A steady intake of sugar calories in liquid form has been responsible for increasing incidences of weight gain (Berkey et al., 2004; Bray et al., 2004a; Gross et al., 2004; Hu & Malik, 2010; Malik et al., 2006; Malik et al., 2010; Schulze et al., 2004b). Over the past two decades, caloric intakes have increased, and the largest cause of this increase has been beverages (Duffey & Popkin, 2007), which has contributed an estimated 50% of increased caloric intake (Briefel & Johnson, 2004; Guthrie & Morton, 2000). Consumption of liquids, such as sugar-sweetened beverages, can increase energy intake more than solids (Raben et al., 2002). An observational analysis of an 18-month trial found that decreased energy intake from liquids has greater influence on weight loss than solids (Chen et al., 2009). Therefore, increased intake of soft drinks

and sugar-sweetened beverages is linked to increased energy intake, which can lead to higher weight gain.

However, commitment to the following three commandments (B4 ‘picky with meat’, B5 ‘have a high with low’, and B7 ‘enjoy your food’) have low association with observed weight reduction in this current study. In fact, they have low value of correlation with weight reduction, therefore, their contribution for reduced body weight are in doubt. In other words, slowing eating patterns, increased chewing time and eating awareness, decrease consumption of red meat and controlling the energy density of consumed food were shown to have a lower impact to achieved reduction of BMI compared to the other commandments in our study.

In the follow-up phase of the study, the study found that Commitment to two of the 10 commandments was shown to be related significantly to BMI reduction and weight loss during the follow-up period: B1 “Sugars are evil!” and B10 “No buzz with fizz!”. The commitment to these two commandments correlated negatively with the maintenance of the achieved weight loss during the follow-up period, which means that a decreased sugar intake and controlled consumption of liquid calories have the most prominent roles in maintaining the achieved weight loss. These outcomes reflect the high influence of sugar intake and liquids calorie consumption, and support the view that the trend increase in overweight and obesity that has occurred in recent years is a consequence of increased energy intake, especially of foods and beverages high in sugar (Chen et al., 2009; Malik et al., 2006; Vartanin et al., 2007). In recent years, there has been a dramatic change in the food environment and a remarkable increase in the consumption of hyper-palatable food (food high in sugar and fat), which seems to override the reward properties of traditional foods (foods rich in fibre, vegetables and fruit) (Gearhardt et al., 2011a; Gearhardt et al., 2011b).

Over the past 2 decades, caloric intakes have increased, and the vast majority of this increase is accounted for by beverages (Duffey & Popkin, 2007). The steady intake of sugar calories in liquid form has increased the incidence of weight gain (Bray et al., 2004a; Berkey et al., 2004; Gross et al., 2004; Malik et al., 2010; Hu & Malik, 2010; Schulze et al., 2004b). Sugar is highly palatable and represents 22 % of the daily energy content of a typical American diet (Drewnowski, 1995). In addition, soft drinks constitute 47 % of the added sugar in this diet (Guthrie & Morton, 2000).

The surge in the popularity of soft drinks could be explained by the high palatability of sweet tastes (Lenoir et al., 2007), the high energy density and low cost



(Drewnowski & Bellisle, 2007). Smiciklas-Wright et al. (2003) argued that the main cause of increased calorie intake (300 kcal/day) between 1985 and 2000 was the greater consumption of added fats and sugars. The increased prevalence of overweight and obesity has coincided with the increased consumption of caloric beverages (soft drinks and fruit drinks), and the daily energy intake from sweetened beverages has increased by 222 kcal in recent decades (Duffey & Popkin, 2007). For example, in the US there was a 278 kcal/day increase in beverage energy intake in the period 1999-2001 compared with 1977-1978 (Nilson & Popkin, 2004). In adulthood, individuals tend to consume caloric beverages more often than healthy drinks (Duffey & Popkin, 2006; Popkin et al., 2005).

Several studies have illustrated that the influences of beverage intake on appetite sensations are less satiating than solid foods (Almiron-Roig et al., 2003; Drewnowski & Bellisle, 2007; Haber et al., 1977; Hulshof et al., 1993; Tournier & Louis-Sylvestre, 1991); thus, increasing the consumption of energy-containing liquid beverages could result in increased body weight (Ludwig et al., 2001) due to its weaker appetitive effect (Mattes, 2006). The low satiety value of caloric beverages could be due to three reasons. First, beverages take a shorter time to consume and are emptied quickly from the stomach, compared with solid foods (Kissileff, 1985). This possibility is supported by Stull et al. (2008) who suggested that isocaloric beverages increase food consumption. Second, the appetite-related hormonal response is influenced by the food form, either liquid or solid (Tieken et al., 2007), and finally, high caloric beverages are composed mostly of carbohydrates, which give fewer satiety signals compared with fats or protein (Wolf et al., 2008). It has been suggested that satiety signals work to decrease energy intake by modulating the value of the rewards of food (Figlewicz, 2003). With inadequate satiety signals there will be a failed decrease in the hedonic value of food, which may illustrate eating without calorie deficiency (non-homoeostatic eating) (Baskin et al., 1999; Figlewicz & Woods, 2000; Fulton et al., 2000).

In conclusion, our study found significant negative correlation between the achieved reduction in BMI, after 3 months of the intervention, and increased commitment to seven commandments; B1, B2, B3, B6, B8, B9, and B9. After 6 months of the intervention, the study found continuation negative relationship between BMI and commitments to these commandments except for B8 and B9. However, commitment to B1 and B10 were the only ones that showed negative correlation with BMI in the follow-up period (three months after the end of the intervention).

### **3.6.2 Effectiveness of the intervention on food cravings**

This study aimed to assess the effectiveness of our developed intervention on food craving at 3 the different time points of the study. Moreover, the study aimed to find the correlations between food craving and body weight measure, and commitment to the commandments. In the present study, we used FCQ (states and traits) to measure food cravings. The dropout and completion participants had no significant differences in initial cravings (state and trait). This result may explain that food cravings were not the main reason for dropping out of the study. However, it is unknown whether participants who dropped out experienced increased craving levels. The completion group had a significant reduction (3 months after the intervention) in food craving scores (total and subscales) for both the FCQ-S and the FCQ-T. Clearly, the FCQ-T is more important because it indicates cravings across time, while the FCQ-S measures cravings in certain situations. We found that the majority of participants experienced food cravings at baseline, which is consistent with previous studies on food craving and obesity (Batra et al., 2013; Christensen, 2007; Delahanty et al., 2002). This finding might reflect the crucial role of food cravings in the maintenance of obesity. Over 6 months of the intervention, the intervention produced reductions in all FCQ-T dimensions, except for guilt. However, the intervention's influence on FCQ-T dimensions in the last 3 months was not significant. This trend suggests that the intervention had a strong effect on FCQ-T, reducing cravings in the first 3 months, and prevented a relapse in cravings in the last 3 months, which permitted more overall weight loss during the study period of 6 months

#### **3.6.2.a Food cravings and body weight measures.**

This study hypothesized to find correlations between food craving and body weight measure. Generally, this study showed that food cravings decreased with weight loss. However, in the first 3 months of the intervention, FCQ-S is correlated but not significantly with weight loss. Only one FCQ-S subscale change score 'intense desire to eat' had significant correlation with weight and BMI reduction. Indeed, state cravings have been shown to occur only in certain situations. On the other hand, craving traits usually appear across time (Moreno et al., 2008), which could make them more appropriate to weight-loss research such as this study. In any case, the reduction in food craving trait score was correlated with the reduction in the weight measures.

In addition, BMI change was correlated significantly with two subscales: “the anticipation of positive reinforcement that might result from eating” and “the emotions that might be experienced before and during food cravings or eating” over the first 3 months of the intervention. While, after 6 months of the intervention, the study shows a correlation between BMI reduction and the change in two FCQ-T dimensions: ‘anticipation of positive reinforcement that might result from eating’ and ‘cravings as a physiological state’.

Sibilia and colleagues (2004, 2008) reported that irregular eating-related habits and emotions were correlated with BMI in both normal and obese individuals (Sibilia et al., 2008; Sibilia et al., 2004). Psychological factors are more strongly related to food cravings than dietary restraint or daily calorie intake (Hill et al., 1991). In particular, emotions have a critical role in the generation and maintenance of food cravings (Cooper & Bowskill, 1986). Emotions influence food choice and eating behaviour in human being but have a stronger influence in obese individuals. A review carried out by Lowe and Levine (2005) highlighted that the obese were susceptible to emotional eating. De Lauzon et al. (2004) revealed that emotional eating is connected to high intake of high-fat sweet snacks and foods, which in turn is correlated with higher BMI (Kontinen et al., 2010). Negative emotional experiences are common triggers of food cravings (Christensen, 2007; Lafay et al., 2001). For example, Schlundt et al. (1993) found that boredom occurred during cravings for high-sugar foods more often than in the absence of food cravings.

Food consumption is frequently reinforced simply by the positive effect of immediate gratification (Berridge, 1996; Berridge & Robinson, 2003) and anticipated relief (Cooper et al., 2004). Obese individuals reported that more reinforcement from food intake than lean individuals (Jacobs & Wanger, 1984; Saelens & Epstein, 1996; Westenhoefer & Pudel, 1993). Wise (1988) suggested that cravings emerge because of an association between positive reinforcement and specific substances. Additionally, we found that declines in BMI and body weight associated with decreased ‘anticipation of positive reinforcement from eating’, which led to less cravings and lower food intake.

Food cravings are generally defined as ‘an intense desire for a specific food that is difficult to resist’ (White et al., 2002). Many studies have reported a positive relationship between BMI and food craving (Delananty et al 2002; Franken & Muris 2005; Gendall et al., 1998). Individuals with obesity usually report higher food cravings (Fabbricatore et al., 2011; Jakicic, 2009), experience more negative effects from eating

and eat arousing foods more frequently (Von Dennen & Liu, 2011) compared to average-weight peers. This suggests the comprehensive and important role of cravings in food consumption and body weight regulation (Franken & Muris 2005).

However, after 3 months of the end of the intervention (follow-up period), the study showed that there was no significant difference in the food craving (state and trait) between the food craving level at the end of the intervention and at the follow-up (three months). This means that the study participants maintained the significant change that they achieved during the interventional period. These outcomes may confirm our results from previous phases of current study that engaging in modest weight loss with a great reduction in food craving levels might be the best way to maintain obtained weight loss over the long-term.

In conclusion, our study found significant correlation between BMI reduction and some FCQ-t dimension. In the first 3 months, BMI reduction correlated with “anticipation of positive reinforcement” and “emotions” dimensions. While, over 6 months of the intervention, “anticipation of positive reinforcement” and “craving as physiological state” dimensions of FCQ-t were correlated with BMI. Anyway, in the follow-up period, the study found that there were no significant correlations between the change in BMI and food craving-traits.

### **3.6.2.b Food cravings and commandments.**

This current study hypothesized to find correlations between food craving and commitment to the commandments. It is remarkable, in the first 3 months of the intervention, that we obtained a significant association between commitment to some commandments and change in FCQ-T scores. The commandment (B1, sugars are evil) related to increased control over sugary food and drinks consumption was significantly and negatively correlated with total FCQ-T score and four subscale scores: “thoughts or preoccupation with food”, “intent or plan to eat”, “cues that trigger cravings” and “cravings as a physiological state”. Moreover, “thoughts or preoccupation with food” dimension was correlated negatively with B10 (related to liquid calorie).

Decreasing the intake of sugary foods and drinks was found to result in a decline in preoccupation with food. FCQ-T analysis results reveal that there was significant reduction in the ‘thoughts or preoccupied with food’ dimension of the FCQ-T, and this reduction correlated with controlled intake of food and drinks that are high in sugar through increase commitment to B1 ‘sugars are evil’. In a study on short-term

carbohydrate restrictions, Coelho et al. (2006) showed a selective effect on cravings for these food types. Abstaining from complex-carbohydrate-rich foods was found to be associated with increased craving and intake of them. Chocolate cravings are the most frequent cravings in western cultures (Bruinsma & Taren, 1999; Pelchat, 1997; Rogers & Smit, 2000), experienced by 40% of women and 15% of men (Rozin et al., 1991). Although many who crave chocolate report an overall preference for sweet foods, most state that other foods do not satisfy a craving for chocolate (Weingarten & Elston, 1991).

Food cravings have been connected to thought (Fedoroff et al., 1997; Hill et al., 1991). For example, Fedoroff et al. (1997) found that thinking about food before eating can provoke overconsumption. Several studies have noted that preoccupation with food and eating have an important role in the development of eating disorders (Cooper & Fairburn, 1992; Dritschel et al., 1991). However, our intervention, which is not a descriptive diet and which relies on the reflective process, has a positive influence on preoccupation with food, while other studies, which are based on restricted caloric intake and avoiding certain foods, resulted in increased thoughts and preoccupation with forbidden food and might relatively increase the desire to eat. (Keys et al., 1950; Mann & Word, 2001; Warren & Cooper, 1988). This result may point out that the reflective work is important in changing eating behaviour, while described diet may not lead to the same outcome.

The preoccupation with sweetened drinks might be attributed both to their low influence on appetite and satiety and to their attractive taste. Ludwig et al. (2001) stated that increasing consumption of liquid energy beverages, which have a weaker effect on appetite, could result in greater body weight (Mattes, 2006). The low satiety value of caloric beverages could be due to three reasons. First, compared to solid foods, beverages take a short time to consume and are emptied quickly from the stomach (Kissileff, 1985). This explanation is supported by Stull et al. (2008) who suggested that isocaloric beverages increase food consumption. Secondly, appetite-related hormonal response is influenced by whether food is in liquid or solid form (Tieken et al., 2007). Finally, caloric beverages are composed mostly of carbohydrates, which give fewer satiety signals compared to fat or protein (Wolf et al., 2008).

In addition, this study observed that increased commitment to the commandment that aims to reduce sugar intake (B1 'sugars are evil') influences the individual's intentions and plans to consume food. Several studies have stated that

obese patients that report more weight-loss treatments have lower planning in regard to consuming food (Fabbriatore et al., 2013; Odom et al., 2010). BMI was found to be correlated with cravings for foods high in sugars (Schlundt et al., 1993). Most foods high in sugar are poor nutritional quality foods. Therefore, thinking about the sugar content of food will improve the quality of selected food and limit a wide selection. Martin et al. (2006) stated that limited dietary selection during weight loss has been proposed as a potential mechanism by which cravings decline, and other studies have been reported that decline in food craving with decrease energy intake (Harvey et al., 1993; Lappalainen et al., 1990). Numerous studies have reported that cravings were usually for sweets, carbohydrates and fatty food (Batra et al., 2013; Christensen, 2007; Delahanty et al., 2002). Compared with men, women have higher craving for foods such as chocolate (Weingarten & Elston, 1991), often resulting in eating that food (Hill & Heaton-Brown, 1994), while the rapid increase in obesity rates has been linked to the taste preference for palatable foods (Salbe et al., 2004).

Recently, several studies have been conducted to determine the brain mechanisms involved in the strong pleasure response to foods with a sweet taste (Fernstrom et al., 2012). The sensory pleasure derived from tasting sweet substances has an innate basis (Liem & Mennella, 2008; Mennella, 2008) as the sensory preference for a sweet taste is present at birth (Birch, 1999). Foods and drinks high in sugar might activate the pleasure- and desire-generating brain circuitry (Berridge & Kringelbach, 2008; Drewnowski et al., 2012; Kringelbach & Berridge, 2010). Sweet taste is always linked to the hedonic reward value of food (Kampov-Polevoy et al., 2006); for example, Drewnowski (1997) revealed that taste is the driving force behind food consumption. Based on orosensory responses, taste preference leads to food liking which results in increased consumption; thus, the predisposition to over-consumption could be connected to the perception of or hedonic responses to a particular food (Mela, 2001; Mela, 2006). With sugary food, obese might have greater perception of sweetness due to their greater liking for it and, consequently, overeat high-sugar food (British Nutrition Foundation, 1999; Mela & Rogers, 1998).

It has been proposed that abnormalities in food rewards processing are related to obesity aetiology. While some studies suggested that increased risk of overconsumption is related to hyper-responsiveness of the reward circuitry (Davis et al., 2004b; Dawe & Loxton, 2004), other studies proposed that obese participants had a hypo-responsive reward circuitry (Blum et al., 2000; Wang et al., 2002). Stice et al.

(2009) reviewed studies related to food rewards abnormalities and found that obese individuals anticipate higher rewards from food consumption than lean individuals. Expectancy rewards from food operates by identifying the food reinforcement value, but frequent presentations of food lead to a drop in the level of the hedonic reward value. Meanwhile, the expectancy rewards values increases (Robinson & Berridge, 2000), which may lead to higher consumption to compensate for the drop in hedonic reward value. In addition, individual differences in the behavioural activation system (BAS) are related to the reward threshold (Gray, 1987). People with high BAS (high rewards sensitivity) are more prone to detect reward signals in their environment, to more quickly approach potentially rewarding stimuli and to experience more positive affect (pleasure/reinforcement) in situations with reward cues. Reward sensitivity corresponds to a heightened sensitivity to rewarding stimuli (Franken et al., 2006; Franken & Muris, 2006; Dawe et al., 2004; Dawe & Loxton, 2004; Nederkoorn et al., 2006).

As well, our study outcomes show a reduction in the hunger dimension of FCQ-T, which is related to physiological hunger and unreliable hunger signals. Several studies have downplayed the role of hunger in the experience of food cravings (Davis et al., 1985; Hill et al., 1991). Hedonic hunger, or the desire to eat purely for taste and pleasure, triggers overeating and leads to weight gain (Monteleone et al., 2012). Consuming an enjoyable food can trigger reward centres in the brain and encourage more eating. Eating provides two primary reward values: nutritional and hedonic. Nutritional reward arises from metabolic and homeostatic signalling, and hedonic reward arises from the sensory properties perceived as pleasurable. Though highly palatable foods will motivate consumption even in a calorically replete state, the independence of this hedonic motivation from homeostatic mechanisms has been challenged (Beeler et al., 2012). Sibilia (2010) suggested that the sense of hunger might help hinder eating habits, leading to irregularities in eating connected to increased body weight. With obesity management, targeting the cognition hunger might have precious value (Sibilia, 2010).

Hunger and satiety mechanisms have attracted growing interest in food overconsumption research because they involve two important pathways the homeostatic (energy balance) and the hedonic pathway (response to food) (Berridge, 2007). Overconsumption might happen when weak satiety signals follow food consumption (homeostatic pathway) or when the responsiveness and enjoyment of

food is strong (hedonic pathway) (Blundell & Finlayson, 2004; Drapeau et al., 2007). However, in modern environments rich with food, overconsumption is usually a consequence of pleasure. When pleasure becomes the main drive to eat, the reward signals are activated, and the inevitable result is overconsumption (Monteleone et al., 2012).

The influence of food-cues is well documented in the eating literature. For example, several studies have suggested that higher reactivity to food cues is an important predictor of future increased body weight and obesity (Polivy et al., 2008; Stice et al., 2010; Stice et al., 2011; Yokum et al., 2011). Our study found a correlation between controlled consumption of high-sugar food and drinks and the cues dimension of FCQ-T (cues that might trigger food craving). In environment with abundant food, cues trigger impulses for individuals to eat food at the moment of encounter and contribute in overeating, result in long-term increased caloric intake and body weight (Berthoud & Morrison, 2008; Davis & Carter, 2009; Holland & Petrovich, 2005; Kessler, 2010). There is a relationship between food cravings and cues (Hill & Heaton-Brown, 1994). Several studies have reported that exposure to food cues (e.g., smell and sight) can elicit cravings (Cornell et al., 1989; Ferriday & Brunstrom, 2011; Jansen, 1998; Legenbauer et al., 2004; Nederkoorn et al., 2000; Rodríguez et al., 2005; Sobik, et al., 2005; Tetley et al., 2009).

More food is consumed after a period of exposure to food cues (Ferriday & Brunstrom, 2008). Ferrer-Garcia et al. (2013) found that exposure to high-calorie food results in the highest level of food cravings. Numerous studies have also shown that individuals have less desire for low-calorie than high-calorie snacks (Blundell & Finlayson, 2004; Lowe & Butryn, 2007; Yeomans, 1998). Indeed, intensity of food cravings in response to food cues has been considered an important predictor of the amount of presented food (Nederkoorn et al., 2000).

Our data also presented a significant, positive correlation between the changes in the guilt from food cravings subscale of FCQ-T and commitment to the B7 commandment, reflecting eating patterns that emphasise increased awareness of the food consumed. This correlation means that eating slowly, increased chewing and focusing on a meal by avoiding external distractions are associated with decreased guilt from food cravings and giving into them. Food awareness might be linked to the possible rewards and pleasure of eating. Pleasure is described as ‘a state or feeling of



happiness and satisfaction resulting from an experience that one enjoys' (Beeridge, 1996; Esch & Stefano, 2004).

It has been believed that slower eating can promote satiety, likely by providing enough time for the body to prepare physiological satiety signals (Melanson, 2004; Rolls, 2007; Stuart, 1967; Stuart & Davis, 1972) or by decreasing feelings of deprivation through promoting and prolonging the pleasurable sense of eating (Brownell, 2000). It seems that obese individuals have a fast eating rate (Otsuka et al., 2006). In addition, a decreased eating rate has a role in decreasing hunger and increasing inter-meal satiety (Andrade et al., 2008; Andrade et al., 2012). One laboratory study changed the eating rate of females and found that food consumption increased with a fast eating rate compared to a slow eating rate (Andrade et al., 2006). Several studies have found that, regardless physical activity or energy intake, a fast eating rate is associated with a high body weight (Maruyama et al., 2008; Nishitani et al., 2009; Otsuka et al., 2006; Shin et al., 2009). The enjoyment of eating food is influenced by different factors, such as the taste of the food eaten. Foods linked to preferable consequences tend to be more liked (Myers & Sclafani, 2006). However, enjoyment of food is associated positively with food responsiveness and inversely with satiety responsiveness and slow eating rates (Carnell & Wardle, 2007, 2008; Llewellyn et al., 2011; Webber et al., 2009).

Taste is the most influential factor in food choice (Glanz et al., 1998). Food selection is driven mainly by sweetness (Birch, 1999; Booth et al., 1987), and the proportion of caloric intake from sweets was correlated positively with sweet preference (Mattes & Mela, 1986). Additionally, several studies have shown that overweight and obese individuals have lower taste sensitivity for sweets compared to their normal-weight peers (Bartoshuk et al., 2006; Sartor et al., 2011; Von Atzingen & Silva, 2012). Brownell et al. (2009a) reported that high consumption of soft drinks might have detrimental influences on taste preference and food acceptance.

promoting commitment to specific nutritional and behavioural commandments through the reflection approached resulted in decreased cravings and weight. Our study showed that reflection on increased control of consumption of high-sugar food controlled intake of calories from liquid sources such as sweetened beverages and alcohol. Reflection also increased awareness of eating by encouraging eating slowly away from distractions, such as watching television and using the Internet. These steps affect the specific psychological components of food cravings, including "thoughts or

preoccupation with food”, “intention and plan to consume food”, “cues that might trigger food cravings”, “cravings as a physiological state” and “guilt from food cravings”. In addition, two psychometric properties ‘the anticipation of positive reinforcement that might result from eating’ and ‘the emotions that might be experienced before or during food craving or eating’ were associated with weight loss. Reduction of food cravings was the consequence of commitment more to commandments than to weight loss. In particular, mediation analysis (Process by Andrew Hayes) showed that the effect of commitment to the commandments on food cravings was not mediated by weight loss. These findings revealed that, regardless of weight loss, our intervention technique based on reflection on commitment to specific commandments played a role in decreasing food cravings because we found a significant correlations between these two parameters. The goal of controlling one’s cravings is to reduce body weight and the negative experience of food. However, our study shows that, although weight loss contributes to reduction of food cravings, the major factor was strong commitment to three commandments: B1 ‘sugars are evil’, B10 ‘no buzz with fizz’ and B7 ‘enjoy your food’. The correlation between cravings and the commitment to these commandments was stronger than the correlation to BMI reduction. Moreover, commitment to the commandments had an impact on five of the FCQ-T subscales, while BMI reduction had an influence on two of the FCQ-T subscales. In other words, the reduction in BMI might be a consequence of the commitment to the commandments more than a result of food craving reduction.

After 6 months of the intervention, the study shows a significant association between certain commandments and change in FCQ-T scores. The commandment related to the avoidance of sugary food and drinks (B1, sugars are evil) had a significant, negative correlation with the total FCQ-T score and some subscale scores: ‘anticipation of positive reinforcement that might result from eating’, ‘intention and plan to consume food’, ‘thoughts or preoccupation with food’ and ‘lack of control over eating’. Additionally, there was a negative correlation between commitment to the ‘picky with the meat’ commandment and the ‘guilt from food cravings and/or for giving into them’ dimension. Negative correlations also existed between the ‘intention and plan to consume food’ dimension and commitment to the B5 commandment ‘have a high with the low’ and between the ‘thoughts or preoccupation with food’ dimension and commitment to the B10 ‘no buzz with fizz’ commandment.

In the follow-up period, three months after the end of the intervention, the study found that the changes in some food craving trait subscales had correlations with the commitment to some commandments. People who committed themselves to B1 and B10, which emphasised the reduced intake of sugar, controlled intake of liquid calories and sweetened beverages, and added sugar consumption reported a decrease in the “cues that trigger craving” subscales of the craving trait. It is known from previous studies that food cues increase consumption, and our study showed that the controlled intake of sugary foods and drinks may help to reduce the influence of food cues from the environment, especially since the foods recently introduced to the environment are high in sugar. This result shows that the major roles of these two commandments lead to achieving more weight loss, or at least maintaining the achieved weight loss and playing a major role in maintaining the craving-trait reduction that obtained during the intervention period.

In addition, commitment to B3, which aimed to increase the intake of foods rich in fibre, was correlated negatively with the “thoughts or preoccupation with food” subscale of the food craving trait. This correlation confirms the high importance of fibres on food intake regulation. Dietary fibre could influence obesity development (Ali et al., 1982) because consuming fibre has been suggested to decrease energy intake by creating satiety (Blundell & Burley, 1987; Burton-Freeman; 2000; Samra & Anderson, 2007; Krauss et al., 2000). Howarth et al. (2001) summarized the influence of dietary fibre on hunger, satiety, and energy intake and body weight. Fibre has an effect on palatability and the other sensory characteristics of the diet, which may have an impact on energy intake (Drewnowski, 1998; Rolls, 1995). Heaton et al. (1973) suggested that dietary fibre may reduce energy intake through three mechanisms: (a) fibre displaces available calories and nutrients from the diet, (b) fibre increases chewing, which has a role in reducing intake by enhancing saliva secretion and gastric juices, leading to stomach widening and increased satiety, and (c) fibre could reduce the absorption competence of the small intestine.

The world’s diet has shifted from a greater intake of complex carbohydrates and fibre toward energy-dense foods with a higher content of fat and sugar (Drewnowski, 2000; Drewnowski & Popkin, 1997; WHO, 2003). There are numerous benefits from consuming fibre-rich foods, such as improving large bowel function and slowing down the digestion and absorption of carbohydrates and fats, as well as reducing the risk of some diseases (Ali et al., 1982; Schneeman & Tietyen, 1994). Several studies have

examined the benefits of fibre in promoting compliance with diets formulated for weight loss by reducing hunger, such as in low-calorie diets (Astrup et al., 1990; Mickelson et al., 1979; Pasman et al., 1997; Ryttig et al., 1985).

In conclusion, commitment to several commandments were correlated with different dimension of FCQ-t at the study phases. However, commitment to two commandments (B1 and B10) were appeared frequently at all-time points of the study and correlated with many dimensions of FCQ-t, which may reflect the strong influence of commitment to these two commandments on food craving.

### **3.6.3 Effectiveness of study intervention on attitudes towards food**

This study aimed to investigate the effectiveness of our intervention on attitudes towards food at the three phases of the study; 3 months, 6 months after the intervention, and in the follow-up period. The theoretical and empirical results indicate that implicit attitudes are predictors of spontaneous, involuntary behaviour, and explicit attitudes of conscious decision-making and controlled actions (Deutsch & Strack, 2006; Perugini, 2005; Wilson et al., 2000). Recently, implicit attitude measures have been effectively utilised to research health-risk behaviour in predicting different aspects of addictive behaviour (Jajodia & Erleywine, 2003; Ostafin & Palfai, 2006; Wiers et al., 2006). This study investigated whether explicit and implicit attitudes towards healthy and unhealthy food differed between before intervention and 3 months after intervention.

The outcomes of this study demonstrated that the influence of the intervention on preference for healthy and unhealthy food differed dependent upon on how preferences are assessed (explicitly and implicitly). Although the study intervention succeeded in achieving significant changes in explicit attitudes towards healthy and unhealthy food, there was no change in the IAT. The IAT is thought to represent a person's repeated experience with attitudes towards an object, which might be shaped by the repeated implementation of reflective decision (Rothman et al., 2009). The potential ceiling effect might be a possible explanation for the failure to achieve a significant improvement in the IAT score. The mean baseline score achieved by participants was already high as most of the participants had achieved a good pre-intervention score on the IAT, which made it very difficult to improve the IAT score three months after the intervention.

The present study's findings on attitudes towards food supports previous research which distinguishes between explicit (conscious decisions or mental

experiences) and implicit attitudes (automatic decisions or mental processes) (Greenwald & Banaji, 1995). However, the study found positive correlations between the changes in the IAT and explicit attitudes towards unhealthy food. Despite existing correlation between implicit and explicit attitudes towards unhealthy food, the two types of attitudes originate from dissimilar information processing streams and are connected to stimulations in different areas of the brain (Cunningham et al., 2003).

A discrepancy arises in previous studies on the relationship of implicit and explicit attitudes. On one hand, studies published slight or no relation between them, indicating that each measures distinct knowledge structures (Dovidio et al., 1997, studies 1 and 3; Fazio et al., 1995, study 1; Greenwald et al., 1998, study 3). On the other hand, several other studies have shown a positive correlation between implicit and explicit attitudes (Dovidio et al., 1997, study 2; Greenwald et al., 1998, study 2; Wittenbrink et al., 1997). These divergent outcomes result from the many factors that influence the relationship between explicit and implicit attitudes, such as the kind of object being evaluated, attitude preparation and self-presentation (Nosek & Banaji, 2002). Greenwald et al. (2002) assumed no dissociation when ‘participants have little motivation to disguise their attitudes on explicit measures’ (p. 18). Thus, a slight or no correlation between implicit and explicit attitudes could be found when individuals were highly motivated to control their explicit attitudes.

### **3.6.3.a Attitudes, Body Weight Measures and Commitment**

Our study hypothesized to find correlations between changes in attitudes towards food and body weight measure, and commitment to the commandments. Regarding the correlation between attitudes and weight change after 3 months of the intervention, there was no correlation between the change in IAT score and the body weight measures. Moreover, the increased explicit attitudes towards healthy food and the decreased attitudes towards unhealthy food were not correlated with the changes in BMI and body weight. In addition, there is no correlation between commitment to commandments and change in explicit attitudes towards healthy and unhealthy food. Some studies have found that obese participants high negative attitudes, both implicit and explicit, towards unhealthy foods, such as those high in fat (Roefs et al., 2005; Roefs & Jansen, 2002).

Over first 6 months, the intervention obtained improvement in explicit attitudes towards healthy and unhealthy foods but not in implicit attitudes. In fact, over the first

3 months, the intervention reduced explicit attitudes towards unhealthy food and increased explicit attitudes towards healthy foods. In the last 3 months, the intervention's influence on explicit attitudes towards healthy and unhealthy food was not significant. These findings suggest that the intervention's effect on explicit attitudes towards food seems to have been greater in the first 3 months of the study. An increased explicit attitude towards healthy foods was correlated with commitment to the 'sugars are evil' commandment, while decreased explicit attitudes towards unhealthy food were not correlated with commitment to commandments.

3-months after the end of the intervention, this study showed no significant changes in the attitudes towards healthy and unhealthy food, compared with the explicit attitudes at the end of the intervention. This means that the participants maintained the significant improvement in their explicit attitudes achieved during the intervention period. In other words, although the individuals disused the interventional tools, there is a lasting effect of intervention on maintaining the increased explicit attitudes towards healthy food and decreased explicit attitudes towards unhealthy food. The findings of the current study are consistent with those of Hearty et al. (2007) who found that attitudes towards healthy food are linked to eating behaviour. Several studies have reported strong associations between attitudes and food choice (DeGraaf et al., 1997; Paisley et al., 1995; Sparks et al., 1995). Moreover, the outcomes of the follow-up study showed that there were no correlations between the changes in attitudes and the changes in body weight measures. However, in the previous phases of the study (three and six months) outcomes did not reveal any correlations between the weight change and the change in the attitudes, so it was not expected to find any correlations in this follow-up study.

In conclusion, the study intervention has successfully influenced the explicit attitudes towards healthy and unhealthy food after 3 and 6 months of the intervention. However, there was no significant influence on IAT. After 6 months of the intervention, commitment to B1 was correlated positively with changes in attitudes towards healthy food. Over the follow-up period of the study, there were no significant changes in the explicit attitudes detected. Moreover, there was no correlation between changes in explicit attitudes towards food and the change in BMI 3 months after the end of the intervention.

### **3.6.4 The Theory of Planned Behaviour and our intervention**

Many individuals, at some point in their lives, intend to make changes in their health behaviour. These intentions might result in successful behaviour change. However, for most individuals these intentions do not translate to actual behaviour changes or may only result in changed behaviour in the short-term (Ogden et al., 2007). Changing one's eating behaviour is very complicated especially when it involves weight loss-related dieting. In spite of some studies that have found significant reductions in dieters' energy intake (Thompson et al., 1988; Van Strien et al., 2000), other studies have found that dieters rarely reduce energy intake enough to be successful at weight loss (Herman & Mack 1975; Ogden, 1994; Polivy et al., 1994). Moreover, many treatment programs and interventions have obtained successful weight loss over the short-term (Jeffery et al., 2000); however, the success in maintaining the achieved weight loss over the long-term is poor and disappointing (Wing & Phelan, 2005; Aronne et al., 2009), as many individuals who successfully lost weight gradually regained it (Wing and Phelan, 2005; Dale et al., 2008; Dale et al., 2009). Therefore, the majority of dieters find it difficult to change their eating behaviour. Research findings point to a potential role for cognition, which may explain successful changes in eating behaviour beyond that shown by the minority of dieters. In particular, research in health and social psychology has drawn upon social cognition models such as the theory of planned behaviour (TPB) (Ajzen, 1985).

According to the theory, as described by Ajzen (1991), human behaviour is guided by three elements: attitude toward the behaviour, subjective norm and the perception of behavioural control. All together, these three elements lead to the formation of a behavioural intention. A meta-analysis conducted by Sutton (1998) found that when behaviour is predicted from intention alone, or from intention and perceived behavioural control, between 19-38% of the variance is explained. Currently, the Theory of Planned Behaviour (TPB) is a theoretical approach that has been used to predict and understand a variety of health behaviours (Glanz, Rimer & Lewis, 2002; Armitage & Conner, 2001; Hardeman et al., 2002; Godin & Kok, 1996). More precisely, it has been applied to a number of behaviours related to eating. For example, fat intake reduction (de Bruijn et al., 2008; Paisley & Sparks, 1998), fruit and vegetable consumption (Bogers et al., 2004; Kellar & Abraham; 2005; Lien et al., 2002; Perugini & Bagozzi, 2004), health-related eating behaviours (Ajzen & Timko, 1986), healthy

eating behaviours (Conner et al., 2002; Povey et al., 1999) and weight control (Netemeyer et al., 1991; Palmeira et al., 2007; Schifter & Ajzen, 1985).

We utilise the TPB as the backbone of our intervention. Based on Ajzen's work, interventions designed to change behaviour can be directed at one or more of its determinants: attitudes, subjective norms or perceptions of behavioural control. Thus, our intervention has focused on two important elements of the theory: attitudes and perceived behavioural control. Attitude has generally been found to be more predictive of behaviour intention than subjective norm (Trafimow & Fishbein, 1994). Perceived behavioural control is also an important factor in terms of helping individuals to overcome their undesired behaviours (Kanfer & Hagerman, 1981). Changes in these factors should produce changes in behavioural intentions and give people adequate control over their behaviour. However, the intervention will still be ineffective unless individuals are in fact capable of carrying out their newly formed intentions.

In terms of attitudes, our intervention was successful in changing explicit attitudes towards foods. The study participants experienced significant reduction in their explicit attitudes towards unhealthy food. At the same time, their explicit attitudes towards healthy foods increased significantly. However, although the intervention was effective in terms of their improvement of explicit attitudes, these improvements do not seem to correlate with all of the study commitment levels of the given 'commandments'. Only B1 (sugars are evil) showed positive correlation with a change of explicit attitudes towards healthy foods. This can be interpreted as a conclusive sign for the influence of the commitment to B1 on explicit attitudes towards foods. However, in spite of attitudes being mentioned among several studies as strong predictors of behaviour, attitudes do not always predict behaviour (Millar & Millar, 1996; Ajzen & Fishbein, 1980). Often, people express positive attitudes toward an activity, yet admit that they seldom engage in it. Our study showed that although there was an achieved improvement in explicit attitudes towards unhealthy foods, we found no correlation with commitment to the commandments, which reflects some eating behaviours. Several studies have found that the relationship between attitude and behaviour is stronger when the measures of attitude and behaviour correspond (e.g. Ajzen & Fishbein, 1977; Davidson & Jaccard, 1979; Jaccard, King & Pomazal, 1977). With B1, this correspondence between attitudes and behaviours is presented as the information that sugar is a threat for health and the subjects' attitudes are linked to this. Therefore, the outcomes of the behaviour to avoid sugar and the health closely correspond.



With regards to perceived behavioural control, the theory of planned behaviour assumes that the fulfilment of behavioural goals does not only rely on intention but also on perceived behavioural control, an effect that can be examined in terms of the direct relation between perceived behavioural control and behaviour. Ajzen et al. (1986) stated that “it is often very difficult to secure an adequate measure of actual control in advance of observing the behaviour” (p. 456). Eagly and Chaiken (1993) defined perceived behavioural control as “one’s perception of how easy or difficult it is to perform the behavior” (pp. 186-187). Therefore, we used the FCQ-t, which includes dimensions close to perceived behavioural control. We believed that when participants answered the FCQ-t it may reflect participants’ experienced control over the dimensions. Our intervention resulted in significant reduction in some scores in FCQ-t, which might reflect an increased score of control over the cravings dimensions. Moreover, commitment to some of the commandments appeared to have a significant relationship with some dimensions of the FCQ-t. For example, after the first 3 months, commitment to B1 and B10 commandments (these two commandments related to control intake of sugar as liquid calories) were correlated with increased control over the following dimensions: intention and plan to consume food, cues that may trigger food cravings, thoughts or preoccupation with food, and craving as a physiological state. Wallace et al. (2005) stated that low perceived behavioural control creates a strong situation in which participants are swayed more by the perceived lack of resources and opportunities to perform the behaviour than by their own attitudes toward doing so. Terry and O’Leary (1995) found that the levels of perceived behavioural control emerged as a significant (positive) predictor of actual behaviour. Also, they mentioned that there was evidence that the effects of intentions on behaviour were moderated by the level of perceived behavioural control. However, there are two conditions in which perceived behavioural control is expected to be strong. The first is that the predicted behaviour must not be under complete volitional control. Whilst the second is that perceptions of behavioural control must reflect actual control in the situation with some degree of accuracy (Ajzen et al., 1986).

### **3.7 Conclusion:**

Many interventions and treatment programs have presented ways to counter the increased rates of overweight and obesity. Most of the programs were effective over the short term, but they were ineffective over the long-term. Thus, effective

interventions for weight and obesity management are urgently needed to prevent and decrease the rapid increase in the prevalence of obesity and obesity-related diseases which clearly influence individuals' health. Based on the best knowledge of nutrition and behaviours from previous studies, we developed a weight loss programme which uses the reflection process and consists of 10 commandments, and based on multiple behaviour change theories and techniques. The present study was aimed to investigate the effectiveness of our intervention in achieving moderate weight loss, reducing food craving, improving implicit and explicit attitudes towards healthy food and inhibiting explicit attitudes towards unhealthy food.

In the first phase of this study, 3-month after the intervention, participants achieved remarkable weight loss (6.4 % of their initial body weight). They also reported significant lower food cravings and explicit attitudes towards unhealthy foods, and higher explicit attitudes towards healthy foods, in comparison to their scores at the initial visit. Their implicit attitudes did not change. This study found that the influence of commitment to the commandments has two dimensions. Some commandments had great effects on body weight measures, while others had a greater influence on food cravings. This result might explain why studies have produced conflicting results on the influence of weight loss on food cravings. The outcomes at first 3-months suggest that the study intervention has remarkable influences on different criteria for a successful weight-loss programme.

However, participants who applied the study tools for 6 months achieved remarkable weight loss (9.1 % of their initial body weight) and reported significantly improvement in food cravings and explicit attitudes towards healthy and unhealthy foods compared to their food craving score at their initial visit. Implicit attitudes did not change. More precisely, the intervention had greater influence in the first 3 months and, while in the last 3 months, the intervention played a role in maintaining achieved improvements. That might show the strong influence of the intervention in the first 3 months. However, we don't know whether that the last 3 months is important for the intervention or not, but it is obvious that the last 3 months maintained the achieved score and prevent the relapse in the scores. The study found that the influence of commitment to the commandments has three dimensions. Some commandments had great effects on body weight measures regardless of food cravings (B2 'veg and fruit you need', B3 'rich with fibres', B7 'enjoy your food', B8 'regular is better', B9 'long ways to eat'). Others had great effects on food cravings regardless of weight loss (B4

‘picky with the meat’, B10 ‘no buzz with fizz’). Two commandments had great influence on both food cravings and BMI reduction (B1 ‘sugars are evil’ and B5 ‘have a high with low’). This result might explain why studies have produced conflicting results regarding the influence of weight loss on food cravings and vice-versa.

This study, in the third phase (follow-up), confirms the lasting effectiveness of the novel intervention, even after stopping the use of the interventional tools. Three months after the end of the intervention, the participants maintained their achieved improvement in terms of weight loss, declines in food cravings, increased attitudes towards healthy food and decreased explicit attitudes towards unhealthy food. Moreover, this study showed a significant correlation between weight during the follow-up and the commandments aimed to reduce sugar intake and liquid calories, supporting the view that the rapid increase in obesity and overweight is related to the increased consumption of sugary foods and drinks.

To our knowledge, this study provides the first data on food cravings and implicit attitudes and explicit attitudes towards healthy and unhealthy foods from a weight-loss programme based on 10 nutritional and behavioural commandments using self-reflection process. Our study intervention was effective and had various effects on body weight, food cravings and explicit attitudes over short-term (3 months), medium-term (6 months), and 3 months follow-up after the end of the intervention. These outcomes demonstrated that the study intervention has remarkable influences on different criteria, which means that it can be considered a successful weight-loss programme. In addition, the study highlights the importance of each commandment in relation to weight loss and food cravings.

## **Chapter Four**

### **Efficacy of the novel intervention on body weight and health-related parameters and risks based on 10 nutritional/behavioural commandments using a reflective process (self-reflection) in SA**

#### **4.1 Introduction**

We have focused in the first study (UK study) on body weight and composition outcomes, and mainly on the psychological parameters (implicit and explicit attitudes, and food cravings as investigator for the effectiveness of our intervention. In the current study, we will be more concerned about metabolic blood parameters which are known to be predictive and associated with chronic diseases like cardiovascular and diabetic disease. Thus, the major aims of the present study is to examine the effectiveness of the novel weight-loss intervention on body weight measures and compositions, glucose homoeostasis, lipid profiles and blood pressure. In addition, the study aimed to identify which commandments and combinations of commandments have the strongest influence on physiological factors (body weight, BMI, body characteristics, glucose homoeostasis, lipid profiles, cardiovascular risk parameters), and on psychological factors (explicit attitudes towards healthy and unhealthy food).

#### **4.2 Hypothesis**

The current study hypothesised that commitment to the 10 commandments would result in loss of 5%–10% of initial body weight; improvement in glucose homoeostasis, lipids profile, BP and RHR; and positive changes in explicit attitudes towards healthy and unhealthy food at the three different time-points of the study. It was also hypothesized that obtained improvements in health parameters and explicit attitudes would be correlated with weight change and commitment to the commandments. Finally, the study attempted to find the best combination of commandments that are showing association with weight loss, improved health parameters and changed explicit attitudes towards healthy and unhealthy food.

#### **4.3 Methods**

##### **4.3.1 Participants**

Female participants were recruited for this study from an obesity outpatient clinic at King Fahad Medical City (KFMC) in Riyadh, Kingdom of Saudi Arabia

(KSA). The participants were met the following criteria: overweight or obese females, age 18 to 60 with a BMI of >25. Participants who were not engaging in any stringent exercise schedule or dieting were included. The exclusion criteria included the presence of pregnancy or chronic health complaints, such as cancer, heart disease, liver disease, gastrointestinal disorders and other contraindications. Participants were also excluded if they were taking psychiatric medications or medications known to have an effect on body weight and metabolism, such as sibutramine and orlistat. In addition, participants who lost more than 5% of their initial body weight were excluded.

Before agreeing to take part in the study, participants were given a written study information sheet at the clinic. The information sheet (see the appendix) outlined all expectations for participants, study procedures, measurements and number of expected laboratory visits and provided contact information for had any questions. Potential participants were invited to attend a session where all their questions were answered. At this session, the study intervention was described in detail, and participants practised using the study tools with two examples of popular meals (see the Appendix). The practise ensured that participants became adept and familiar with using the tools. At the end of the session, participants was asked if they had any further questions about the study and to sign the informed consent form if they agreed to take part. Informed consent was obtained by the principal researcher, and all participants were aware that taking part was completely voluntary and that they were free to withdraw at any time without giving a reason. Written, informed consent was obtained before enrolling participants in the study. Potential participants were screened using pre-study and medical questionnaires which evaluated their medical conditions and any medications that could prevent them from participating in the weight-loss programme.

#### **4.3.2 Ethics**

This study followed all regulations concerning the ethical use of volunteers. The protocol, surveillance instruments and experimental procedures received ethical approval from the Saudi Ministry of Health and the institutional review board at KFMC, Riyadh, KSA (Ethical No.H-01-R-012).

#### **4.3.3 Intervention**

For the study the novel weight-loss intervention which uses reflective processes on 10 commandments based eating behavioural strategies from recent

literature and based on concept from behavioural change theories and techniques (for more details, see p 131) was applied. However, as the present study was conducted in Saudi Arabia, I have translated the study's tools (laminated card, leaflet and compliance sheet) into Arabic. The translation was done by the Certified Translation Office and the Arabic copies of the tools were revised by the research team.

#### **4.3.4 Measures**

All measurements and questionnaires were completed by participants at baseline, after the 3-month and 6-months of the study intervention. In the follow-up phase, we received self-reported body weight.

##### **4.3.4.a Height and body weight and composition.**

Height was measured to the nearest 0.5cm using a wall mounted stadiometer (Holtain, Crosswell, Wales). Participants were measured barefoot, with their back positioned against a wall. The body weight and composition was measured by bioimpedance analysis (BIA) tool (Inbody 720, Body Composition Analyzer, Biospace Co. Ltd). Participants were weighed in the non-fasting state, wearing minimal lightweight clothes. The electronic bioimpedance analyzer was used at each time-point. Waist and hip circumferences were measured using a tape measure.

##### **4.3.4.b Explicit attitudes**

Same tools and procedures were used as in the UK studies; for detail, see chapter 3.

##### **4.3.4.c Blood pressure and resting heart rate.**

Blood pressure and resting heart rate were measured using a digital sphygmomanometer (OMNI, Infinium medical Inc., USA). Participants were requested to sit quietly and rest for about 5-10 min. measurements were taken on non-dominant arm while it was placed on the table, arm at the level of the heart, and the palm facing upwards. Blood pressure was determined as the mean of two measurements taken with the subject. An expert nurse had taken the measurements.

#### **4.3.4.d Blood analysis.**

Blood samples, 5 ml, were acquired by venepuncture between 7am and 9am after a 12-hours overnight fasting. The level of glucose, TC, TG, LDL, HDL, and HB.A1c were measured on Siemens Dimension RXL Max by using an VITRO FLEX REAGENT CARTRIDGE KIT (Siemens healthcare diagnostic Ltd, UK). Each blood sample was measured in triplicate. Fasting plasma glucose concentration was measured by glucose oxidase method (Jietz, 1982). Plasma insulin level was measured by enzyme immunoassay using human insulin ELISA kit (Q-1-Diaplus, USA). Total cholesterol (TC) was determined by a Triderbased (CHOD-PAP) colorimetric method (Allain et al., 1974). High density lipoprotein cholesterol (HDL-C) was estimated by a precipitant method (Gordon et al., 1977). Low density lipoprotein cholesterol (LDL-C) was estimated according to the Fiedewald's formula;  $LDL\text{-Cholesterol} = Total\ Cholesterol - (HDL\ cholesterol + Triglycerides/5)$ . (Fiedewald et al., 1972). Triglycerides (TG) were determined using a Trinder-based (GPO-PAP) method (Jacobs & VanDenmark, 1960). Hemoglobin A1c was determined with the use of Cobas integra reagents and equipment. Insulin sensitivity was determined by Homeostasis Model Assessment (HOMA2) which based on fasting glucose and insulin concentrations (The HOMA2 model is available from [www.ocdem.ox.ac.uk](http://www.ocdem.ox.ac.uk)).

These measures were performed in the certified clinical lab in King Fahad Medical City which works to the highest diagnostic standard.

#### **4.3.5 Data Collection and Analysis**

Data collection was performed by the main investigator with assistance from a small research team in the obesity clinic at KFMC. The collected data were analysed using Statistical Package for Social Sciences (SPSS ver. 20). Descriptive statistics were applied. T-tests between baseline and 3 months after the intervention were conducted. Pearson's correlation coefficients (r) between the study variables were calculated. Also, one-way repeated measure was conducted to find the differences between the commitments to the commandments level. P-values were considered significant at  $<0.05$ .

#### **4.4 Design**

The study consisted of four visits over 3 months. Body weight, BMI, HHR and body composition were assessed at each visit, and participants were requested to

complete EAQs at baseline (first visit) and 3 months after the intervention (fourth visit). Blood samples were taken twice (pre- and post-intervention). Figure 1 shows the study design, procedure and measures.

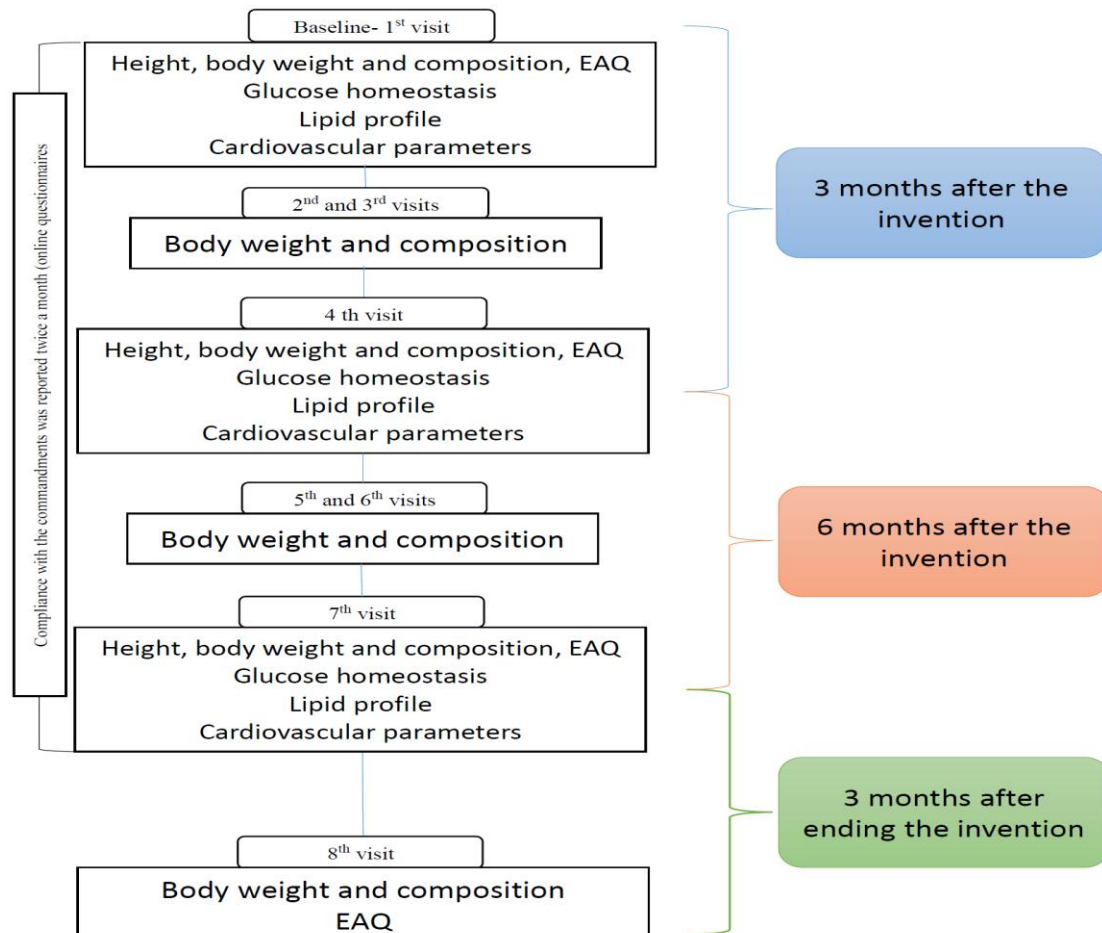


Figure 4.1 The study design diagram

## 4.5 Results

### 4.5.1 The result report of the 3 months after the intervention:

The study' participants were recruited from the obesity clinic at KFMC, where obese patients receive treatment; there, they may branch out and try a different treatment scheme. This means that while they are enrolled in the clinic, they may decide to obtain a different form of treatment, which makes it difficult for the research team to determine the actual dropout rate. However, this weight-loss study enrolled 104 overweight and obese female participants (age  $37.5 \pm 11.3$ , BMI  $41.40 \pm 7.58$ ) who decided to follow our treatment scheme. These 104 participants successfully completed the three-month program using the study's intervention and tools.



This results section presents the main outcomes from analysis to determine the effectiveness of the intervention in various dimensions: level of commitment to the commandments, body weight and characteristics, glucose homeostasis, cardiovascular risk parameters (lipid profile, BP, RHR) and explicit attitudes towards healthy and unhealthy food.

#### 4.5.1.1 Commitment to the 10 commandments

The means and SDs of commitment level for each commandment over 3 months are shown in Table 4.1. There were small variations between the levels of commitment to the 10 commandments. The B6 commandment had had the highest level of commitment ( $65.25 \pm 23.83$ ), while the B2 commandment had the lowest ( $53.06 \pm 21.36$ )

**Table 4.1** Means and SDs of commitment to the 10 commandments

Diet Commandment Headings			Commitment
In leaflets	In laminated cards	Symbol	(day/84) Mean $\pm$ SD
Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added-sugar products and snacks, especially sweets	Sugars are evil!	B1	59.31 $\pm$ 24.80
Eat at least half a kilogramme variety of vegetables and fruit a day	Veg and fruit You need!	B2	53.06 $\pm$ 21.36
Base your meals on fibre-rich foods	Rich with fibres!	B3	55.90 $\pm$ 20.59
Eat fish, and meat no more than twice a week	Picky with the meat!	B4	60.76 $\pm$ 23.90
Eat foods low in energy density	Have a high with the low!	B5	54.06 $\pm$ 23.28
Choose low-salt products	Short of salt!	B6	65.25 $\pm$ 23.83
Take your time, and focus on your meal whilst eating	Enjoy your food!	B7	54.11 $\pm$ 22.61
Have regular meal times	Regular is better!	B8	56.98 $\pm$ 23.05
Be aware of your caloric needs and how much you eat	Long ways to eat!	B9	53.33 $\pm$ 23.32
Limit calorie intake from alcohol and drinks	No buzz with fizz!	B10	59.21 $\pm$ 24.92
Total commitment			572.16 $\pm$ 223.2

However, we performed one-way repeated measure ANOVA to assess whether there are statistical differences between the levels of commandments' commitment. The next table (table 4.2) shows the significant differences between the levels of commitments to the commandments.

**Table 4.2** The significant levels of the commitments to the commandments

	<b>Mean</b>	<b>P value</b>		<b>Mean</b>	<b>P value</b>
	<b>differences</b>			<b>differences</b>	
B1-B2	6.05±1.09	<b>0.000*</b>	B4-B7	6.65±1.17	<b>0.000*</b>
B1-B5	5.25±1.12	<b>0.000*</b>	B4-B9	7.43±1.12	<b>0.000*</b>
B1-B6	-5.94±1.39	<b>0.002^</b>	B5-B6	-11.19±1.16	<b>0.000*</b>
B1-B7	5.20±1.09	<b>0.000*</b>	B5-B8	-2.92±0.85	<b>0.037+</b>
B1-B9	5.98±1.03	<b>0.000*</b>	B5-B10	-5.15±1.14	<b>0.001^</b>
B2-B3	-2.64±0.71	<b>0.015+</b>	B6-B7	11.14±1.11	<b>0.000*</b>
B2-B4	-7.5±1.13	<b>0.000*</b>	B6-B8	8.27±1.13	<b>0.000*</b>
B2-B6	-11.99±1.09	<b>0.000*</b>	B6-B9	11.92±1.16	<b>0.000*</b>
B2-B8	-3.72±0.821	<b>0.001^</b>	B6-B10	6.04±1.36	<b>0.001^</b>
B2-B10	-5.85±1.08	<b>0.000*</b>	B7-B8	-2.88±0.7	<b>0.004^</b>
B3-B4	-4.86±1.13	<b>0.002^</b>	B7-B10	-5.11±1.06	<b>0.000*</b>
B3-B6	-9.35±1.04	<b>0.000*</b>	B8-B9	3.65±0.75	<b>0.000*</b>
B4-B5	6.7±1.02	<b>0.000*</b>	B9-B10	-5.89±1.04	<b>0.000*</b>
<b>B4-B6</b>	-4.49±0.99	<b>0.001^</b>			

\*p<0.0005; ^p<0.01; +p<0.05

#### 4.5.1.2 Body characteristics

The first set of analyses examined the impact of the intervention on body weight and composition because we proposed that the intervention would achieved modest weight loss (5%–10% of initial body weight) and result in significant changes in body composition. A paired-sample t-test was conducted to compare body characteristics at baseline and 3 months after the intervention. The means and SDs of participants' body characteristics at baseline and 3 months after the intervention are shown in Table 4.3. There were strong, significant differences in all body characteristics (p<0.0005).

**Table 4.3** Means and SDs of body characteristics (baseline, 3 months after the intervention, and changes)

<i>n</i>	Characteristics	Baseline	3 months after the intervention	Changes	T-test
104	Weight (kg)	104.2±21.6	96.9±21.2	-7.3±5.3	<b>0.000*</b>
104	BMI (kg/m <sup>2</sup> )	41.4±7.6	38.5±7.6	-2.9±2.1	<b>0.000*</b>
88	SMM (kg)	27.8±4.9	26.8±4.7	-0.9±1.1	<b>0.000*</b>
88	BFM (%)	52.8±13.8	47.6±13.9	-5.1±3.8	<b>0.000*</b>
104	Waist (cm)	107.6±14.7	99.9±14.8	-7.8±12.9	<b>0.000*</b>
104	WHtR (cm)	0.7±0.09	0.6±0.11	-0.05±0.08	<b>0.000*</b>

\*p<0.0005

After 3 months of using the study tools, the mean weight loss was (-7.3±5.3) kg, or 7% of the initial body weight, and the mean BMI loss was (-3±2.1) kg/m<sup>2</sup>. The intervention had a significantly strong effect on BFM (p<0.0005), reducing it by (-5.1±3.8%) over 3 months. Waist-c and WHtR also experienced very significant reductions, with a mean (7.5) cm and (0.05) cm, respectively. In short, the study intervention has been shown to be effective at achieving significant reductions 3 months after the intervention in body weight (7.3 kg), BMI (3 kg/m<sup>2</sup>), BFM (5.1%), waist-c (7.8 cm) and WHtR (0.05).

#### 4.5.1.3 Glucose homeostasis

We hypothesised that the intervention would result in healthy change in the glucose homeostasis parameters 3 months after the intervention. A paired-sample t-test was conducted to compare glucose homeostasis parameters at baseline and 3 months after the intervention. Table 4.4 shows the means and SDs of glucose homeostasis at baseline, 3 months after the intervention and changes over the study period. From the data in Table 3, it is apparent that there were significant reductions in the fasting glucose (0.39±0.87 mmol/L), fasting insulin (18.5±29.3 mmol/L), HG.A1c (0.321±0.52 %) and Homeostasis Model Assessment insulin resistance (HOMA IR) (-0.367±0.546) and significant increase in HOMA insulin sensitivity (HOMA S) (8.67±18.44) 3 months after the intervention. However, there was no significant difference in HOMA beta cell function (HOMA B) (p>0.05) from baseline to 3 months after the intervention.

In short, the study intervention achieved significant improvement in glucose homeostasis parameters.

**Table 4.4** Means and SDs of Glucose homeostasis parameters (baseline, 3 months after the Intervention, and changes)

<i>n</i>	Parameters	Baseline	3 months after the intervention	Changes	T-test
83	Fastin glucose (mmol/L)	5.9±2	5.6±1.5	-0.39±0.9	<b>0.000*</b>
59	Fasting insulin (pmol/L)	119.2±53.5	100.7±41.4	-18.5±29.3	<b>0.000*</b>
85	HG.A1c (%)	6.3±1.4	5.9±1.2	-0.32±0.5	<b>0.000*</b>
58	HOMA B	129.1±50.6	128.6±46.5	-0.49±18.4	0.839
58	HOMA S	53.7±25.8	62.3±30.8	8.7±18.4	<b>0.001<sup>^</sup></b>
58	HOMA IR	2.3±0.98	1.9±0.76	-0.36±0.6	<b>0.000*</b>

\*p<0.0005; ^p<0.01

#### 4.5.1.4 Lipids profile

The study hypothesised that the after 3 months, the intervention would result in significant improvements to lipids profile parameters. A paired-sample t-test was performed to compare lipids profile parameters at baseline and 3 months after the intervention. The results are presented in Table 4.5. Most interestingly, HDL cholesterol had increased 3 months after the study intervention (0.06±0.17 mmol/L), marking a significantly difference from the baseline value (p<0.05). After 3 months, LDL, cholesterol and TG also decreased significantly (p<0.005) by (0.22±0.36 mmol/L), (0.23±0.52 mmol/L) and (0.16±0.34 mmol/L), respectively.

In short, after 3 months of using the study intervention, the lipids profile parameters had significantly improved.

**Table 4.5** Means and SDs of Lipids profile (baseline, 3 months After the intervention, and changes)

<i>n</i>	Parameters	Baseline	3 months after the intervention	Changes	T-test
87	HDL (mmol/L)	1.2±0.3	1.3±0.3	0.06±0.2	<b>0.001<sup>^</sup></b>
87	LDL (mmol/L)	2.9±0.8	2.7±0.7	-0.22±0.4	<b>0.000*</b>
87	TC (mmol/L)	4.7±0.9	4.5±0.8	-0.23±0.5	<b>0.000*</b>
87	TG (mmol/L)	1.3±0.7	1.2±0.5	-0.16±0.3	<b>0.000*</b>

#### 4.5.1.5 Cardiovascular parameters

Our study hypothesised that the intervention would result in a significant decrease of cardiovascular risk parameters (SBP, diastolic blood pressure, and RHR). A paired-sample t-test was conducted to compare cardiovascular parameters variables at baseline and 3 months after the intervention. Table 4.6 shows the mean and SD of SBP, DBP and RHR at baseline, after 3 months and the change over 3 months. While SBP was reduced (-1.92 mmHg) significantly ( $p < 0.05$ ), neither DBP nor RHR changed significantly ( $p > 0.05$ ). In short, the study intervention resulted in a significant reduction of only SBP after 3 months of the intervention.

**Table 4.6** Mean and SD of Cardiovascular parameters (baseline, 3 months, and changes)

N	Parameters	Baseline	3 months	Changes	T-test
104	SBP (mmHg)	125.7±12.9	123.8±10.6	-1.9±6.7	<b>0.004<sup>^</sup></b>
104	DBP (mmHg)	79.1±8.2	78.1±8.4	-1.1±6.9	0.109
104	RHR (bpm)	83.8±11.8	83.5±9.7	-0.3±6.8	0.654

<sup>^</sup> $p < 0.01$

#### 4.5.1.6 Explicit attitudes towards healthy and unhealthy food

We hypothesised that the study intervention would result in significant improvements in explicit attitudes towards healthy and unhealthy food. A paired-sample t-test found significant differences ( $p < 0.0005$ ) in explicit attitudes towards healthy and unhealthy food at baseline and after 3 months of the intervention (see Table 4.7). There was significant increase in the explicit attitudes towards healthy food ( $6.7 \pm 6.20$ ) and on other hand, there was strong decrease in the explicit attitudes towards unhealthy food ( $-5.5 \pm 4.3$ ).

In short, the study intervention successfully obtained a significant increase in explicit attitudes towards healthy food and a significant reduction in explicit attitudes towards unhealthy food.

**Table 4.7** Means and SDs of explicit attitudes

<b>N</b>	<b>Parameters</b>	<b>Baseline</b>	<b>3 months</b>	<b>Changes</b>	<b>T-test</b>
104	Healthy food	38.59 $\pm$ 4.95	45.29 $\pm$ 5.78	6.7 $\pm$ 6.20	<b>0.000*</b>
104	Unhealthy food	35.19 $\pm$ 4.21	29.67 $\pm$ 4.94	-5.52 $\pm$ 4.34	<b>0.000*</b>

\* $p < 0.0005$

#### 4.5.1.7 Correlations between commitment and changes in body weight measures

We hypothesised that achieved weight loss would correlate with commitment to the commandments. A Pearson's correlation was computed to assess the relationship between participants' commitment to the commandments and their achieved loss in weight and BMI. Table 4.8 shows the correlations between weight loss and commitment to each commandment. There were strong significant correlation between commitment to the commandments and achieved loss in body weight and BMI. These correlations were negative; increased commitment to the commandments resulted in significant reduction in body weight. Notably, the strength of the correlations was  $> 0.6$ , and the strongest 3 correlations were with the B1 ( $r = -0.725$ ), B5 ( $r = -0.719$ ) and 'no buzz with fizz' ( $r = -0.706$ ) commandments. In short, weight loss and BMI reduction seem to be correlated strongly with commitment to all 10 commandments.

**Table 4.8** Correlation between commandments and weight and BMI changes

N	Commandment	Weight change		BMI	
		r	p	r	p
104	B1	-0.740	<b>0.000</b>	-0.725	<b>0.000</b>
104	B2	-0.714	<b>0.000</b>	-0.705	<b>0.000</b>
104	B3	-0.723	<b>0.000</b>	-0.706	<b>0.000</b>
104	B4	-0.614	<b>0.000</b>	-0.616	<b>0.000</b>
104	B5	-0.735	<b>0.000</b>	-0.719	<b>0.000</b>
104	B6	-0.628	<b>0.000</b>	-0.622	<b>0.000</b>
104	B7	-0.705	<b>0.000</b>	-0.707	<b>0.000</b>
104	B8	-0.713	<b>0.000</b>	-0.703	<b>0.000</b>
104	B9	-0.724	<b>0.000</b>	-0.715	<b>0.000</b>
104	B10	-0.715	<b>0.000</b>	-0.706	<b>0.000</b>
104	TOTAL	-0.734	<b>0.000</b>	-0.725	<b>0.000</b>

p<0.0005

#### 4.5.1.8 Correlation between Glucose homeostasis parameters and commandments' Commitments

The present study hypothesised that commitment to the commandments would correlate with improvement in glucose homeostasis parameters. We calculated a Pearson's correlation to evaluate the relationship between the level of commitment for each commandment and changes in glucose homeostasis parameters. The correlations between glucose homeostasis change and the commitment to each commandment are shown in Table 4.9.

Except for commitment to two commandments (B4 'picky with meat', and B6 'short of salt'), there were significant negative correlations with reduction in fasting glucose. High commitment to the other eight commandments (B1 'sugars are evil', B2 'veg and fruit you need', B3 'rich with fibres', B5 'have a high with the low', B8 'regular is better', B7 'enjoy your food', B9 'long ways to eat', B10 'no buzz with fizz') was correlated with decreases in fasting glucose.

Commitment to the B1 'sugars are evil' and B2 'veg and fruit you need' commandments were correlated negatively with fasting insulin, so increased commitments to these were correlated with decreased fasting insulin. HOMA IR was correlated negatively with commitment to the B1 'sugars are evil', B2 'veg and fruit

you need’ and B10 ‘no buzz with fizz’ commandments, which means that reduced HOMA IR resulted from increased commitment to these commandments.

In short, commitment to two commandments (B1 ‘sugars are evil’ and B2 ‘veg and fruit you need’) which aiming to reduce intake of sugar and increase intake of vegetables and fruits were correlated significantly with three glucose homeostasis variables: FG, FI, and HOMA IR. Fasting glucose was also correlated with other five commandments: B5 ‘have a high with the low’, B7 ‘enjoy your food’, B8 ‘regular is better’ and B10 ‘no buzz with fizz’. In addition, HOMA IR was, also, correlated with the commandment B10 ‘no buzz with fizz’.

**Table 4.9** Correlation between commandments and Glucose homeostasis changes

	Fasting glucose		Fasting insulin		HG.A1c		HOMA B		HOMA S		HOMA IR	
	r	p	r	p	r	p	r	p	r	p	r	p
B1	-0.310	<b>0.004</b>	-0.257	<b>0.047</b>	-0.183	0.092	-0.138	0.301	0.156	0.243	-0.284	<b>0.031</b>
B2	-0.276	<b>0.012</b>	-0.282	<b>0.025</b>	-0.095	0.386	-0.235	0.075	0.232	0.079	-0.310	<b>0.018</b>
B3	-0.229	<b>0.037</b>	-0.238	0.07	-0.075	0.490	-0.165	0.216	0.167	0.210	-0.247	0.062
B4	-0.170	0.124	-0.208	0.113	-0.062	0.570	-0.190	0.153	0.174	0.190	-0.244	0.065
B5	-0.221	<b>0.045</b>	-0.221	0.093	-0.083	0.450	-0.202	0.128	0.179	0.179	-0.226	0.088
B6	-0.168	0.129	-0.204	0.121	-0.120	0.272	-0.142	0.287	0.060	0.653	-0.242	0.067
B7	-0.272	<b>0.013</b>	-0.199	0.130	-0.052	0.637	-0.115	0.391	0.112	0.402	-0.209	0.115
B8	-0.274	<b>0.012</b>	-0.238	0.070	-0.090	0.410	-0.171	0.199	0.132	0.323	-0.250	0.059
B9	-0.234	<b>0.033</b>	-0.223	0.090	-0.051	0.639	-0.217	0.101	0.143	0.283	-0.236	0.074
B10	-0.314	<b>0.004</b>	-0.252	0.054	-0.212	<b>0.050</b>	-0.135	0.312	0.074	0.582	-0.276	<b>0.036</b>
T	-0.262	<b>0.017</b>	0.250	0.056	-0.110	0.314	-0.183	0.169	0.153	0.251	-0.270	<b>0.040</b>

#### 4.5.1.9 Correlation between lipid profile parameters and commandments’ Commitments

This study hypothesised that improvement in lipids profile parameters would be correlated with weight loss. A Pearson’s correlation was computed to determine the relationship between the level of commitment and improvement in lipids profile parameters. Table 4.10 shows the correlation between lipids profile parameters and commitments. LDL and triglycerides were correlated negatively with commitment to all commandments, such that increased commitment was associated with significant



reductions in LDL and triglyceride levels. Except for two commandments (B1 ‘sugars are evil’ and B10 ‘no buzz with fizz’), all the commandments had significant, negative correlations with TC. Therefore, increased commitment to eight commandments (B2 ‘veg and fruit you need’, B3 ‘rich with fibres’, B4 ‘picky with the meat’, B5 ‘have a high with the low’, B6 ‘short of salt’, B8 ‘regular is better’, B7 ‘enjoy your food’, B9 ‘long ways to eat’) was associated with reduced cholesterol. Interestingly, HDL was correlated positively with the B1 ‘sugars are evil’ and B10 ‘no buzz with fizz’ commandments. Increased commitment these two commandments which aim to reduce intake of sugar intake and liquids calories were correlated with increased HDL; however, this correlation was weak ( $r < 0.3$ ).

In short, LDL and TG were correlated with commitment to all the commandments. TC was also correlated will all the commandments, except B1 ‘sugars are evil’ and B10 ‘no buzz with fizz’. Conversely, these two commandments were correlated with HDL.

**Table 4.10** Correlation between commandments and Lipid profile changes

	HDL		LDL		TC		TG	
	r	p value	r	p value	r	p value	r	p value
B1	0.218	<b>0.042</b>	-0.263	<b>0.014</b>	-0.179	0.097	-0.240	<b>0.025</b>
B2	0.164	0.128	-0.330	<b>0.002</b>	-0.317	<b>0.003</b>	-0.299	<b>0.005</b>
B3	0.135	0.214	-0.337	<b>0.001</b>	-0.320	<b>0.003</b>	-0.328	<b>0.002</b>
B4	0.065	0.550	-0.461	<b>0.000</b>	-0.473	<b>0.000</b>	-0.376	<b>0.000</b>
B5	0.142	0.189	-0.419	<b>0.000</b>	-0.340	<b>0.001</b>	-0.335	<b>0.002</b>
B6	-0.003	0.976	-0.358	<b>0.001</b>	-0.357	<b>0.001</b>	-0.321	<b>0.002</b>
B7	0.120	0.269	-0.389	<b>0.000</b>	-0.328	<b>0.002</b>	-0.308	<b>0.004</b>
B8	0.152	0.160	-0.369	<b>0.000</b>	-0.319	<b>0.003</b>	-0.294	<b>0.006</b>
B9	0.130	0.231	-0.4	<b>0.000</b>	-0.344	<b>0.001</b>	-0.356	<b>0.001</b>
B10	0.215	<b>0.045</b>	-0.248	<b>0.021</b>	-0.158	0.143	-0.227	<b>0.035</b>
T	0.143	0.187	-0.377	<b>0.000</b>	-0.330	<b>0.002</b>	-0.325	<b>0.002</b>

#### 4.5.1.10 Correlation between cardiovascular parameters (SBP, DBP, RHR) and commandments' Commitments.

Our study hypothesised that increased commitment to the commandments would correlate with reductions in cardiovascular risk parameters (BP, RHR). A Pearson's correlation was performed to assess the relationship between the level of commitment to the commandments and change in cardiovascular parameters. The correlation between cardiovascular parameters and commitments are presented in Table 4.11. No correlation appears with SBP, DBP, or RHR. That means that there is no correlation between increased commitment to the commandments and the significant change in SBP achieved after 3 months of the intervention.

In short, there was no correlation between commitment to the commandments and changes in SBP, DBP and RHR.

**Table 4.11** Correlation between commandments and Cardiovascular parameters changes

Commandment	SBP		DBP		RHR	
	r	p value	r	p value	r	p value
B1	-0.072	0.467	0.103	0.298	-0.013	0.894
B2	-0.094	0.341	0.093	0.349	0.067	0.502
B3	-0.084	0.421	0.073	0.463	-0.014	0.885
B4	-0.121	0.221	0.084	0.396	0.058	0.559
B5	-0.084	0.398	0.098	0.321	0.085	0.402
B6	-0.082	0.411	0.130	0.188	-0.031	0.896
B7	-0.072	0.470	0.113	0.252	0.059	0.553
B8	-0.035	0.723	0.102	0.302	0.026	0.796
B9	-0.103	0.299	0.105	0.287	0.049	0.621
B10	-0.076	0.446	0.111	0.262	-0.012	0.903
T	-0.086	0.388	0.106	0.283	0.029	0.768

#### 4.5.1.11 Correlation between explicit Attitude and commandments' commitments.

We hypothesised that increased commitment to the commandments would be correlated with improvements in explicit attitudes towards healthy and unhealthy food. A Pearson's correlation was calculated to identify the relationship between the level of

commitment and explicit attitudes towards healthy and unhealthy food. Table 4.12 shows the results. Commitment to all commandments was correlated strongly and negatively with explicit attitudes towards unhealthy food. Thus, increased commitment to the commandments was correlated with lower attitudes towards unhealthy food. Explicit attitudes towards healthy food were correlated positively with all commandments, except with B4 ‘picky with meat’ commandments. Therefore, increased commitment to the commandments (except B4) was correlated with increased explicit attitudes towards healthy food. Although commitment to the commandments was significantly correlated to explicit attitudes towards healthy food, the strength of the correlation was weak ( $r < 0.3$ ), while the strength of correlations with explicit attitudes towards unhealthy food were moderate ( $r > 0.3$ ).

In short, a reduction in explicit attitudes towards unhealthy food was correlated with commitment to all 10 commandments. Except for commitment to the B4 ‘picky with meat’ commandment, explicit attitudes towards healthy food were correlated all commandments.

**Table 4.12** Correlation between commandments and explicit attitudes

	Healthy food		Unhealthy food	
	r	p value	r	p value
B1	0.224	<b>0.022</b>	-0.404	<b>0.000</b>
B2	0.223	<b>0.023</b>	-0.422	<b>0.000</b>
B3	0.250	<b>0.011</b>	-0.399	<b>0.000</b>
B4	0.169	0.086	-0.427	<b>0.000</b>
B5	0.245	<b>0.012</b>	-0.454	<b>0.000</b>
B6	0.209	<b>0.033</b>	-0.368	<b>0.000</b>
B7	0.233	<b>0.017</b>	-0.411	<b>0.000</b>
B8	0.256	<b>0.009</b>	-0.401	<b>0.000</b>
B9	0.252	<b>0.010</b>	-0.429	<b>0.000</b>
B10	0.232	<b>0.018</b>	-0.406	<b>0.000</b>
T	0.240	<b>0.014</b>	-0.431	<b>0.000</b>

#### 4.5.1.12 Correlation between glucose homeostasis parameters and change in body weight measures

We hypothesised that weight loss would be correlated with improvements in the homeostasis parameters. A Pearson's correlation was calculated to identify the relationship of glucose homeostasis parameters to weight loss and BMI. The results are shown in Table 4.13. BMI reduction had positive correlations with fasting insulin, HOMA B and HOMA IR, so decreases in fasting insulin, HOMA B and HOMA IR are correlated with reduced body weight and BMI. In short, there were significant correlations between weight loss and fasting insulin, HOMA B and HOMA IR.

**Table 4.13** Correlations between weight, BMI Change and Glucose homeostasis changes

parameters	Weight change		BMI	
	r	p value	r	p value
F. glucose	0.073	0.510	0.081	0.468
F. insulin	0.308	<b>0.018</b>	0.322	<b>0.013</b>
HG.A1c	-0.006	0.958	-0.018	0.866
HOMA B	0.302	<b>0.021</b>	0.310	<b>0.018</b>
HOMA S	-0.168	0.207	-0.184	0.167
HOMA IR	0.316	<b>0.016</b>	0.329	<b>0.012</b>

#### 4.5.1.13 Correlation between lipids profile parameters and change in body weight measures

We hypothesised that weight loss would be correlated with improvements in lipids profile parameters. A Pearson's correlation was performed to assess the relationship between lipids profiles parameters and weight loss and BMI. Table 4.14 shows the correlation between reduced in weight measures and lipids profile parameters. There was a positive correlation between weight loss and LDL, in which decreased LDL is correlated with weight loss. Notably, the correlation between weight loss and TC showed a trend value. In short, there was a significant correlation between weight loss and LDL.

**Table 4.14** Correlation between weight, BMI changes and Lipid profile changes

parameters	Weight change		BMI	
	r	p value	r	p value
HDL	-0.089	0.413	-0.096	0.377
LDL	0.337	<b>0.001</b>	0.341	<b>0.001</b>
TC	0.179	0.097	0.205	0.056
TG	0.170	0.116	0.181	0.094

#### 4.5.1.14 Correlation between cardiovascular parameter and change in body weight measures

The present study hypothesised that cardiovascular parameters (SBP, DBP and RHR) would be correlated with weight loss. A Pearson's correlation was performed to assess the relationship between cardiovascular parameters and weight loss and BMI. Table 4.15 shows the correlations between cardiovascular parameters and weight loss. There were no significant correlations between the achieved weight loss and SBP, DBP and RHR.

**Table 4.15** Correlation between weight, BMI changes and Cardiovascular parameter changes

parameters	Weight change		BMI	
	r	p value	r	p value
SBP	0.026	0.797	0.041	0.679
DBP	-0.006	0.954	-0.052	0.602
RHR	0.014	0.884	-0.025	0.802

#### 4.5.1.15 Correlation between explicit attitude and change in body weight measures

We hypothesised that improvements in explicit attitudes towards healthy and unhealthy food would be correlated with weight loss. A Pearson's correlation was performed to assess the relationship between weight loss, BMI and explicit attitudes towards healthy and healthy food. Table 4.16 shows the correlations between weight loss and explicit attitudes towards healthy and unhealthy food. Weight change was correlated negatively with the change in explicit attitudes towards healthy food and positively with the change in explicit attitudes towards unhealthy food. That means that weight loss was correlated with increased explicit attitudes towards healthy food and decreased explicit attitudes towards unhealthy food. In short, correlations were found between weight loss and changes in explicit attitudes towards healthy and unhealthy food.

**Table 4.16** Correlations between weight, BMI changes and explicit attitudes

<b>EAQ</b>	<b>Weight change</b>		<b>BMI</b>	
	r	p value	r	p value
Healthy food	-0.278	<b>0.004</b>	-0.266	<b>0.006</b>
Unhealthy food	0.357	<b>0.000</b>	0.338	<b>0.000</b>

#### 4.5.2 The result report after 6 months of the intervention:

##### 4.5.2.1 Commitment of the 10 commandments

Means and SDs of commitment to the commandments for the first 3 months, last 3 months, and over the whole study period of 6 months are shown in Table 4.17. Over 6 months, there were variations in the level of commitment to the diet commandments. However, commandment B6 ‘have a high with the low’ had the highest level of commitment ( $145.67 \pm 35.02$ ), while B1 ‘sugars are evil’ commandments had the lowest level ( $126.96 \pm 35.53$ ). Comparing the levels of commitment to the commandments in first and last 3 months shows an extremely significant reduction in the commitment to the B1 ‘sugars are evil’ commandment ( $4.92 \pm 8.89$ ). Notably, reductions in commitment to the B4 ‘picky with the meat’ and B10 ‘no buzz with fizz’ commandments obtained trend values (0.055 and 0.061), respectively. Generally, when total commitment to the commandments declined, the decrease was significant ( $14.42 \pm 64.21$ ).

**Table 4.17** Means and SDs of commitment to the 10 commandments

Commandment	F3 months	L3 months	F3-L3 change	P value	6 months
B1	69.63±18.61	64.71±18.83	-4.92±8.89	<b>0.012</b>	134.33±36.37
B2	63.50±18.30	63.46±17.85	-0.04±6.69	0.976	126.96±35.53
B3	66.21±17.90	64.92±17.8	-1.29±9.93	0.530	131.13±34.29
B4	70.96±20.07	67.83±20.06	-3.13±7.56	0.055	138.79±39.41
B5	67.71±18.74	65.21±18.61	-2.5±8.98	0.186	132.92±36.26
B6	72.83±18.07	72.83±18.06	0.00±8.88	1	145.67±35.02
B7	65.42±19.63	67.08±18.19	1.67±7.11	0.263	132.50±37.17
B8	67.71±19.39	68.87±17.95	1.17±9.66	0.560	136.58±36.09
B9	66.04±19.91	64.79±18.20	-1.25±9.82	0.539	130.83±36.86
B10	70.29±17.83	66.17±18.89	-4.13±10.27	0.061	136.46±35.27
total	680.29±179.65	665.88±174.7	-14.42±64.21	0.283	1346.17±348.5

F3: first 3 months' L3: last 3 months

#### 4.5.2.2 Body characteristics

The body characteristics and composition of the completion group (n=26, age 36.77±12.1 and height 159.2±6.3) at baseline, after 3 months and after 6 months of the completion group are presented in Table 4.18.

**Table 4.18** Body characteristics and composition at baseline, after 3 months, and after 6 months

N	Characteristics	Baseline	3 months	6 months
26	Weight	100.58±19.6	89.39±18.52	85.49±18.12
26	BMI	39.75±7.09	35.28±6.83	33.76±6.77
20	SMM	28.24±5.53	26.70±5.21	26.94±5.55
21	BFM	50.39±12.89	42.69±12.29	37.39±15.43
26	Waist-c	105.27±13.39	96.08±11.57	93.29±10.72
26	WHtR	0.662±0.0843	0.604±0.0733	0.587±0.0687

Over 6 months, the intervention reduced all body characteristics variables, including body weight by 15.1 kg, BMI by 6, SMM by 1.3 kg, body fat by 13%, waist-c by 0.08 cm and WHtR by 12 cm. One-way repeated measures ANOVA was used to



determine whether there were changes in the body characteristics variables within the study sample over time. The outcomes are presented in Table 4.19. Mauchly's test showed that the assumptions of sphericity were not met ( $p < .05$ ) for all body characteristics variables. The ANOVA results revealed significant differences in all variables at the 3 times of measurement: baseline, after 3 months and after 6 months. In short, the study intervention achieved change in all body characteristics variables over the study period.

**Table 4.19** Results of one-way repeated measure ANOVA for body characteristics

Characteristics	SS	df	MS	F	P	Partial $\eta^2$
Weight	3191.06	1.24	2575	77.02	<b>0.000</b>	0.755
	1035.79	30.97	33.440			
BMI	503.22	1.22	411.2	78.7	<b>0.000</b>	0.759
	159.86	30.6	5.23			
Waist-c	2043.71	1.2	1703.82	66.23	<b>0.000</b>	0.726
	771.46	29.99	25.73			
WHtR	0.081	1.2	0.067	65.98	<b>0.000</b>	0.725
	0.031	29.96	0.001			
Fat %	1793.12	1.25	1434.68	28.9	<b>0.000</b>	0.591
	1240.93	25	24.99	49.64		
SMM	26.87	1.4	19.19	20.12	<b>0.000</b>	0.514
	25.37	26.6	0.954			

In Table 4.20, the Bonferroni comparison shows that all body characteristics were significantly decreased from baseline to 3 months after the intervention, which supports the hypothesis. From the first 3 months to 6 months after the intervention, significant reductions occurred in all body characteristics, except SMM. However, the Bonferroni comparison found significant reductions in all body characteristics variables 6 months after the intervention compared to baseline. In short, over first 3 months, the intervention reduced all body characteristics over the first 3 months and the entire 6 months, while over the last 3 months, its influence continued on all characteristics, except SMM.

**Table 4.20** Pairwise comparisons of mean scores for body characteristics across times of measure

<b>Variable</b>	<b>Time</b>	<b>Mean</b>	<b>Pairwise</b>	<b>M difference</b>	<b>P value</b>
Weight	T1	100.58	T2-T1	-11.19	<b>0.000</b>
	T2	89.39	T3-T1	-15.09	<b>0.000</b>
	T3	85.49	T3-T2	-3.9	<b>0.000</b>
BMI	T1	39.75	T2-T1	-4.47	<b>0.000</b>
	T2	35.28	T3-T1	-5.99	<b>0.000</b>
	T3	33.76	T3-T2	-1.52	<b>0.000</b>
Waist-c	T1	105.27	T2-T1	-9.19	<b>0.000</b>
	T2	96.08	T3-T1	-11.98	<b>0.000</b>
	T3	93.29	T3-T2	-2.79	<b>0.001</b>
WHtR	T1	0.662	T2-T1	-0.058	<b>0.000</b>
	T2	0.604	T3-T1	-0.075	<b>0.000</b>
	T3	0.587	T3-T2	-0.017	<b>0.001</b>
Fat%	T1	50.39	T2-T1	-7.69	<b>0.000</b>
	T2	42.7	T3-T1	-12.99	<b>0.000</b>
	T3	37.39	T3-T2	-5.31	<b>0.022</b>
SMM	T1	28.25	T2-T1	-1.51	<b>0.000</b>
	T2	26.75	T3-T1	-1.32	<b>0.001</b>
	T3	26.94	T3-T2	0.19	0.703

There was a steady decline in body weight and BMI. The mean weight loss and BMI reduction were 11.2 kg and 4.5 kg/m<sup>2</sup> after 3 months and 15.1 kg and 6 kg/m<sup>2</sup>, respectively, after 6 months.

#### **4.5.2.3 Commitment and change in body weight measures**

Table 4.21 shows the correlations between commitment to the commandments and the change in BMI and weight loss values over 6 months. BMI changed had a significant correlation with commitment to all commandments, except for B4 ‘picky with the meat’ and B6 ‘short of salt’. These correlations were negative, which means that increased commitment to the commandments resulted in reduced body weight measures over 6 months.

In short, negative, significant correlations were found between weight loss and commitment to all commandments, except for B4 ‘picky with the meat’ and B6 ‘short of salt’.

**Table 4.21** Correlations between commitments and change in BMI and weight loss values

Commandments	Weight change		BMI	
	R	P value	R	P value
B1	-0.620	<b>0.001</b>	-0.625	<b>0.001</b>
B2	-0.575	<b>0.003</b>	-0.577	<b>0.003</b>
B3	-0.549	<b>0.005</b>	-0.546	<b>0.006</b>
B4	-0.368	0.077	-0.385	0.063
B5	-0.534	<b>0.007</b>	-0.547	<b>0.006</b>
B6	-0.401	0.052	-0.408	<b>0.048</b>
B7	-0.478	<b>0.018</b>	-0.506	<b>0.012</b>
B8	-0.594	<b>0.002</b>	-0.610	<b>0.002</b>
B9	-0.542	<b>0.006</b>	-0.564	<b>0.004</b>
B10	-0.593	<b>0.002</b>	-0.597	<b>0.002</b>
T	-0.545	<b>0.006</b>	-0.557	<b>0.005</b>

#### 4.5.2.4 Glucose homoeostasis

The mean and SD of glucose homoeostasis at baseline, after 3 months and after 6 months are presented in Table 4.22.

**Table 4.22** Means of Glucose homoeostasis at baseline, after 3 months and after 6 months

	Baseline	3 months	6 month
Fasting glucose	5.57±0.452	5.25±0.398	5.13±0.40
Fasting insulin	119.69±53.85	96.31±30.74	90.98±29.97
HG.A1c	5.68±0.4	5.45±0.35	5.08±1.02
HOMA B	133.92±43.6	129.25±32.41	129.21±27.39
HOMA S	50.73±17.11	59.71±15.93	63.94±17.44
HOMA IR	2.24±0.96	1.79±0.55	1.69±0.56

Over 6 months, all variables improved. FG was reduced by 0.44, FI by 28, GH.A1c by 0.6, HOMA B by 4.1 and HOMA IR by 0.54., HOMA S increased by 12.9. One-way repeated measures ANOVA was used to determine whether there were changes in body characterises variables within the study sample over time. The outcomes are presented in Table 4.23. Mauchly’s test showed that the assumptions of sphericity was not met ( $p < .05$ ) for all glucose homoeostasis variables. The ANOVA results revealed significant differences in all variables between the 3 times of measurement. In short, the study intervention achieved significant improvements in all glucose homoeostasis variables, except HOMA B, over the study period.

**Table 4.23** Results of one-way repeated measure ANOVA for Glucose homoeostasis

Characteristics	SS	df	MS	F	P	Partial $\eta^2$
Fasting glucose	1.93	1.2	1.61	30.69	<b>0.000</b>	0.63
	1.13	21.66	0.052			
Fasting insulin	8106.17	1.13	7168.27	5.38	<b>0.028</b>	0.240
	25615.7	19.22	1332.47			
HG.A1c	3.48	1.08	3.21	6.34	<b>0.019</b>	0.260
	9.88	19.51	0.506			
HOMA B	233.57	1.24	188.81	0.319	0.625	0.018
	12435.1	21.03	591.31			
HOMA S	1583.69	1.39	1132.35	4.17	<b>0.04</b>	0.197
	6460.74	23.78	271.73			
HOMA IR	3.01	1.15	2.63	6.06	<b>0.02</b>	0.263
	8.43	19.46	0.433			

In Table 4.24, the Bonferroni comparison showed that FG and HG.A1c significantly decreased from baseline to 3 months after the intervention, which supports the hypothesis. The comparison of 3 months to 6 months detected a significant reduction only in FG. However, the Bonferroni comparison found that significant reductions in FG and HG.A1c over the entire 6 months, compared to baseline. In short, the intervention obtained reductions in FG and HG.A1c after both three and 6 months.

**Table 4.24** Pairwise comparisons of mean scores for body characteristics across times of measure

Variable	Time	Mean	Pairwise	M difference	P value
Fasting glucose	T1	5.57	T2-T1	-0.316	<b>0.000</b>
	T2	5.25	T3-T1	-0.437	<b>0.000</b>
	T3	5.13	T3-T2	-0.121	<b>0.022</b>
Fasting insulin	T1	119.69	T2-T1	-23.38	<b>0.026</b>
	T2	96.31	T3-T1	-27.98	<b>0.032</b>
	T3	91.71	T3-T2	-4.6	0.279
HG.A1c	T1	5.69	T2-T1	-0.236	<b>0.001</b>
	T2	5.45	T3-T1	-0.601	<b>0.035</b>
	T3	5.08	T3-T2	-0.365	0.232
HOMA B	T1	133.92	T2-T1	-4.67	1
	T2	129.25	T3-T1	-4.09	1
	T3	129.83	T3-T2	0.58	1
HOMA S	T1	50.73	T2-T1	8.98	0.088
	T2	59.71	T3-T1	12.94	0.128
	T3	63.67	T3-T2	3.96	0.92
HOMA IR	T1	2.24	T2-T1	-0.45	0.054
	T2	1.79	T3-T1	-0.54	0.071
	T3	1.71	T3-T2	-0.09	0.802

#### 4.5.2.5 Lipids profile

The means and SDs of lipids profile at baseline, after 3 months and after 6 months are presented in Table 4.25.

**Table 4.25** Means of Lipids profile at baseline, after 3 months and after 6 months

parameters	Baseline	3 months	6 months
HDL	1.23±0.29	1.23±0.29	1.34±0.24
LDL	3.06±0.84	2.74±0.87	2.5±0.59
TC	4.77±0.99	4.46±0.93	4.16±0.66
TG	1.29±0.51	1.06±0.36	0.95±0.26

Over 6 months, there were significant improvements in all variables, except for HDL. LDL was reduced by 0.6, TC by 0.62 and TG by 0.34.

One-way repeated measures ANOVA was used to determine whether there were changes in lipids profile within the study sample over time. The outcomes are presented in Table 4.26. Mauchly's test showed that the assumptions of sphericity were met (p

>.05) for HDL and TC but violated for the remaining variables (LDL and TG). The ANOVA results revealed that there were significant differences in all variables between the 3 times of measurement. In short, the study intervention achieved significant improvement in all lipids profile variables over the study period.

**Table 4.26** Results of one-way repeated measure ANOVA for Lipids profile

<b>PARAMETERS</b>	<b>SS</b>	<b>df</b>	<b>MS</b>	<b>F</b>	<b>P</b>	<b>Partial <math>\eta^2</math></b>
HDL	0.103	2	0.052	3.94	<b>0.028</b>	0.179
	0.473	36	0.013			
LDL	2.99	2	1.49	11.245	<b>0.000</b>	0.384
	4.79	36	0.133			
TC	3.59	2	1.8	7.72	<b>0.002</b>	0.3
	8.39	36	0.233			
TG	1.14	1.21	0.946	11.79	<b>0.001</b>	0.396
	1.75	21.76	0.08			

In Table 4.27, the Bonferroni comparison shows that LDL and TG significantly decreased from baseline to 3 months after the intervention, which supports the hypothesis, but only TG posted a significant reduction from after 3 months to 6 months. However, the Bonferroni comparison found significant reductions in LDL, TC, and TG and a significant increase in HDL after 6 months compared to baseline. In short, over 6 months, the intervention produced significant improvements in lipids profile variables.

**Table 4.27** Pairwise comparisons of mean scores for Lipids profile across times of measure

Variable	Time	Mean	Pairwise	M difference	P value
HDL	T1	1.23	T2-T1	0.062	0.295
	T2	1.3	T3-T1	0.104	0.082
	T3	1.34	T3-T2	0.042	0.624
LDL	T1	3.06	T2-T1	-0.324	<b>0.004</b>
	T2	2.74	T3-T1	-0.59	<b>0.001</b>
	T3	2.5	T3-T2	-0.24	0.283
TC	T1	4.77	T2-T1	-0.31	0.203
	T2	4.46	T3-T1	-0.615	<b>0.007</b>
	T3	4.16	T3-T2	-0.305	0.103
TG	T1	1.29	T2-T1	-0.235	<b>0.012</b>
	T2	1.06	T3-T1	-0.338	<b>0.006</b>
	T3	0.953	T3-T2	-0.103	<b>0.049</b>

#### 4.5.2.6 Blood pressure and resting heart rate

The means and SDs of glucose homeostasis at baseline, after 3 months and after 6 months are presented in Table 4.28.

**Table 4.28** Means of BP and RHR at baseline, after 3 months and after 6 months

parameters	Baseline	3 months	6 months
SBP	123.88±13.38	123.08±10.56	123.88±6.85
DBP	79.54±8.06	79±7.34	78.73±3.35
RHR	83.23±14.15	83.88±13.27	81.77±10.41

Over 6 months, there were improvements in all variables. However, the improvements in cardiovascular parameters were not significant.

One-way repeated measures ANOVA was used to determine whether there were changes in BP and RHR within the study sample over time. The results are presented in Table 4.29. Mauchly's test showed that the assumptions of sphericity were met ( $p > .05$ ) for DBP and RHR but violated for SBP. The ANOVA results revealed no

significant differences in BP and RHR between the 3 times of measurement. In short, the study intervention failed to achieve significant improvement in BP and RHR over the study period.

**Table 4.29** Results of one-way repeated measure ANOVA for BP and RHR

parameters	SS	df	MS	F	P	Partial $\eta^2$
SBP	11.31	1.37	8.24	0.214	0.723	0.008
	1320.69	34.29	38.52			
DBP	8.79	2	4.39	0.195	0.823	0.008
	1127.21	50	22.54			
RHR	61	2	30.5	1.19	0.313	0.045
	1281.67	50	25.63			

In Table 4.30, the Bonferroni comparison showed no significant differences in BP and RHR across time.

**Table 4.30** Pairwise comparisons of mean scores for BP and RHR across times of measure

Variable	Time	Mean	Pairwise	M difference	P value
SBP	T1	123.89	T2-T1	-0.81	1
	T2	123.08	T3-T1	0	1
	T3	123.89	T3-T2	0.81	1
DBP	T1	79.54	T2-T1	-0.54	1
	T2	79	T3-T1	-0.81	1
	T3	78.73	T3-T2	-0.269	1
RHR	T1	83.23	T2-T1	0.65	1
	T2	83.89	T3-T1	-0.65	0.9
	T3	81.77	T3-T2	-2.12	0.5

#### 4.5.2.7 Explicit attitudes

The means and SDs of explicit attitudes towards health and unhealthy food at baseline, after 3 months and after 6 months are presented in Table 4.31.



**Table 4.31** Means of explicit attitudes towards healthy and unhealthy food at baseline, after 3 months and after 6 months

<b>EAQ</b>	<b>Baseline</b>	<b>3 months</b>	<b>6 months</b>
Healthy food	39.85±4.57	46.62±4.67	50.85±3.54
Unhealthy food	36.12±3.43	28.81±4.72	26.23±7.20

Over 6 months, there were significant improvements in explicit attitudes towards healthy and unhealthy foods. We observed increased explicit attitudes towards healthy food (11) and decreased explicit attitudes towards unhealthy food (~10).

One-way repeated measures ANOVA was used to determine whether there were changes in explicit attitudes towards healthy and unhealthy foods within the study sample over time. The results are presented in Table 4.32. Mauchly's test showed that the assumptions of sphericity were met ( $p > .05$ ) for explicit attitudes towards unhealthy food but violated for explicit attitudes towards healthy food. The ANOVA results revealed no significant differences in BP and RHR between the 3 times of measurement. In short, the study intervention achieved significant improvement in explicit attitudes towards healthy and unhealthy foods over the study period.

**Table 4.32** Results of one-way repeated measure ANOVA for explicit attitudes towards healthy and unhealthy food

<b>EAQ</b>	<b>SS</b>	<b>df</b>	<b>MS</b>	<b>F</b>	<b>P value</b>	<b>Partial <math>\eta^2</math></b>
Healthy food	1600.92	2	800.46	90.33	<b>0.000</b>	0.783
	443.08	50	8.86			
Unhealthy food	1367.15	1.26	1088.66	45.16	<b>0.000</b>	0.644
	756.85	31.39	24.11			

In Table 4.33, the Bonferroni comparison showed explicit attitudes towards healthy and unhealthy foods significantly improved from baseline to 3 months after the intervention, which supports the hypothesis. Only explicit attitudes towards healthy foods posted a significant reduction from 3 months to 6 months after the intervention. However, the Bonferroni comparison found a significant increase in explicit attitudes towards healthy food and a significant decrease in explicit attitudes towards unhealthy foods after 6 months compared to baseline. In short, over 3 months, the intervention

obtained significant improvements in explicit attitudes towards healthy and unhealthy foods.

**Table 4.33** Pairwise comparisons of mean scores for explicit attitudes towards healthy and unhealthy food across times of measure

Variable	Time	Mean	Pairwise	M difference	P value
Healthy food	T1	39.85	T2-T1	6.77	<b>0.000</b>
	T2	46.62	T3-T1	11	<b>0.000</b>
	T3	50.85	T3-T2	4.23	<b>0.000</b>
Unhealthy food	T1	36.12	T2-T1	-7.31	<b>0.000</b>
	T2	28.81	T3-T1	-9.89	<b>0.000</b>
	T3	26.23	T3-T2	-2.58	0.091

#### 4.5.3 The result report 3 months after ending the intervention:

We invited the participants who completed the previous study to take a part in the follow-up study. The invitation was sent via email three months after the last measurement session and contained a study information sheet. The participants who replied to the invitation email and agreed to take part in the follow-up study were asked to sign the informed consent form. Note that during the last measurement session the participants were told that it would be the last session, not to continue using the intervention tools but try to follow the commandments based on their learned skills. The participants were unaware that they would be invited after three months to re-measure the changes in the study variables. The aim of this study was to determine the change in body weight and BMI, as it was the major aim of the novel weight-loss intervention. Self-reported body weight was sent to the major investigator by email.

##### 4.5.3.1 Body weight and BMI

We hypothesized that three months after the end of the intervention the achieved weight loss and changes in the body composition would be sustained. An independent t-test was performed to identify changes in body weight and characteristics three months after the end of the intervention (follow-up period) (see Table 4.34). The body weight and BMI showed significant differences ( $p < 0.05$ ) between the end of the

intervention and three months afterwards. The net weight change for the individuals was  $-2.3 \pm 2.64$  kg, and the change in BMI was  $-0.92 \pm 1.1$  kg/m<sup>2</sup>.

**Table 4.34** Body weight and BMI at the end of the intervention and follow-up period.

	<b>End of intervention</b>	<b>Follow-up</b>	<b>Changes</b>	<b>P value</b>
Weight	92.22±23.17	89.93±23.58	-2.29±2.64	0.016
BMI	35.55±7.91	34.64±8.05	-0.92±1.11	0.021

#### **4.6 Discussion:**

This study aimed to investigate the effectiveness of the proposed weight loss intervention which consists of 10 commandments based on the best knowledge of nutrition and behaviours from previous studies and on behaviour change theories. It uses a reflection process with overweight and obese female participants. The intervention effectiveness was investigated in the dimensions of body weight and composition, glucose homeostasis, lipids profile, BP and RHR.

##### **4.6.1 Effectiveness of the Study Intervention on Body Weight Characteristics**

This study aimed to assess the effectiveness of our intervention on body weight measures at three time points; 3-months, 6 months of the intervention, and three months after the end of the intervention. The mean weight loss achieved after 3 months of the intervention (4th visit) was 7.34 kg, approximately 7% of the initial body weight. Commitments to all 10 commandments were significantly and strongly correlated with achieved weight loss. Various studies have shown that loss of 5%–10% of initial body weight is associated with significant improvement of obesity-related comorbidities (Blackburn, 1995; Goldstein, 1992). The achieved weight loss was higher than that achieved by sibutramine over 12 weeks. For example, using 15mg/day of sibutramine for 12 weeks resulted in weight losses of 2.3kg (Finer et al., 2000), 3.5 kg (Hanotin et al., 1998), 3.9 kg (Kim et al., 2001) and 3.3 kg (Walsh et al., 1999). A systemic review by Arterburn et al. (2004) found that the mean weight loss from 3 months of using sibutramine was 2.78 kg.

In addition, the weight loss achieved in our study (7.34 kg) seems superior compared to that obtained in 4 diet intervention over 12 weeks: High-CHO/high-GI diet: 3.1 kg; High-CHO/low-GI diet: 4.8 kg; High-protein/high-GI diet 5.4 kg; High-

protein/low-GI diet 3.5 kg (McMillan-Price et al., 2006). Moreover, the study intervention resulted in significant reduction of body characteristics: BMI -2.95, waist-c 7.77, WHtR 0.048 and body fat percentage -5.1%. Compared with the 4 diet interventions in the study by McMillan-Price et al. (2006), our study achieved higher outcomes for waist-c and FM than achieved all 4 diets. In addition, a weight loss study employed a low-carbohydrate diet showed that participants lost (6.8%) of initial body weight after 3 months (Foster et al., 2003), a lower outcome than the present study. Also, the mean weight loss after 10 weeks of a diet-and-exercise programme and a diet-only programme was (9.3) kg and (5.6) kg, respectively (Wing et al., 1988). A meta-analysis of studies conducted from 1969 to 1994 showed that a 15-wk diet or diet-plus-exercise programme resulted in approximately 11 kg of weight loss (Miller et al., 1997). Additionally, our study intervention produced higher outcomes than some cognitive behavioural intervention have been used in some obesity studies. For example, a study conducted by Rapoport et al. (2000) evaluated modified cognitive behavioural weight management programme for obese women participants, which involved weekly, 2-h sessions over a 10-week period. The programme reduced body weight by (3.8) kg, BMI by (-1.1), waist-c by (-3.2) cm and hip-c by (2.7) cm.

Over 6 months, we found that the intervention was very effective as it resulted in significant reductions in weight (15.1 kg), BMI (6 kg/m), waist-c (12 cm), WHtR (0.08 cm), body fat (13%) and SMM (1.3). The achieved weight loss was correlated with commitment to eight commandments: B1 'sugars are evil', B2 'veg and fruit you need', B3 'rich with fibres', B5 'have a high with the low', B7 'enjoy your food', B8 'regular is better', B9 'long ways to eat' and B10 'no buzz with fizz'.

Our findings were higher than those of others on weight loss. For example, Shai et al. (2008) compared three diet interventions and found achieved weight losses of 6.5 kg (low-carbohydrate diet) and 4.5 kg (low-fat diet, Mediterranean diet). Additionally, the mean weight loss in 4 commercial diets was 6 kg (Atkin's), 6.6 kg (Weight Watchers), 4.8 kg (Slim Fat) and 6.3 kg (Rosemary diet) (Truby et al., 2006). As well, studies on the effectiveness of 6-month diet interventions at reducing weight have produced varied outcomes: 4.6 kg (Bacon et al., 2002), 2.7kg (Manning et al., 1998) and 4.3 kg (Trials of Hypertension, 1997). McManus et al. (2001) compared 2 diet programmes (moderate-fat diet, low-fat diet) and found that, after 6 months, both programmes reduced weight (4.9 kg, 5.1 kg, respectively), BMI (2, 1.9), body fat (3%, 2%), waist-c (6 cm, 5.1 cm) and WHR (0.02, 0.01), lower than our findings.

In addition, studies investigating the effectiveness of diet-plus-exercise at reducing weight over 6 months and found different results: 7 kg (DPP, 2002), 8 kg (Harvey-Berino et al., 2002) and 7.6 kg (Harvey-Berino et al., 2004). A meta-analysis suggested that exercise interventions achieve minimal weight loss (~2.4kg) compared to diet interventions (~4.9kg) and exercise-plus-diet interventions (~7.9kg) over 6 months in overweight and obese individuals (Franz et al., 2007).

Our results for achieved weight loss were higher than those achieved by 6-month studies on behavioural intervention-only programmes: 7 kg (Knowler et al., 2002), 7.8 kg (Lantz et al., 2003), 5.7 (Riebe et al., 2005) and 4.9 kg (Simkin-Silverman, 2003). Other studies achieved equal or higher weight loss than this study, but they combined behavioural therapy with a very-low-carbohydrate diet; for example, Lantz et al. (2003) achieved weight loss of 15.7 kg, and Kajaste et al. (2004) of 19.1 kg. This outcome reveals that the study intervention is effective and resulted in modest weight loss. It well known that achieving weight loss of 5%–10% of initial body weight is associated with significant improvements of obesity-related comorbidities (Blackburn, 1995; Dattilo & Kris-Etherton, 1992; Wing et al., 1987; Wing et al., 1998).

The follow-up phase of the study illustrated a significant reduction in the body weight and BMI, where the mean of the weight loss was -2.3 kg and the reduction in the BMI was -0.9 kg/m<sup>2</sup>. These outcomes proved that the long-lasting effects of the study-developed weight loss intervention as obtained weight loss was maintained successfully more than three months after the end of the intervention. Thus, the study's weight loss intervention program played a major role in maintaining the craving trait reduction that was obtained during the intervention period.

In conclusion, our intervention showed strong influence on body weight. In the first phase of the study (3-months) the intervention seem to be effective to achieved successful weight loss (7.3 kg), and the weight loss was associated with commitment to all commandments. However, commitment to eight commandments (B1, B2, B3, B5, B7, B9, B10) were associated with achieved weight loss (15.1 kg) after 6-months of the intervention. Over follow-up period, our intervention successful not just to maintained the achieved weight loss in the second phase of the study, it achieved successful weight loss (2.3 kg). These results show the strong effect of the study intervention on body weight, and the continuation of the effect of the intervention even after the end of the intervention in Saudi overweight and obese women is encouraging in term of a potential longer lasting effect.

## 4.6.2 Effectiveness of the Study Intervention on Health Risk Parameters

### 4.6.2.a Glucose homeostasis.

Our study aimed to assess the influence of the study intervention on glucose parameters. Moreover, to find the association between improvement in these parameter and commitment to the commandments after 3-, and 6-months of the intervention. Over 3-months of the intervention, we observed significant improvement in most glucose homeostasis variables. Fasting insulin and glucose, HGA1c and HOMA IR decreased, while HOMA S increased. However, HOMA B did not change significantly. Our study produced higher reductions in fasting insulin (18.5) and glucose (~0.4) compared to 4 diet interventions: High-CHO/high-GI diet 0.04, 8.1; High-CHO/low-GI diet 0.06, 13.3; High-protein/high-GI diet 0.05, 7.1; High-protein/low-GI diet 0.02, 10.4) (McMillan-Price et al., 2006). Our finding of HOMA IR (~0.4) was higher than that for all 4 diets (McMillan-Price et al., 2006). Furthermore, our study also achieved a higher increase in HOMA S (~8.7) than the high-CHO/high-GI intervention (1.7).

A study based on a modified cognitive-behavioural treatment intervention (10-week) for obese female participants failed to reduce blood glucose (Rapoport et al., 2000). Our achieved reduction in fasting glucose (0.39 mmol/L) was also higher than three 12-week diets in a study carried out by Noakes et al. (2006): very-low-carbohydrate diet: (0.1) mmol/L; very-low-fat diet: (0.1) mmol/L; and high-unsaturated-fat diet: (-0.2) mmol/L. In addition, our reduction of fasting insulin (18) pmol/L was higher than that achieved by a very-low-fat diet (9) pmol/L and high-unsaturated-fat diet (11.8) pmol/L but lower than obtained by a very-low-carbohydrate diet (-25) pmol/L (Noakes et al., 2006).

Our study showed that commitment to two commandments (B1 'sugars are evil' and B2 'veg and fruit you need') was correlated significantly with three glucose homeostasis parameters: fasting glucose, fasting insulin and HOMA IR. In addition, fasting glucose was correlated with commitment to other five commandments: B5 'have a high with low', B7 'enjoy your food', B8 'regular is better' and B10 'no buzz with fizz'. HOMA IR was correlated with commitment to the B10 'no buzz with fizz', B1 'sugars are evil' and B2 'veg and fruit you need' commandments. The results of this phase of the study indicate positive correlations between reduction in BMI and weight loss and change in three glucose homeostasis variables (fasting insulin, HOMA B, HOMA IR).

However, the study found that the intervention obtained significant reductions in two glucose homeostasis parameters (fasting glucose and Hg.A1c) after 6 months. In fact, the study resulted in significantly reduced fasting glucose in the first and last 3 months such that the intervention had continuous influence on fasting glucose beyond the first 3 months. On the other hand, Hg.A1c decreased significantly in the first 3 months, but its decline in the last 3 months was not significant. It seems possible that the intervention works to maintain the achieved improvement in Hg.A1c during the last 3 months as the Hg.A1c value was significantly different at baseline and after 6 months. The achieved improvement in glucose homeostasis parameters did not correlate with achieved weight loss. However, the Hg.A1c reduction correlated negatively with commitment to the B10 'no buzz with fizz' commandment. These findings support previous research on the relationship of Hg.A1c with soft drinks and sweetened beverages.

#### **4.6.2.b Lipids profile.**

Obesity is related to hypertension, decreased HDL and increased TG, TC and LDL, which are all well-documented as CVD risk factors (Brolin, 2002; Poirier et al., 2006; Asztalos et al., 2010). After 3 months of our intervention, a significant increase in HDL level and significant decreases in TC, LDL and TG levels were observed. The study showed that LDL and TG were correlated with commitment to all the commandments. TC was also correlated with all commandments, except for B1 'sugars are evil' and B10 'no buzz with fizz'. Conversely, these two commandments were correlated with HDL.

Several epidemiological studies have demonstrated that increased BMI that a correlation with increased levels of TC, LDL and TG and an inverse correlation with HDL (Denke et al., 1994; Despres et al., 1989; Krauss et al., 1998). It was estimated that, for every 1 kg reduction in body weight, TC, LDL-C and TG decreased by (0.05, 0.02, and 0.015 mmol/L), respectively, and for every 1 kg decrease in body weight, HDL-C increased (0.007) mmol/L (Dattilo & Kris-Etherton, 1992). Our study showed a positive correlation between reduced BMI and decreased LDL levels. There were trend values in the correlation of BMI and the levels of TC and TG. Reduced LDL is a favourable result influenced by weight loss (National Institutes of Health, 1998; Panel, 1998; Van Gaal et al., 2005). The relationship between LDL and BMI has been proposed to be a contributing factor in increased rates of cardiovascular and obesity-

related disease (Shamai et al., 2011). A systemic review conducted by Poobalan et al. (2004) concluded that that weight loss has long-term beneficial effects on lipids, especially LDL and total cholesterol levels. HDL response to weight loss, though, varies greatly and has a poor relationship with weight loss compared to the other lipid levels.

A study conducted by McMillan-Price et al. (2006) on 4 diet interventions over 12 weeks: High-CHO/high-GI (diet 1), high-CHO/low-GI (diet 2), high-protein/high-GI (diet 3) and high-protein/low-GI (diet 4). Our achieved outcomes for TC and LDL were higher than those of all 4 diets, while the achieved TG reduction was greater than that of diets 1 and 2. The obtained increase of HDL (0.06) in our study was higher than that in diets 2 and 3. In addition, our achieved HDL was higher than 2 diets out of 3 diets studied by Noakes et al. (2006): very-low-carbohydrate diet (0.06), very-low-fat diet (-0.06) and high-unsaturated diet (-0.06). Regarding LDL, we obtained reduction in LDL (-0.22) than the very-low-carbohydrate (0.18) and lower than obtained by very-low-fat diet (-0.4), and by high-unsaturated diet (-0.34). Our study also reduced TC (-0.23) by more than the very-low-carbohydrate diet (0.09). Finally, the decline in TG obtained by our intervention (-0.16) was higher than achieved by the very-low-fat diet (0.06) and high unsaturated diet (0.15). The achieved lipid profile outcomes in our study were much higher than those achieved by Rapoport et al. (2000) in a study evaluating CBT weight-management programme with obese women participants. The programme, which involved weekly, 2-h sessions for 10 weeks, TC, HDL and LDL by (0.4), (0.1) and (0.2), respectively, and failed to change TG.

Our study, after 6 months, found significant reductions in 3 lipids profile parameters: LDL (0.6, ~18.3%), TC (0.62~12.8%) and TG (0.34, ~26.4%). The significant improvement in the lipids profile was higher than that obtained by other studies. For example, Simkin-Silverman et al. (1995) showed that 6-month diet interventions reduced body weight by 7kg, LDL by 9%, TC by 8% and TG by 11%. A study by Sarter et al. (2008) found that a high-nutrient-density diet reduced LDL by 12%, TC by 6% and TG by 16%. Obviously, our findings were superior. Studies comparing low-carbohydrate and low-fat diets achieved weight loss and improved lipids profile (Foster et al., 2003; Dansinger et al., 2005; Samaha et al., 2008) but by less than obtain the current study. In addition, Hellen et al (1993) found that diet-only interventions reduced BMI, LDL, TC and TG by 2%, 3%, 1% and 2%, respectively,



and diet-plus-exercise 4%, 4%, 5% and 12%. O'Connor et al (1995) found that drug interventions reduced weight over 6 months by 6 kg and increased TC by 5%.

#### **4.6.2.c Cardiovascular parameters (BP, RHR).**

This study aimed to find the effectiveness of the intervention on the cardiovascular parameters after 3 and 6 months of the intervention. Many studies have linked increases in RHR and BP to increased incidences of cardiovascular mortality (Fox et al., 2007; Ezzati et al., 2008; Kannel, 2002; Wang et al., 2005; Woodward et al., 2012). It is well documented that overweight and obese individuals have elevated BP (Rocchini, 2004) and that a higher RHR is related to increased BP (Fernandes et al., 2011). Our study observed reductions in SBP and DBP, but the reduction was significant only for SBP. Our intervention reduced DBP by (1.09) mm Hg, and Sjostrom et al. (1997) estimated that a 1 mm Hg decrease in DBP reduces the risk of myocardial infarction by 2%–3%. Notably, the cause of the insignificant difference in DBP and RHR might be that BP and RHR were within the normal limits at baseline.

Our study showed no correlation between commitment to the commandments and changes in BP and RHR. Several studies have found an inverse relationship between hypertension and intake of dietary fibre among women (Wang et al., 2007). Our study failed to find this relation as the BP levels were in the normal range at the initial (pre-test) evaluation visit. BMI has been found to be an important predictor of BP (Fu et al., 2003; Saito et al., 2003). However, our study did not find a significant correlation of the achieved weight loss and BMI reduction with SBP, DBP and RHR, likely because the values of the cardiovascular parameters (BP, RHR) were within normal limits at the baseline point.

#### **4.6.2.d Health parameters improvement.**

Our study demonstrates significant improvements in health parameters (glucose homeostasis and lipids profile) as a result of weight loss and commitment to the commandments. Unsurprisingly, weight loss improved the health parameters, as is well documented in the literature. Although our study have achieved significant improvement in the metabolic and cardiovascular parameters, not all of these improvement were clinically relevant. However, it is important to consider that achieving an improvement in these parameters, even if they are not leading to a change in clinically defined groups related to ranges of risk markers (like being hypertensive

or diabetic), can play a role in decline the risk of health-related diseases in the long-term. Moreover, Prospective Studies Collaboration (2002) revealed that successfully lowering blood pressure by 1 mmHg systolic blood pressure could reduce about 10 thousands CHD death events per year. Several studies and reviews have stated that for every 10 mmHg systolic blood pressure reduction and 5 mmHg diastolic blood pressure reduction, there are 20-40% reduction in cardiovascular mortality, 8-22% reduction in CHD, 34-41% reduction in stroke, 21% reduction in IHD, and 11% reduction in CVD (Hender et al., 1996; Law et al., 2003; Somes et al., 1999). Also, for cholesterol, many studies stated that for every 1 mmol/l reduction in LDL, there is 20-36% reduction in cardiovascular diseases (de Lemos et al., 2010; SIGN, 2001; Yusuf et al., 2009). Moreover, increase in HDL by 1 mmol/l is associated with decreased risk of CHD by 2-3% (Gordon et al., 1989). Stratton et al., 2000 suggested that for each reduction by 1% in HGA1c, there are 21% reduction in diabetes-related death, 14% reduction in myocardial infarction, and 43% reduction in death events from cardiovascular diseases. Therefore, even if the achieved alterations in the intervention do not lead to an alteration of clinical treatment for an individual, the success of the intervention is clearly visible in terms of reduced future risks for chronic diseases for the whole group.

The most striking result to emerge from the data is that increased commitment to B1 'sugars are evil', B2 'veg and fruit you need', B3 'rich with fibres', B9 'long ways to eat' commandments played a major role in the improvement of the glucose homoeostasis parameters, while a commitment to B1 'sugars e evil', B2 'veg and fruit you need', B4 picky with the meat', B5 'have a high with the low', B9 'long ways to eat', and B10 'no buzz with fizz' commandments improved the lipids profile parameters, regardless of weight loss.

#### **4.6.3 Explicit Attitudes towards food.**

The underlying proposition of attitudes is the belief that attitudes affect, direct and shape the current behaviour (Kraus, 1995). In terms of food attitudes, the theoretical and empirical studies are based on attitudes towards food that affect food choices (Hearty et al., 2007). People with positive attitudes towards healthy eating behaviours were more susceptible to complying with nutrition guidelines than people with negative attitudes towards healthy eating. Studies on food choice have shown that obese individuals tend to consume food high in sugar, fat and protein more than their non-obese peers (McGloin et al., 2002; Nicklas et al., 2003). A likely explanation of this

behavioural pattern might be obese attitudes toward food (Brug et al., 1998). Individuals with obesity could have high attitudes towards unhealthy food. For example, many researches have connected high-fat food with excessive weight gain (De Graaf, 2005; Davis et al., 2007; Drewnowski et al., 1996). Thus, our study aimed to assess the effectiveness of the study intervention on explicit attitudes towards foods after three and six months of the intervention.

After 3 months of our intervention, significant increases in explicit attitudes towards healthy food and significant reductions in the explicit attitudes towards unhealthy food were observed. There was no significant change in implicit attitudes towards healthy and unhealthy food. Several studies have shown that obese participants have strong, negative explicit and implicit attitudes towards high-fat food (Roefs et al., 2005; Roefs & Jansen, 2002). This study showed a reduction in explicit attitudes towards unhealthy food was correlated with commitment to all 10 commandments. Explicit attitudes towards healthy food were also correlated with all the commandments, except for the B4 'picky with the meat' commandment. The study showed that weight loss was correlated negatively with explicit attitudes towards healthy food and positively with explicit attitudes towards unhealthy food. In other words, decreased body weight was correlated with increased explicit attitudes towards healthy food and decreased explicit attitudes towards unhealthy food.

However, after 6 months of the intervention, we found a significant increase in explicit attitudes towards healthy food and a significant decrease in explicit attitudes towards unhealthy food. These improvements in explicit attitudes were correlated with achieved weight loss. However, the decline in the explicit attitude towards unhealthy food was not correlated with commitment to the 10 commandments, while increased explicit attitudes towards healthy food were correlated with commitment to all commandments, except for B4 'picky with the meat' and B7 'enjoy your food'.

#### **4.7 Conclusion**

Obesity and obesity-related diseases have increased rapidly, affecting individuals' health in many countries. Thus, a simple, effective weight loss intervention is urgently needed. In this study we have used the novel weight-loss intervention (chapter 1 and 2) which uses a reflection process based on 10 behavioural commandments. The present study hypothesised that our intervention which based on the 10 nutritional and behavioural commandments is an effective strategy to achieve

moderate weight loss, enhance explicit attitudes towards healthy food and make positive changes on glucose homeostasis and cardiovascular risks (TC, LDL, HDL, TG, BP, RHR).

To the best of our knowledge, interventions which used a cognitive approach to progressively train people to control their eating habits with evidence-based diet rules do not exist. As well, the operation of specific changes in nutrition and their synergistic effects in changes to major health risk factors have been not investigated. Our study found that, after 3 months, the proposed intervention achieved significant reductions in weight loss and body composition and improvements in the indices of glucose homeostasis, lipoprotein profiles and SBP. In addition, we found that study intervention had great impact on explicit attitudes towards healthy and unhealthy food. After 6 months, we found that our intervention achieved significant reductions in weight loss and body composition and improvements in the indices of glucose homeostasis and lipoprotein profile. In addition, we found that the study intervention had a positive effect on explicit attitudes towards healthy and unhealthy food. Moreover, in the follow up period, our intervention showed significant influence on the body weight and BMI

These results are highly encouraging and support the literature which has found that modest weight loss is associated with great improvements in obesity-related cardiovascular and metabolic abnormalities. Furthermore, these results highlight the importance of progressively training people from a cognitive approach to control their eating habits, achieve modest weight loss, reduce the risk of obesity-related diseases and improve their health risk parameters. Therefore, health professionals (doctors, nurses, dieticians) they must shift from focusing exclusively on the direct utility of weight loss program: how much you lose? to emphasis on the positive beneficial outcomes of the modest weight loss which may can motivate individual to continue healthy change in their diet and eating behaviour. Health professionals must ensure that patient understand the health benefits underlying achieve modest weight loss especially that most patient with overweight/obesity are unaware of the beneficial of modest weight loss achieved through changing diet and eating behaviour to what healthier.

## **Chapter Five**

### **General summary and limitations**

Major efforts to reduce obesity by simply prescribing specific diets or promoting physical activity have been shown not to have long lasting effects, often leading to even stronger weight gain after rapid weight loss (Anderson et al., 2001). Achieving successful weight loss for a short period is not difficult but maintaining the achieved weight loss is much more complicated than a simple energy balance equation but includes sustained behavioural change. Currently, a growing body of research gives more concern to the influence of eating behaviour for achieving sustained weight loss (Elfhag & Rossner, 2005; Keränen et al., 2009; Keränen et al., 2011). However, there is a need for interventions which are effective in reducing weight as well as influencing eating behaviour. Therefore, this thesis was aimed to develop a new weight loss intervention influencing body weight and eating behaviour. To maximise the potential efficacy of interventions, it is necessary to include theoretical concepts of behavioural change (Davis et al., 2014). It has been indicated that interventions which are based on multiple behaviour change theories and techniques are more effective than interventions which lacks theoretical foundations (Painter et al., 2008; Fishben & Yzer, 2003). Theories can have a substantial role in the design of an intervention and can help to explain behavioural change (Redding et al., 2000; Michie & Abraham, 2004; Glanz & Bishop, 2010). Thus this intervention was developed with consideration of several behaviour change theories, models, and techniques; in particular the design of this intervention was using principles based on the Control Theory (Carver & Scheier, 1982) and on the Theory of Planned Behaviour (TPB) for a better understanding of possible ways to change eating behaviours. As a core principle for the intervention design, we have used the Control Theory (Carver & Scheier, 1982) which emphasises the feedback loop process of lower level goals towards higher level goals to built our commandment system towards achieving weight loss. Moreover, self-monitoring is an important structure of Control Theory. Many studies have emphasised the importance of self-monitoring in behavioural interventions for obesity. Burke et al. (2011) reviewed prospective studies and randomised trials that examined the effect of self-monitoring on weight loss, and found a consistent association between weight loss and self-monitoring. Besides the Control Theory, we have considered concepts of the Self Determination Theory (SDT) for the intervention design. Motivation is a valuable drive

behind activities and changes in our behaviour, internal motivation and autonomy are important components for behavioural change. Quinn et al. (1987) stated that healthy eating behaviour is affected by eating motives such as achieving weight loss or preventing health-related diseases and it is well documented that behaviour which is autonomously motivated is likely to be maintained in the long-term (Teixeira et al., 2011; Ryan et al., 2010). Moreover, we applied concepts of the TPB, which is often used as a theoretical framework (Ajzen, 1991). It is considered one of the most influential and widely cited models of intentional behaviour in social psychology (Armitage & Conner, 2001). TPB states that intention is driven by perceived behavioural control, subjective norms and attitude. This model suggests that a more positive attitude towards a certain type of behaviour, together with a supportive subjective norm and higher perceived behavioural control, are more likely to result in a stronger intention to perform the behaviour, which in turn creates an impact on the behaviour itself.

Our intervention used three tools (leaflet, laminated card and compliance report); they are connected to multiple behaviour change techniques, which were recommended by Abraham and Michie (2008). The leaflet focused on increasing knowledge and helping the individual understand what the underlying commandments are, and why these commandments are important for our health generally, and for decreasing and controlling body weight. The design of the laminated card was based on various behavioural techniques which supposed to promote eating behavioural changes. Moreover, the laminated card was used to analyse recent eating behaviour in a reflective manner and to monitor compliance with the commandments after each day or even after a meal. The compliance report considers the summary of the participants' efforts during the day, and it reflects their level of compliance with every commandment from day to day. These three tools operate to complement each other, aiming to guide the obese and overweight to assess the merits of different food choices and curb their unhealthy eating behaviours, with an emphasis on cognition in terms food decisions and shopping. In the longitudinal studies reported in this thesis, the influence of this new weight-loss intervention on physiological and psychological parameters was assessed and the commandments having strong influence on the physiological elements (body weight measures and body characteristics), psychological elements (food cravings, explicit and implicit attitudes), and health risk parameters (glucose homeostasis, lipid profile, blood pressure and resting heart rate) have been investigated. The study interventions

successfully achieved modest weight loss in overweight/obese females in the two different cultural background in UK and SA and had enduring effects over a 3 months follow-up period demonstrating the potential ability to prevent relapse in the post intervention period. In addition to the achieved weight loss, the intervention showed significant reductions in food craving traits and improvements in explicit attitude towards healthy/unhealthy food in both longitudinal studies. Moreover, the current intervention obtained significant improvements in health risk factors (glucose homoeostasis and lipid profile). Moreover, the outcomes of our studies show that some health behaviours have strong impact on health risk parameters like the effects of sugary intake and liquid calorie consumption on both weight loss and maintaining weight loss. The results of this investigation also emphasize that the developed weight loss is associated with improvements of physiological and psychological factors. However, interestingly, some behavioural improvements specific to certain commandments have had positive effects on health risk parameters independent from achieved weight loss.

It is important to note that this current research has a number of limitations. Firstly, all studies, with the exception of the 3-month Saudi study, were performed with smaller sample sizes. The second limitation is that our studies did not have control groups, which may not allow us to verify the effect size of achieved improvements in the study outcomes. Thirdly, the proportion of lost follow up participants in the studies is relatively high, perhaps because of low confidence in achieving further weight loss, or because the achieved weight loss may not have met the patients' "dream" weight loss. The lost participants may have increased or decreased their body weights, or may have maintained the achieved weight loss. However, interruption of communication with the researcher was an obstacle which was based on the cultural background of the SA study and could not be avoided.

Another limitation was the reliance on self-reporting data to assess the compliance level, which may not reflect the accuracy status of the compliance with the commandments as they possibly overestimated by repeated self-reporting. Moreover, food craving and explicit attitudes towards healthy and unhealthy food are measured by self-reported questionnaires, which could be biased by the knowledge of aims and objectives of the research. In addition, body compositions were measured by using the BIA, which is well-documented to be lower in terms of accuracy when compared with dual energy X-ray absorptiometry (DEXA). Further limitation of our studies is that we did not measure physical activity levels, especially as some reviews have reported that

modest weight loss can be achieved by exercise (Wing, 1999). Hence, we cannot attribute the achieved weight loss and the improvement in health-related risks entirely to our intervention. Moreover, the study has not taken into account some demographic data (e.g. employment and marital status). Research has stated that eating behaviour is affected by demographic factors (Brandsma, 2007; Støving et al., 2011).

One limitation was related to the UK study which was not including the blood metabolic parameters due to our failure to raise funds for the measurements. With regard to the SA study, we could not apply the IAT and the food craving questionnaires (FCQ) due to the lack of an Arabic version of these measurements. Many terms not directly translatable from English to Arabic. As an example, 'craving' does not exist as a word in Arabic language.

Our study utilised TPB to explain the change in eating behaviour. However, although TPB has been used widely in behaviour change studies, it has some limitations. TPB does not take into account several factors (e.g. cultural and demographic) which have a role in shaping behaviour (Sharma & Kanekar, 2007). In addition, the theory proposes that perceived behavioural control predicts behavioural control, which may not always occur (Sharma & Kanekar, 2007). Another limitation of the theory is that TPB is concerned only with rational thoughts and omits irrational ones (Sharma & Kanekar, 2007). Moreover, in our study we have measured perceived behavioural control and attitudes only, and we omit measuring subjective norms, which may have had an influence on the outcomes of our study.

In regard to future studies, this research will need to be repeated with a randomised controlled design and a larger sample size to confirm the results achieved in the current study. Moreover, we need to expand our set of parameters by adding a measure of self-confidence.

In summary, this thesis presents a newly developed weight loss intervention that induced moderate weight loss, food craving reduction, improvement in the attitudes towards food, and decrease in health risk blood parameters. The intervention outcomes also suggest improvement in the ability of maintaining the achieved weight loss. The outcomes in this thesis support the achievement of weight loss, and the capability to maintain the achieved weight loss working at the cognitive and behavioural levels, rather than the physical activity level. The change in body weight via cognitive techniques, using behavioural techniques to alter unhealthy eating behaviours, as well



as forming new eating behaviours, seemed to be successfully achieved by our intervention and might have a better chance of sustainability over the long-term.

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## Appendices

Bangor University  
SCHOOL OF SPORT, HEALTH AND EXERCISE SCIENCES

1	Title of project	A weight loss intervention based on diet commandments in overweight/obese females
2	Name and e-mail address(es) of all researcher(s)	Dr. Hans-Peter Kubis pes203@bangor.ac.uk 01248 388261 Mishal Alshubrami elpa16@bangor.ac.uk

Please tick boxes

<ul style="list-style-type: none"> <li>• I confirm that I have read and understand the Information Sheet dated ..... for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>• I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without my medical care or legal rights being affected.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>• I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason. If I do decide to withdraw I understand that it will have no influence on the marks I receive, the outcome of my period of study, or my standing with my supervisor, other staff members of with the School.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>• I understand that I may register any complaint I might have about this experiment with the Head of the School of Sport, Health and Exercise Sciences, and that I will be offered the opportunity of providing feedback on the experiment using the standard report forms.</li> </ul>	<input type="checkbox"/>
<ul style="list-style-type: none"> <li>• I agree to take part in the above study.</li> </ul>	<input type="checkbox"/>

Name of Participant .....

Signature ..... Date .....

Name of Person taking consent.....

Signature ..... Date .....

Bangor University  
SCHOOL OF SPORT, HEALTH AND EXERCISE SCIENCES

1	Title of project	A weight loss intervention based on diet commandments in overweight/obese females (consent for continuation of intervention for further 3 months)
2	Name and e-mail address(es) of all researcher(s)	Dr. Hans-Peter Kubis pes203@bangor.ac.uk 01248 388261 Mishal Alshubrami elpa16@bangor.ac.uk

Please tick boxes

<ul style="list-style-type: none"> <li>I confirm that I have read and understand the Information Sheet dated ..... for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.</li> </ul>	
<ul style="list-style-type: none"> <li>I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without my medical care or legal rights being affected.</li> </ul>	
<ul style="list-style-type: none"> <li>I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason. If I do decide to withdraw I understand that it will have no influence on the marks I receive, the outcome of my period of study, or my standing with my supervisor, other staff members of with the School.</li> </ul>	
<ul style="list-style-type: none"> <li>I understand that I may register any complaint I might have about this experiment with the Head of the School of Sport, Health and Exercise Sciences, and that I will be offered the opportunity of providing feedback on the experiment using the standard report forms.</li> </ul>	
<ul style="list-style-type: none"> <li>I agree to take part in the above study.</li> </ul>	

Name of Participant .....

Signature ..... Date .....

Name of Person taking consent.....

Signature ..... Date .....

Bangor University  
SCHOOL OF SPORT, HEALTH AND EXERCISE SCIENCES

1	Title of project	A weight loss intervention based on diet commandments in overweight/obese females. Follow up study (post intervention period)
2	Name and e-mail address(es) of all researcher(s)	Dr. Hans-Peter Kubis pes203@bangor.ac.uk 01248 388261 Mishal Alshubrami elpa16@bangor.ac.uk

Please tick boxes

<ul style="list-style-type: none"> <li>I confirm that I have read and understand the Information Sheet dated ..... for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.</li> </ul>	
<ul style="list-style-type: none"> <li>I understand that my participation is voluntary and that I am free to withdraw at any time without giving a reason, without my medical care or legal rights being affected.</li> </ul>	
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<ul style="list-style-type: none"> <li>I agree to take part in the above study.</li> </ul>	

Name of Participant .....

Signature ..... Date .....

Name of Person taking consent.....

Signature ..... Date .....



**Study Information Sheet:**

**STUDY TITLE:**

A weight loss intervention based on diet commandments in overweight/obese females.

**RESEARCHER:**

Dr Hans-Peter Kubis

Mishal Alshubrami

E-mail : elpa16@bangor.ac.uk

**INVITATION TO TAKE PART:**

You are being invited to take part in a research study. Before you agree to take part it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. If you wish, discuss it with friends and relatives. If you are concerned you may like to discuss it with your GP. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether you wish to take part or not.

**STUDY BACKGROUND:**

Obesity can be defined as a condition of excessive fat accumulation in fat tissue, to the extent that health may be impaired. Obesity plays a major role in increasing risks for several diseases such as; cardiovascular disease, stroke, diabetes, hypertension, and cancer. While the reasons for obesity are not completely clear, it is evident that it is largely driven by an imbalance of caloric intake and consumption, as well as by the type of food consumed.

The main purpose of our study is to help you losing weight by a cognitive training programme using 10 nutritional/behavioural commandments. These commandments are the extract of many research studies performed all over the world over decades. Keeping these commandments will result in weight loss and will improve your health. You will be asked to follow these commandments for 3 months.

The programme tools to help you keeping commandments are as follows: You will receive a small plastic card containing a simple/short reminder version of the nutritional/behavioural commandments. You should carry this card in your handbag or pocket to support you during shopping and eating – try to memorize the short versions of the commandments and link these to the main information about the commandments you will receive in an additional leaflet. This leaflet gives explanatory information about what the commandments are and why these are important for your weight loss and health.

To keep the commandments will be difficult and you may break one or another over time, which is not dramatic but it is important to reflect on this by filling out an electronic feedback sheet where you record how many times you have broken distinct commandments over a period of 14 days. This report will be send to us to keep record and to monitor your effort. You should use an additional paper form you will receive to do daily records for yourself and for the purpose of summarizing these for the email report every 14days. Don't cheat to yourself and send wrong information your weight

loss will prove whether your records are for real. You can only improve your behaviour by reflecting on your real eating behaviour focussing on the commandments.

In addition to your tasks related to the commandments records we will ask you to come monthly to the department to assess your body weight, body fat and waist/hip circumference. Moreover you will be asked to perform a computer task to analyse your food preferences in the beginning and end of the study, to fill out questionnaires about your food preferences, appetite and your confidence to lose weight as well as general health questionnaires before, in the middle and after the study.

Before we start with the intervention we also want you to write a food diary for several days to analyse what your general eating habit is.

All information we will receive from you will be kept confidential.

### **DO I HAVE TO TAKE PART?**

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are free to withdraw at any time and without giving a reason.

### **WHAT WILL HAPPEN TO ME IF I TAKE PART?**

The programme has the following schedule:

#### **FIRST VISIT:**

You will be asked to come to the department and

- fill out a medical and physical activity questionnaire
- perform a computer task for your food preference
- answer a questionnaire for your food preference
- answer a food craving questionnaire
- answer a questionnaire about your confidence for losing weight
- we will take some body weight measurements:
  - height, weight and body fat
  - waist and hip circumference

**EVERY 14 DAYS YOU WILL BE ASKED TO ANSWER A SHORT QUESTIONNAIRE ABOUT YOUR PERFORMANCE REGARDING KEEPING THE COMMANDMENTS WHICH YOU WILL RECEIVE VIA E-MAIL.**

#### **2<sup>nd</sup> and 3<sup>rd</sup> VISIT**

You will be asked to come to the lab and

- answer the confidence questionnaire, which evaluate your confidence for weight loss
- we will take again following measurements:
  - weight and body fat
  - waist and hip circumference

**YOU WILL BE ASKED TO CONTINUE ANSWERING THE SHORT FOOD QUESTIONNAIRES EVERY 14 DAYS**

**Important issue about the short questionnaire and your performance keeping the commandments:**

**To keep the commandments will be difficult and you may break one or another over time (Christmas, weddings, or birthday party), which is not dramatic but it is important to reflect on this by filling out the electronic feedback sheet where you record how many times you have broken distinct commandments over a period of 14 days; the study supports changes in eating behaviour but doesn't expect you to be perfect!!**

**LAST VISIT (after 3 months):**

You will be asked to come to the lab and

- fill out a medical and physical activity questionnaires
- perform the computer task
- answer food preference questionnaire
- answer craving questionnaire
- answer confidence questionnaire
- we will take measurements:
  - weight and body fat
  - waist and hip circumference

**WHAT DO I HAVE TO DO?**

You need to receive information sheet about the research and sign consent forms. Also, you need to follow the study procedure.

**WHAT ARE THE POSSIBLE DISADVANTAGES AND RISKS OF TAKING PART?**

There are no risks involved

## **WHAT ARE THE POSSIBLE BENEFITS OF TAKING PART?**

By taking part of this study you gain several benefit such as:

- there is high possibility of weight loss, improve your health, and decrease risks of different chronic diseases
- you will improve your knowledge about healthy foods
- you will improve your food shopping skills
- you will understand your body's caloric requirements

## **CONFIDENTIALITY:**

All information which is collected about you during the course of the research will be kept strictly confidential. Any information which leaves the school will have your name and address removed so that nobody can be retraced from it. It will not be possible to identify you in any report or publication of the study

## **WHO HAS REVIEWED THE STUDY?**

The study has been reviewed by the departmental ethics committee.

## **FEEDBACK ON CONDUCT OF RESEARCH:**

SSHES is always keen to hear the views of research participants about their experience. If you would like to feedback, please ask your researcher to provide you with Form 6 – Participant Feedback Form – from the Ethics Guidelines Handbook. Completion of this form is optional. The completed form should be returned to:

Dr Andrew Lemmey, Chair, SSHES Ethics Committee, SSHES, Bangor University, Bangor LL57 2PZ.

All information will be treated in a strictly confidential manner.

## **ANY QUESTIONS?**

Please ask us if you have any questions. You should not sign the form consenting to take part in the study if you still have unanswered questions or any doubts.

RESEARCHER: Mishal Alshubrami  
elpa16@bangor.ac.uk

SUPERVISOR: Dr. Hans-Peter Kubis  
pes203@bangor.ac.uk  
01248 388261

**Study Information Sheet:**

**STUDY TITLE:**

A weight loss intervention based on diet commandments in overweight/obese females; post intervention period.

**RESEARCHER:**

Dr Hans-Peter Kubis

Mishal Alshubrami

E-mail : elpal6@bangor.ac.uk

**INVITATION TO TAKE PART:**

You are being invited to take part in a research study. Before you agree to take part it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully. If you wish, discuss it with friends and relatives. If you are concerned you may like to discuss it with your GP. Ask us if there is anything that is not clear or if you would like more information. Take your time to decide whether you wish to take part or not.

**STUDY BACKGROUND:**

Obesity can be defined as a condition of excessive fat accumulation in fat tissue, to the extent that health may be impaired. Obesity plays a major role in increasing risks for several diseases such as; cardiovascular disease, stroke, diabetes, hypertension, and cancer. While the reasons for obesity are not completely clear, it is evident that it is largely driven by an imbalance of caloric intake and consumption, as well as by the type of food consumed.

**This study is a follow up of the intervention you have taken part recently. The main purpose of our study (follow up study) is to record the changes which may happen in your body weight and composition as well as psychological measures after finishing the intervention.**

We will ask you to come once to the department to re-assess your body weight, body fat and waist/hip circumference. Moreover you will be asked to perform a computer task to analyse your food preferences, to fill out questionnaires about your compliance with the 10 diet commandments, food preferences, appetite as well as general health questionnaires

All information we will receive from you will be kept confidential.

**DO I HAVE TO TAKE PART?**

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are free to withdraw at any time and without giving a reason.

## **WHAT WILL HAPPEN TO ME IF I TAKE PART?**

You will be asked to visit our department once.

### **VISIT:**

You will be asked to come to the department and

- Fill out a medical and physical activity questionnaire.
- Perform a computer task for your food preference.
- Answer a questionnaire for your food preference.
- Answer a food craving questionnaire.
- Answer a compliance with diet commandments questionnaire.
- we will take some body weight measurements:
  - height, weight and body fat
  - waist and hip circumference

## **WHAT DO I HAVE TO DO?**

You need to receive information sheet about the follow up study and sign consent forms. Also, you need to follow the study procedure.

## **WHAT ARE THE POSSIBLE DISADVANTAGES AND RISKS OF TAKING PART?**

There are no risks involved

## **WHAT ARE THE POSSIBLE BENEFITS OF TAKING PART?**

By taking part in this study you will know the changes in the study parameter outcomes in the period after the intervention and getting insight into the effectiveness of our intervention

## **CONFIDENTIALITY:**

All information which is collected about you during the course of the research will be kept strictly confidential. Any information which leaves the school will have your name and address removed so that nobody can be retraced from it. It will not be possible to identify you in any report or publication of the study

## **WHO HAS REVIEWED THE STUDY?**

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All information will be treated in a strictly confidential manner.

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Please ask us if you have any questions. You should not sign the form consenting to take part in the study if you still have unanswered questions or any doubts.

RESEARCHER: Mishal Alshubrami  
elpa16@bangor.ac.uk

SUPERVISOR: Dr. Hans-Peter Kubis  
pes203@bangor.ac.uk  
01248 388261

Bangor University  
SCHOOL OF SPORT, HEALTH AND EXERCISE SCIENCES

Name of Participant: ..... Date: .....

Age .....

Are you in good health? YES NO

If no, please explain

How would you describe your present level of activity?

*Tick intensity level and indicate approximate duration.*

Vigorous		Moderate		Low intensity	
----------	--	----------	--	---------------	--

Duration (minutes).....

How often?

< Once per month		2-3 times per week	
Once per month		4-5 times per week	
Once per week		> 5 times per week	

Have you suffered from a serious illness or accident? YES

NO

If yes, please give particulars:

Do you suffer from allergies? YES

NO

If yes, please give particulars:

Do you suffer, or have you ever suffered from:

	YES	NO		YES	NO
Asthma			Epilepsy		
Diabetes			High blood pressure		
Bronchitis					

Are you currently taking medication? YES NO



If yes, please give particulars:

Are you currently attending your GP for any condition or have you consulted your doctor in the last three months? YES NO

If yes, please give particulars:

Have you, or are you presently taking part in any other laboratory experiment? YES NO

#### PLEASE READ THE FOLLOWING CAREFULLY

Persons will be considered unfit to do the experimental exercise task if they:

- have a fever, cough or cold, or suffer from fainting spells or dizziness;
- have suspended training due to a joint or muscle injury;
- have a known history of medical disorders, i.e. high blood pressure, heart or lung disease;
- have had hyper/hypothermia, heat exhaustion, or any other heat or cold disorder;
- have anaphylactic shock symptoms to needles, probes or other medical-type equipment;
- have chronic or acute symptoms of gastrointestinal bacterial infections (e.g. Dysentery, Salmonella);
- have a history of infectious diseases (e.g. HIV, Hepatitis B); and if appropriate to the study design, have a known history of rectal bleeding, anal fissures, haemorrhoids, or any other condition of the rectum.

#### PLEASE COMPLETE AND SIGN THE DECLARATION BELOW

##### **DECLARATION**

I agree that I have none of the above conditions and I hereby volunteer to be a participant in experiments/investigations during the period of the study (6-months).

My replies to the above questions are correct to the best of my belief and I understand that they will be treated with the strictest confidence. The experimenter has explained to my satisfaction the purpose of the experiment and possible risks involved.

I understand that I may withdraw from the experiment at any time and that I am under no obligation to give reasons for withdrawal or to attend again for experimentation.

Furthermore, if I am a student, I am aware that taking part or not taking part in this experiment, will neither be detrimental to, or further, my position as a student.

I undertake to obey the laboratory/study regulations and the instructions of the experimenter regarding safety, subject only to my right to withdraw declared above.

Signature (*participant*) ..... Date .....

*Print name* .....

Signature (*experimenter*) ..... Date .....

*Print name* .....

## Examples how to deal with commandments report

If you eat (cheese burger meal), which involve burger+ chips+ Pepsi,



You break many commandments at one time

- Sugars are evil
- Veg and fruit you need
- have a high with low
- short of salt
- no buzz with fizz

You must also think about other commandments you could break such as:

- enjoy your food
- long ways to eat

If you eat (homemade lean minced meat burger) + salad+ rye bread+ water with lemon juice



You will be complied with diet commandments

## APPETITE TOWARDS SPECIFIC FOOD CHOICES

NAME: \_\_\_\_\_

DATE: \_\_\_\_\_

### FCQ-T

How frequently each statement “would be true for you in general” using a 6-point scale that ranged from 1 (*never*) to 6 (*always*);

	1	2	3	4	5	6
Being with someone who is eating often makes me hungry						
When I crave something, I know I won't be able to stop eating once I start						
If I eat what I am craving, I often lose control and eat too much						
I hate it when I give in to cravings						
Food cravings invariably make me think of ways to get what I want to eat						
I feel like I have food on my mind all the time						
I often feel guilty for craving certain foods						
I find myself preoccupied with food						
I eat to feel better						
Sometimes, eating makes things seem just perfect						
Thinking about my favourite foods makes my mouth water						
I crave foods when my stomach is empty						
I feel as if my body asks me for certain foods						
I get so hungry that my stomach seems like a bottomless pit						
Eating what I crave makes me feel better						
When I satisfy a craving I feel less depressed						
When I eat what I am craving I feel guilty about myself						
Whenever I have cravings, I find myself making plans to eat						

Eating calms me down						
I crave foods when I feel bored, angry, or sad						
I feel less anxious after I eat						
If I get what I am craving I cannot stop myself from eating it						
When I crave certain foods, I usually try to eat them as soon as I can						
When I eat what I crave I feel great						
I have no will power to resist my food crave						
Once I start eating, I have trouble stopping						
I can't stop thinking about eating no matter how hard I try						
I spend a lot of time thinking about whatever it is I will eat next						
If I give in to a food craving, all control is lost						
When I'm stressed out, I crave food						
I daydream about food						
Whenever I have a food craving, I keep on thinking about eating until I actually eat the food						
If I am craving something, thoughts of eating it consume me						
My emotions often make me want to eat						
Whenever I go to a buffet I end up eating more than what I needed						
It is hard for me to resist the temptation to eat appetizing foods that are in my reach						
When I am with someone who is overeating, I usually overeat too						
When I eat food, I feel comforted						
I crave foods when I'm upset						

FCQ-S

Indicate the extent to which you agreed with each statement “right now, at this very moment” using a 5-point scale that ranged from 1 (*strongly agree*) to 5 (*strongly disagree*).

	1	2	3	4	5
I have an intense desire to eat something tasty					
I’m craving (one or more specific foods)					
I have an urge for (one or more specific foods)					
Eating (one or more specific foods) would make things just perfect					
If I were to eat what I’m craving, I am sure my mood would improve					
Eating (one or more specific foods) would feel wonderful					
If I ate something, I wouldn’t feel so sluggish and lethargic					
Satisfying my craving would make me feel less grouchy and irritable					
I would feel more alert if I could satisfy my craving					
If I had (one or more specific foods), I could not stop eating it					
My desire to eat (one or more specific foods) seems overpowering					
I know I’m going to keep on thinking about (one or more specific foods) until I actually have it					
I am hungry					
If I ate right now, my stomach wouldn’t feel as empty					
I feel weak because of not eating					

## FOOD PREFERENCE QUESTIONNAIRE

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

On the scales below, please circle the number that best describes your feelings about **HEALTHY FOOD (food which rich in fibre and low in fat or sugar)**, such as vegetables, fruit, salad, brown bread, muesli, skimmed milk.

Be sure to circle just ONE number for each pair of words.

Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about healthy food.

For me, eating healthy food is .....

	<b>extremely</b>	<b>quite</b>	<b>slightly</b>	<b>neither</b>	<b>slightly</b>	<b>quite</b>	<b>extremely</b>	
<b>Enjoyable</b> <b>Unenjoyably</b>	1	2	3	4	5	6	7	
<b>Harmful</b>	1	2	3	4	5	6	7	<b>Beneficial</b>
<b>Useful</b>	1	2	3	4	5	6	7	<b>Useless</b>
<b>Boring</b>	1	2	3	4	5	6	7	<b>Interesting</b>
<b>Pleasant</b> <b>Unpleasant</b>	1	2	3	4	5	6	7	
<b>Stressful</b>	1	2	3	4	5	6	7	<b>Relaxing</b>
<b>Wise</b>	1	2	3	4	5	6	7	<b>Foolish</b>
<b>Bad</b>	1	2	3	4	5	6	7	<b>Good</b>

## FOOD PREFERENCE QUESTIONNAIRE

NAME: \_\_\_\_\_ DATE: \_\_\_\_\_

On the scales below, please circle the number that best describes your feelings about **UNHEALTHY FOOD (food which rich in fat or sugar and low in fibre)**, such as ready meals, chips, soft drinks, alcohol, take-away-food, chocolate bar.

Be sure to circle just ONE number for each pair of words.

Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally feel about unhealthy food.

For me, eating unhealthy food is .....

	<b>extremely</b>	<b>quite</b>	<b>slightly</b>	<b>neither</b>	<b>slightly</b>	<b>quite</b>	<b>extremely</b>	
<b>Enjoyable</b> <b>Unenjoyably</b>	1	2	3	4	5	6	7	
<b>Harmful</b>	1	2	3	4	5	6	7	<b>Beneficial</b>
<b>Useful</b>	1	2	3	4	5	6	7	<b>Useless</b>
<b>Boring</b>	1	2	3	4	5	6	7	<b>Interesting</b>
<b>Pleasant</b> <b>Unpleasant</b>	1	2	3	4	5	6	7	
<b>Stressful</b>	1	2	3	4	5	6	7	<b>Relaxing</b>
<b>Wise</b>	1	2	3	4	5	6	7	<b>Foolish</b>
<b>Bad</b>	1	2	3	4	5	6	7	<b>Good</b>



## Compliance sheet

- \* You need to fill in the reflection sheet before you go to bed
- \* Read the leaflet and laminated card carefully before you starting answer the reflection sheet
- \* Focus on the various commandments levels while reflecting about your day
- \* Remember your food intake and choices, read available food label with nutritional information
- \* Visualize which commandments you have broken and which you are followed
- \* Be aware that you may break several commandments with some types of food and drink
- \* Analyse your energy behaviour and shopping using the leaflet and plastic card
- \* Put (×) into the form for every commandment you have broken
- \* You may break one or other commandment overtime; do not be disheartened by this

### **Accurate data is important**

When you ready;

**Could you, please, put a tick (√) if you have complied with the commandment and a cross (×) if you have not complied with the commandment**

	Days														X Sum
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Sugars are evil!															
Veg and fruit you need!															
Rich with fibres!															
Picky with the meat!															
Have a high with the low!															
Short of salt!															
Enjoy your food!															
Regular is better!															
Long ways to eat!															
No buzz with fizz!															

- \* think about the non-complied point (×); why they happened
- \* have an eating plan for tomorrow

## DIET QUESTIONNAIRE

You have recently take part in our weight loss intervention based on 10 diet commandments.

This form asks you about your compliance with the 10 diet commandments over the past 3 months; it takes about 10 min to complete. Please follow instruction.

### INSTRUCTIONS:

- Read the full length commandments in the leaflet and laminated card before you start answering the questionnaire
- Try to average your compliance with each diet guideline over the past 3 months
- Estimate if you are not sure; use the past month as a standard for your compliance level
- Be sure that you answer every question
- There is no right/wrong answers for every question
- Remember, the information we get from the study is only as good as the information you give us. Accuracy is essential

## THINK OVER THE PAST 3 MONTHS

**Over the past 3 months; we are interested in knowing the rate of your compliance with the following diet guidelines:**

### **Sugars are evil!**

Avoid added sugar, soft drinks, sweetened drinks, squash, fruit juices, added sugar products and snacks especially sweets

Never extremely  
0 1 2 3 4 5 6 7 8 9 10

### **Veg and fruit you need!**

Eat at least half a kg variety of vegetables and fruit a day

Never extremely  
0 1 2 3 4 5 6 7 8 9 10

**Rich with fibres!**

Base your meals on fibre-rich food

Never											extremely
0	1	2	3	4	5	6	7	8	9	10	

**Picky with the meat!**

Eat fish and meat no more than twice a week

Never											extremely
0	1	2	3	4	5	6	7	8	9	10	

**Have a high with the low!**

Eat food low in energy density

Never											extremely
0	1	2	3	4	5	6	7	8	9	10	

**Short of salt!**

Choose low-salt products

Never											extremely
0	1	2	3	4	5	6	7	8	9	10	

**Enjoy your food!**

Take your time and focus on your meal whilst eating

Never											extremely
0	1	2	3	4	5	6	7	8	9	10	

**Regular is better!**

Have regular meal times

Never										extremely
0	1	2	3	4	5	6	7	8	9	10

**Long ways to eat!**

Be aware of your caloric needs and how much you eat

Never										extremely
0	1	2	3	4	5	6	7	8	9	10

**No buzz with fizz!**

Limit calorie intake from alcohol and drinks

Never										extremely
0	1	2	3	4	5	6	7	8	9	10

**Thank you for participating in this research study**

Participant name:

Date:

### **Focus group interview guide**

Good morning and welcome

Thank you for taking the time to join the discussion regarding the clarity of our produce (diet commandments). My name is Mishal Alshubrami and I am a PhD student here in the School of Sport, Health, and Exercise Science, Bangor University. Assisting me is Alice, who is MRes student in our department. I would like to take this opportunity to thank you for your participation in the focus group today and I appreciate your time.

As you will have read in the information sheet I gave to you, the aim today is to discuss the style and wording of the diet commandments that you received on a plastic card. We think that the discussion with you will help us to improve the product which will be used for research purposes helping people to lose weight. In the long-term, we hope that this information can be used successfully for weight management with support of nutritionists and health professionals.

We are here today to guide the discussion about your views relating to the diet commandments provided on laminated card and leaflet. Feel free to express your questions and concerns. However, if you think you need more information or you have queries after the session, Dr. Hans-peter is available to chat with. His contact details are on the information sheet I have to you.

We are here to listen to your views about our diet commandments and leaflet, and there are no right or wrong views. We are interested in everybody's opinion and it is really important that you express your views freely.

We would like to record the session so we don't miss any of your comments. No names will be included in any reports and your comments are confidential. I would also like to ask that people within this discussion also keep this confidential.

We have name tents in front of us this morning; this will help all of us to address each other. I am here to guide the discussion and I have a set of pre-prepared question. However, please do not feel restricted these.

I have put a few guidelines together for the discussion:

- You should speak freely
- Your opinion are important
- There are no right or wrong opinion, we are interested in both positive and negative comments
- Don't worry about building a consensus
- Don't worry about being on the right track
- Please don't talk at the same time, allow others to speak
- Feel free to get up and get more refreshments whenever you like.

Let's begin

### 1. OPENING

Tell us your name?

### 2. INTRODUCTION/TRANSITION

Explanation of the product (plastic card and leaflet).

Then, let them have a short discussion with each other before starting the structured discussion

### 3. KEY QUESTIONS

The process below will be used for the following 3 questions:

- Silent ideas generation-blank sheet provided
- Discussion to share ideas

A) Could you give me your opinion about diet commandments you hold in small laminated card in term of:

1- Card size and lamination?

2- Colour?

3- Fonts size?

Prompts:

Do you think the card size and lamination are suitable? Or I need to use another?

Do you feel the colour id bring enough? And is the font size readable with the colour selected?

B) About the diet guidelines itself, we need your thoughts about each diet commandment in terms of Clarity in the meaning and wording? Read each diet commandment carefully?

Prompts:

What are your thoughts about the clarity of the diet commandments?

What are your thoughts about the negative and positive boxes under each commandments?

BREAK (5 MINUTES)

C) Regarding the additional leaflet, do you think it provided good explanatory statement?

Prompts:

Do you think it explained commandment benefits?

Do you think that it complements the diet commandments on the plastic card?

Do you think that I need to add or remove some information on the leaflet?

#### 4. ENDING QUESTION

From everything we have discussed during the session, do you have any final thoughts on our product (plastic card and leaflet)? Is there anything you would like to add/anything we have missed?

#### 5. ASSISTANT MODERATOR SUMMARY

Is this an adequate summary?

Has anything been missed/misinterpreted?

#### 6. CLOSING

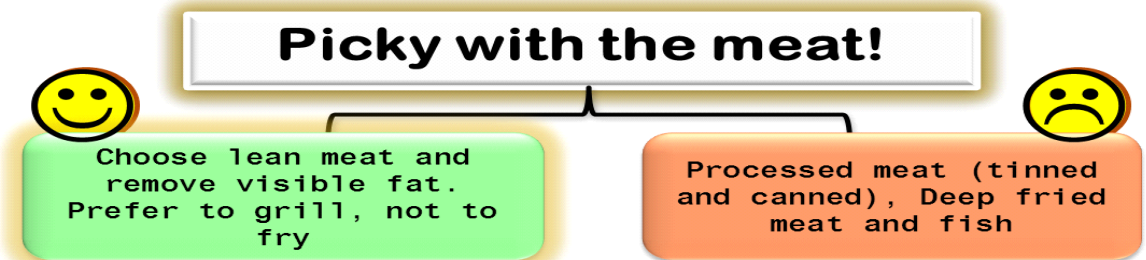
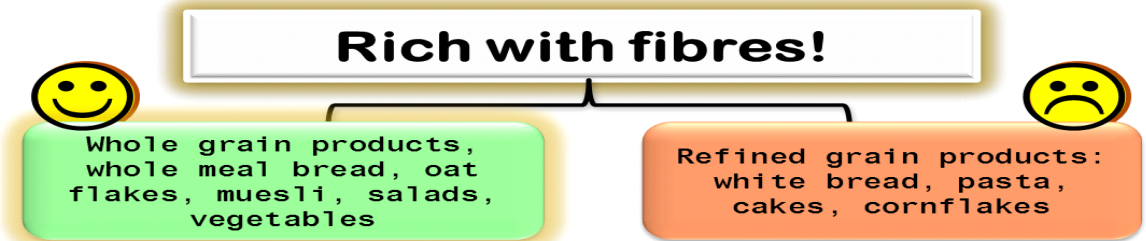
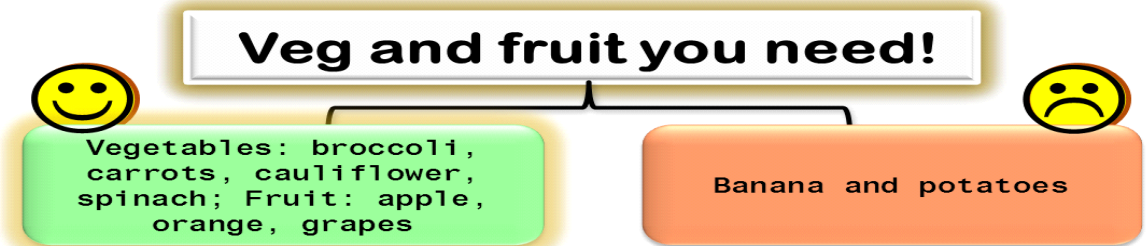
I would like to take this opportunity to thank you again for your participation in the focus group today. Your help towards developing my product (diet commandments) and furthering the knowledge is much appreciated.

If you would like to take part in this study do not hesitate in asking the researcher for a study information sheet or contact him on this Email: [elpa16@bangor.ac.uk](mailto:elpa16@bangor.ac.uk)

Feel free to help yourself to have more refreshment and continue to chat.



Laminated card



## Short of salt!



Cook your own meals



Crisps, ready meals, take away foods

## Enjoy your food!



Eat soup before each main course and spend at least 20 min for your plate - slow down!



Eating while watching TV or surfing the internet, eating take away foods

## Regular is better!



Eat breakfast, lunch, and dinner including variety of foods at regular times - keep your pattern



Resist your cravings, especially for bad snacks; crisps, sweets

## Long ways to eat!



Calculate your caloric allowance with our simple method! The 2000 Kcal allowance is too high for most people!



Move the digit of your food calories (label) to the left by two, then you know the Km you need to run! - for example: 160 kcal is energy for 1.6 km or 1 mile fast running

## No buzz with fizz!

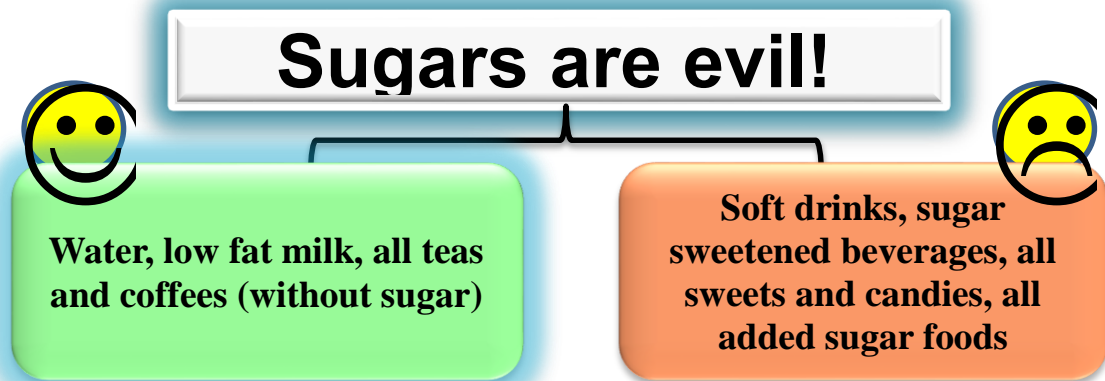


Teas and coffees low in fat and without sugar, water



Coffees with fatty milk and sugar (Latte, Capuccino), soft drinks, fruit juice, smoothies, alcoholic drinks

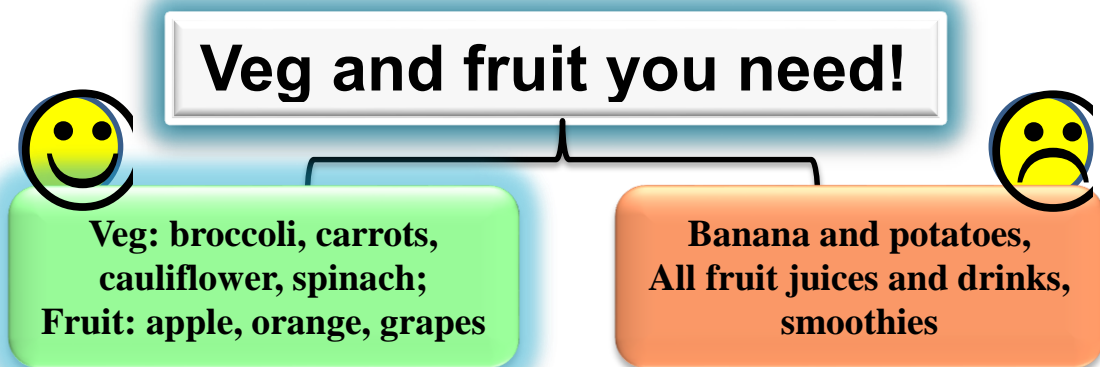
**Avoid added sugar, soft drinks,  
sweetened drinks, squash, fruit juices,  
added sugar products and snacks  
especially sweets**



**Threats:**

- Too much sugar intake makes you overweight; it also stops you burning fat.
- Sugar consumption can lead to diseases related to being overweight like diabetes and heart disease.
- Sugars in a liquid form, like soft drinks and fruit juices, are quickly swallowed – you miss out in satiety and don't know how many calories you have consumed.
- Sugars make you happy...but they can make you addicted and make you develop a very 'sweet tooth' for your food choices.
- All ready meals and freeze dried food (instant soup and noodles) are rich in sugar
- Sugars make your dentist rich.

## **Eat at least half a kg variety of vegetables and fruit a day**



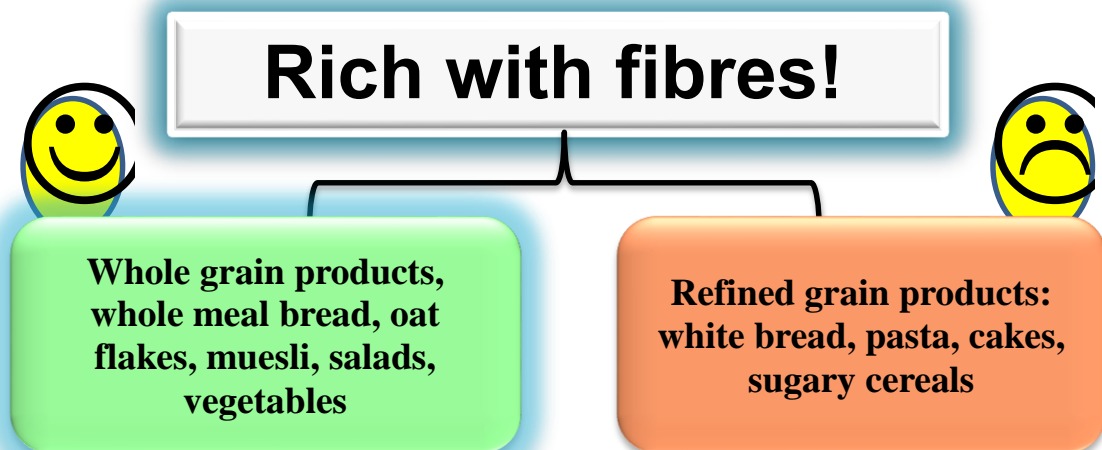
### **Benefits:**

- Veg and fruit consumption can reduce risks of heart diseases, stroke, and diabetes.
- Veg and fruit are safe choices for diabetic patients.
- Veg and fruit contain a wide variety of nutrients, vitamins and minerals.
- Veg and fruit increase satiety and decrease food intake, especially fat intake.
- Veg and fruit intake are related to lower weight gain and general health.

### **Exception:**

- High consumption of potatoes may lead to obesity and type 2 diabetes.
- Bananas are very high in sugar and extremely high in calories
- Fruit juices are not fruit; they contain too much sugar like soft drinks.

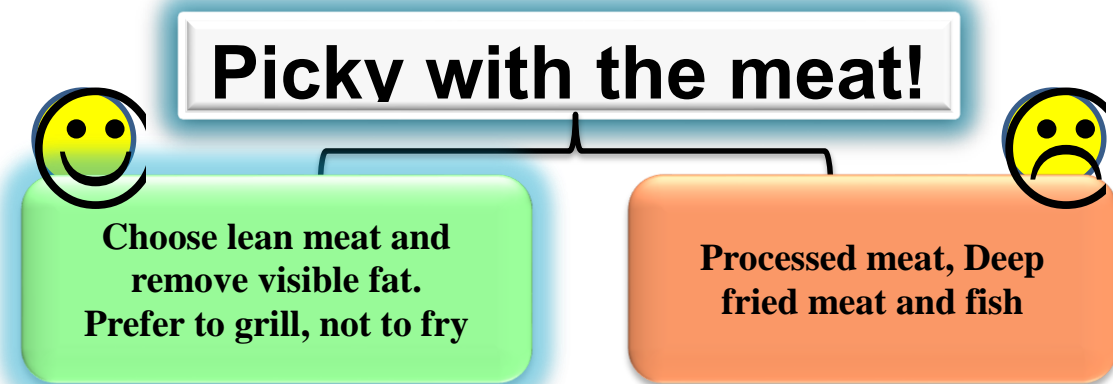
## Base your meals on fibre-rich food



### Benefits:

- Fibre rich food consumption can reduce food intake by increasing satiety and food satisfaction.
- Fibre rich food increases chewing time which makes you feel full earlier.
- Fibre rich food reduces risk of cardiovascular disease, type 2 diabetes, cancer and types of arthritis, lowers blood pressure and improves the immune system
- Fibres can slow down carbohydrate and fat digestion and reduce their uptake in the gut.
- Increase in fibre intake can lead to a reduced body weight and body fat
- High-fibre food is lower in bad saturated fat.

## **Eat fish and meat no more than twice a week**



### **Threats:**

- High consumption of meat, especially processed meat, is related to cancers such as colorectal and stomach cancer.
- High consumption of meat can lead to high blood pressure and cardiovascular disease.
- High meat consumption results in increased risk of diabetes.

### **Benefits:**

- Decrease meat intake results in higher consumption of healthier food such as veg and fruit.
- Limited consumption of meat could help decreasing bad fat consumption because most meat is rich in bad saturated fat
- fish (no deep frying) is high in unsaturated good fat and protein
- Egg and beans are good sources for protein.

## Eat food low in energy density



Energy density = amount of calories (kcal) per food weight (g)

### Threats:

- High energy food consumption can lead to weight gain, overweight and obesity.
- Take-away-food and ready-meals are usually much higher in calorie content than home cooked meals.
- Food rich in fat is always high in calorie density.
- Food with high calorie density gives you less satiety than food with low calorie density.

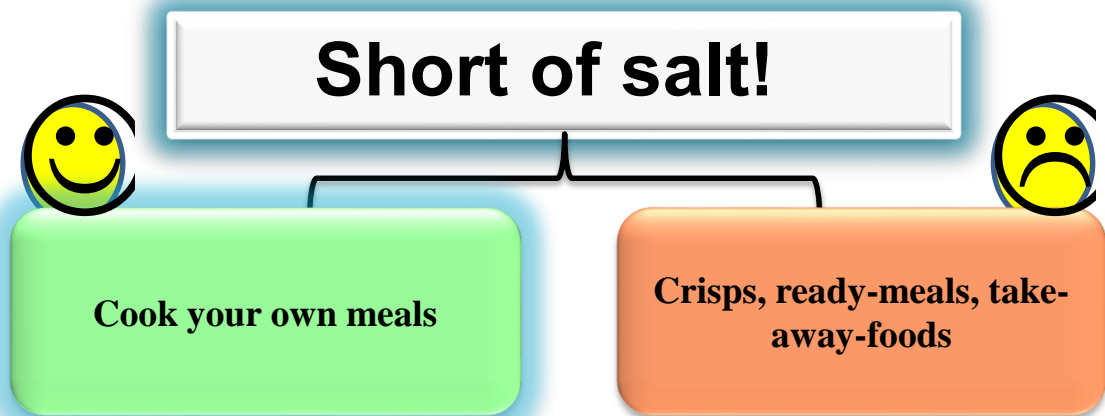
### Benefits:

- Low energy dense food can reduce the amount of caloric intake and can control the hunger levels; it improves food satisfaction at the end of meals
- look on food labels and try limiting your food choices towards low energy dense food, for example:

*Energy density of a plate with salad = 100 Kcal/ 110 g = 0.9*

*Energy density of a chocolate bar= 296 Kcal/58 g= 5.1*

## Choose low-salt products



### Threats:

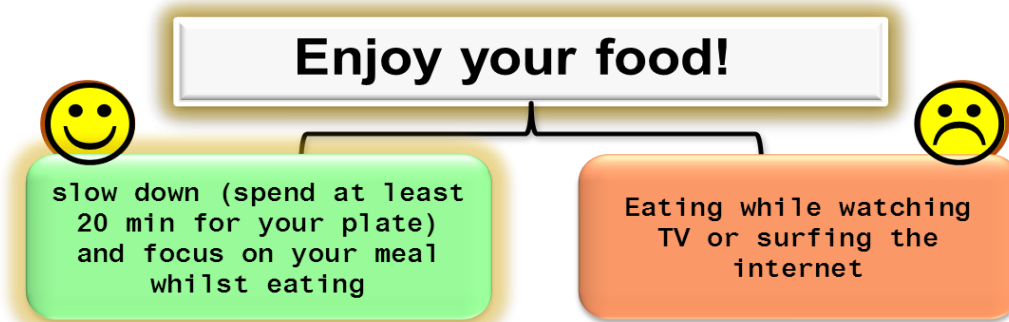
- High salt consumption is related to high blood pressure, cardiovascular and kidney disease.
- High salt in food leads to increased thirst which may increase liquid calorie intake, especially of soft drinks. This can result in weight gain.
- Salt consumption is associated with increased body weight.
- Ready-meals and take-away-food are high in salt.

### Benefits:

- Homemade food is always healthier and you can control added salt.



## Take your time and focus on your meal whilst eating



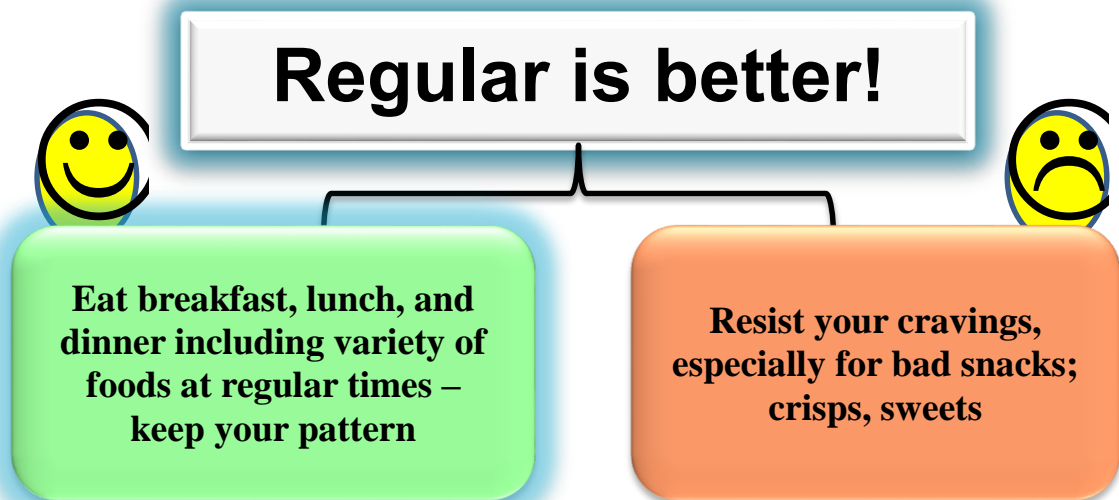
### Benefits:

- Increased chewing time increases satiety from food.
- Slower eating is related to weight loss and lower weight gain.
- Slow eating could promote satiety by providing enough time for the body to prepare satiety signals.

### Threats:

- Watching television and computer 'work' result in larger food intake during a meal and body weight gain
- Quick eating is associated with increased food intake

## Have regular meal times



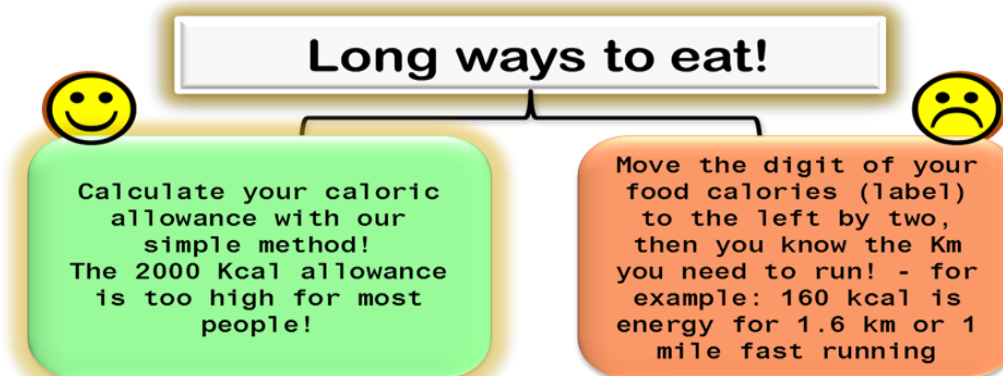
### Benefits:

- Scheduled meal times can reduce body weight gain.
- Breakfast is the most important meal, skipping this meal leads to increased calorie uptake in the following meals.

### Threats:

- Consumption of large portions at night results in increased body weight gain.
- Consumption of only one single meal a day increases risk of obesity – don't starve yourself!
- Skipping meals is related to negative behaviour such as smoking and alcohol drinking
- Eating snacks are highly related to obesity

## Be aware of your caloric needs and how much you eat



The calories (energy you can get out of food stuff) you need for maintaining a healthy body weight depends mainly on your height and age. As an example, an 18 years old women weighing 60kg being 162cm in height burns about 1400 kcal per day in rest; with some allowance for daily activity you would come out with 1700 kcal per day.

However, we all have different heights and ages. To get an idea what you need for maintaining a healthy body weight, there is a simple way to calculate how much you approximately need per day:

For every 5cm in height you are taller than 162cm you can add 70kcal to the 1700kcal; for every 5cm you are smaller than 162cm in height you going to subtract 70kcal from 1700kcal.

As example a women of 172cm would have to add 140kcal to the 1700kcal = 1840kcal

For every year you are older than 18 you have to subtract 5kcal per year.

The 172cm tall women is 40 years old, makes  $22 \times 5\text{kcal} = 110\text{kcal}$  which need to be subtracted. Therefore  $1840\text{kcal} - 110\text{kcal} = 1730\text{kcal}$  is the amount the women may eat per day to maintain a healthy body weight.

**BUT**, if you eat more than you need, you can also calculate how much you have to exercise for burning the excess in

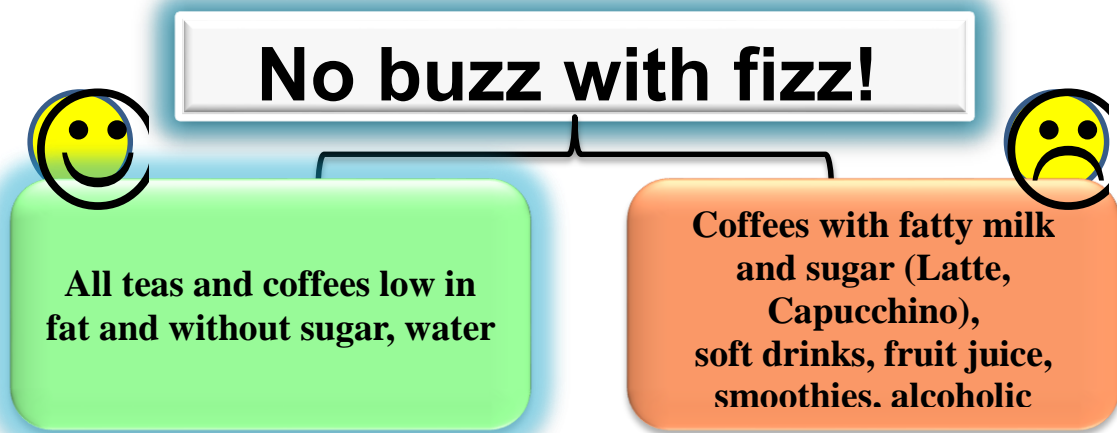
**calories. For each 100kcal you have eaten above your need, you have to run 1km!!**

**In our example the women had feasted on pizza and soft drinks on a certain day, where she had eaten 400kcal calories above her calculated need. To stop gaining weight she would had to run 4km on this day.**

**A little helper:**

**Eat soup before the main course. This brings satiety and can reduce the total amount of food you eat for feeling full.**

## Limit calorie intake from alcohol and drinks



### Threats:

- Liquid calories can increase body weight.
- Liquid calories can increase risks of breast cancer, hypertension, coronary heart disease, and type 2 diabetes.
- Alcohol and soft drinks have usually high caloric values.
- Liquid calories are less satiating than solid foods.

### Benefits:

- Water consumption increases satiety and decreases hunger levels.
- Water intake is linked to a healthier eating pattern.
- Drinking water instead of sweetened beverages can help reducing total energy intake and decreases body weight.

تجنب تناول المنتجات ذات السكر المضاف والمشروبات الخفيفة  
والمشروبات المحلاة والهريسة وعصائر الفواكه والوجبات الخفيفة  
لاسيما الحلويات

## الخطر في السكريات



المياه والألبان الخالية من الدسم وجميع  
أنواع الشاي والقهوى (الخالية من سكر)



المشروبات الخفيفة والمشروبات المحلاة  
بالسكر وجميع الحلويات والحلوى  
المحلاة بالكريم كارامل والشكولاته.. الخ  
وجميع الأطعمة ذات السكر المضاف

### المخاطر:

- تناول الكثير من السكريات يزيد من وزنك ويوقف من عملية حرق الدهون.
- تناول السكريات من الممكن أن يؤدي إلى الإصابة بأمراض متعلقة بزيادة الوزن مثل مرض السكري ومرض القلب.
- السكريات التي هي في شكل سائل، مثل المشروبات الخفيفة وعصائر الفواكه، يتم بلعها بسرعة مما يؤدي إلى عدم الشعور بالشبع وعدم معرفة كيفية استهلاك السعرات الحرارية.
- من الممكن أن تجعلك السكريات سعيداً... ولكنها تجعلك مدمناً لها ومولعاً بها جداً عند اختيارك للأطعمة.
- جميع الوجبات الجاهزة والطعام المجفف المجمد (مثل الشوربات والمكرونات الشرائط) تكون غنية بالسكريات.
- السكريات تجعلك ملازم لعياده طبيب الاسنان.

أكل ما لا يقل عن نصف كيلو غرام من الخضراوات والفواكه المتنوعة  
يوميًا

## انت تحتاج إلى الخضراوات والفواكه



الخضراوات: القرنبيط الأخضر والجزر  
والقرنبيط العادي والسبانغ  
الفواكه: التفاح والبرتقال والعنب



الموز والبطاطس وجميع العصائر  
ومشروبات الفاكهة و المشروبات التي  
تتكون من عصير الفواكه.

### الفوائد:

- تناول الخضراوات والفواكه يقلل من مخاطر أمراض القلب والسكتة الدماغية ومرض السكري.
- الخضراوات والفواكه هما الاختيار الآمن لمرضى السكر.
- تحتوي الخضراوات والفواكه على مواد مغذية وفيتامينات ومعادن مختلفة.
- تزيد الخضراوات والفواكه من الأحساس بالشبع وتقلل من تناول الأطعمة لاسيما السمينه منها.
- تناول الخضراوات والفواكه له علاقة بتخفيف الوزن وبتحسين الصحة وبالصحة عموماً.

### الحالات الاستثنائية:

- قد يؤدي الاستخدام المفرط للبطاطس إلى السمنة وإلى النوع رقم (2) من أمراض السكر.
- يحتوي الموز على درجة كبير من السكريات والسعرات الحرارية.
- عصائر الفواكه ليست فواكه؛ حيث أنها تحتوي على سكريات كثيرة حالها حال المشروبات الخفيفة و الغازيه.

## أجعل وجباتك الرئيسية عبارة عن غذاء غني بالألياف

### أجعل وجباتك الرئيسية عبارة عن غذاء غني بالألياف



منتجات الحبوب الكاملة: مثل الخبز الذي يحتوي على قشور القمح، والقطع الصغيرة من حبوب الشوفان، ووجبة الشوفان مع الفاكهة المجففة والسلطات والخضراوات.



منتجات الحبوب المكررة (أي المصفاة من الشوائب): مثل الخبز الأبيض والبسطة (نوع من المكرونة) والكيك والحبوب السكرية.

#### الفوائد:

- تناول الأطعمة الغنية بالألياف يقلل من تناول الأطعمة الأخرى وذلك من خلال زيادة الإحساس بالشبع وزيادة الإحساس بعدم الرغبة في الطعام.
- تناول الأغذية الغنية بالألياف يزيد من وقت المضغ الذي يجعلك تشعر بالإمتلاء مبكرًا.
- تناول الأطعمة الغنية بالألياف يقلل من خطر أمراض القلب والأوعية الدموية، والنوع رقم (2) من مرض السكري، والسرطان وأنواع من التهاب المفاصل، ويقلل من انخفاضات ضغط الدم، ويقوي من نظام المناعة.
- تناول الأغذية الغنية بالألياف يبطئ عملية هضم الكربوهيدرات والدهون ويقلل عملية امتصاصهما في المعدة.
- زيادة تناول الأغذية الغنية بالألياف يجعل الجسم خفيف الوزن.
- لا تحتوي الدهون المشبعة الضارة إلا على القليل من الأغذية الغنية بالألياف.



## عدم تناول الأسماك واللحوم لأكثر من مرتين اسبوعياً

### تناول اللحوم بعناية



اختر اللحوم الخالية من الدهون وقم بإزالة  
الدهون المرئية، وقم بشوائها وعدم قليها.



اللحوم المعلبة والمصنعة  
لحوم وسماك مقلية.

#### المخاطر

- التناول المفرط للحوم لاسيما المجمدة منها يؤدي إلى الإصابة بأنواع من السرطانات منها سرطان القولون والمعدة.
- التناول المفرط للحوم يؤدي إلى الإصابة بارتفاع ضغط الدم وأمراض القلب والأوعية الدموية.
- التناول المفرط للحوم يزيد من خطر الإصابة بمرض السكر.

#### الفوائد:

- تقليل تناول اللحوم يؤدي إلى زيادة تناول الغذاء الصحي مثل الخضراوات والفواكه.
- الحد من تناول اللحوم قد يساعد في تقليل تناول الدهون الضارة لأن أغلب اللحوم مشبعة بالدهون الضارة.
- السمك (غير المقلي في طنجرة تحتوي زيت كثير) يكون غني بالدهون الجيدة غير المشبعة وغني بالبروتين.
- يعتبر البيض والفاصوليا مصادر جيدة للبروتين.

## تناول الأطعمة ذات كثافة طاقة قليلة

### تناول الأطعمة الغنية بالبروتين والقليلة الدهون



الخضراوات والسلطات والفواكه ومنتجات الألبان الخالية من الدسم.



المقليات ورقائق البطاطس والبتزا والشكولاته

كثافة الطاقة = كمية السعرات الحرارية (كيلو سعرة حرارية) لكل وحدة وزن من الغذاء (بالغرام).

#### المخاطر:

- تناول الإغذية الغنية بالطاقة يؤدي إلى زيادة في الوزن وأفراط في الوزن وإلى بدانة.
- تحتوي الأطعمة والوجبات الجاهزة عادة على نسبة عالية من السعرات الحرارية مقارنة بالتي تحتويها الوجبات المطهية في المنزل.
- الأغذية الغنية بالدهون تحتوي عادة على سعرات حرارية عالية.
- الأغذية التي تحتوي على سعرات حرارية عالية لا تعطيك إحساس بالشبع مقارنة مع تلك التي تحتوي على سعرات حرارية أقل.

#### الفوائد:

- من الممكن أن تقلل الأطعمة ذات الطاقة القليلة من تناول الأطعمة التي تحتوي على كميات من السعرات الحرارية ومن الممكن أن تتحكم بمستويات الجوع؛ حيث أنها تزيد من درجة الإحساس بعدم الرغبة في الطعام في نهاية الوجبات.
- انظر على بطاقة التعريف الموجودة على الأغذية ومن ثم حاول توجيه اختيارك إلى الأغذية التي تحتوي على طاقة أقل على سبيل المثال:

كثافة طاقة طبق السلطة = 100 كيلو سعرة / 110 غرام = 0.9

كثافة قطعة الشكولاته = 296 كيلو سعرة / 58 غرام = 5.1

## اختيار المنتجات قليلة الملح

### تقليل الملح



قم بطهي وجباتك الخاصة بنفسك.



رقائق البطاطس المقلية والوجبات والأطعمة الجاهزة.

#### المخاطر:

- تناول المفرط للملح يزيد من حالات ارتفاع ضغط الدم وأمراض القلب والأوعية الدموية والكلية.
- الملح الزائد في الأطعمة يزيد من الظمأ الذي قد يؤدي إلى تناول سوائل ذات سعرات حرارية لا سيما المشروبات الخفيفة وهذا قد يؤدي إلى زيادة في الوزن.
- تناول الملح يصاحبه زيادة في وزن الجسم.
- تحتوي الوجبات والأطعمة الجاهزة على كميات عالية من الملح.

#### الفوائد:

- الأطعمة المطهية في المنزل تكون دائماً صحية حيث يكون بإمكانك التحكم بالملح المضاف.

## خذ وقتك عند تناول الطعام وركز على وجبتك الغذائية

### تمتع بطعامك



الأكل عند مشاهدة التلفاز أو عند التصفح على الانترنت.



الأكل عند مشاهدة التلفاز أو عند التصفح على الانترنت.

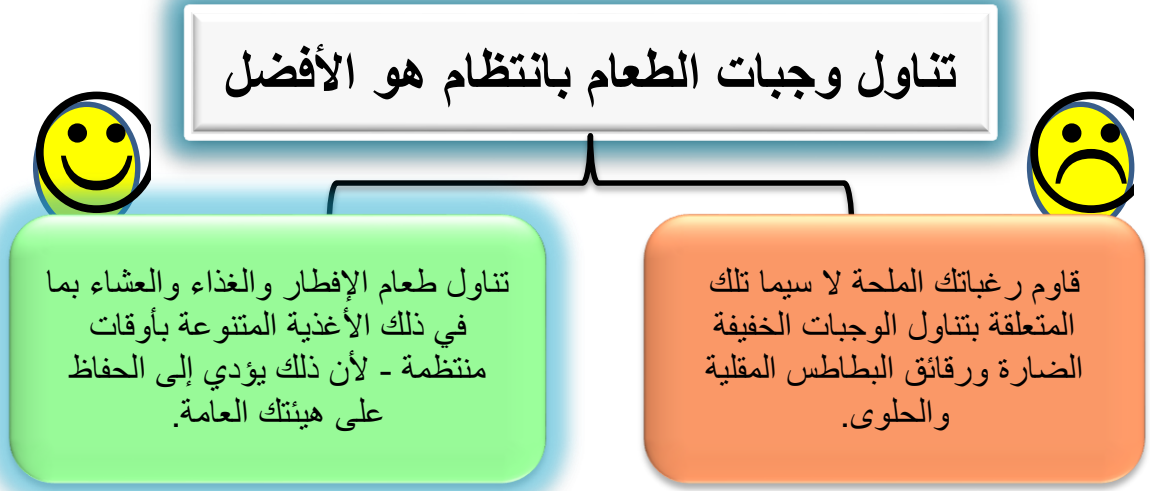
#### الفوائد:

- زيادة وقت المضغ يزيد من الاحساس بالشبع من الطعام.
- الأكل ببطئ يؤدي إلى تقليل الوزن والوزن الزائد.
- الأكل ببطئ يزيد من الإحساس بالشبع، حيث أن ذلك يوفر الوقت الكافي للجسم حتى يتمكن من إعداد إشارات الشبع.

#### المخاطر:

- تناول الطعام عند مشاهدة التلفاز والعمل على الحاسب الآلي يؤدي إلى تناول كميات أكثر من الطعام خلال الوجبة ومن ثم يؤدي إلى زيادة في وزن الجسم.
- الأكل السريع يصاحبه زيادة في تناول الطعام.

## تناول الوجبات بشكل منتظم



### الفوائد:

- عدد الوجبات المجدولة زمنياً يقلل من زيادة وزن الجسم.
- تعتبر وجبة الإفطار من الوجبات المهمة، حيث أن عدم تناول تلك الوجبة أو إهمالها يؤدي إلى إمتصاص أكثر للسعرات الحرارية في باقي الوجبات التي تليها.

### المخاطر:

- تناول الكميات الكبيرة من الطعام في الليل يؤدي إلى زيادة في وزن الجسم.
- تناول وجبة واحدة فقط في اليوم يزيد من خطر البدانة - لذا لا تقم بتجويد نفسك.
- تخطي الوجبات أي عدم تناولها في مواعيدها يؤدي إلى سلوك سلبي كالتدخين وشرب الكحول.
- تناول الوجبات الخفيفة يؤدي إلى البدانة بشكل كبير.

عليك معرفة السعرات الحرارية التي تحتاجها وكمية الطعام الذي تأكله

## السعرات الحرارية المناسبة



احسب الكميات المسموح بها من السعرات الحرارية بطريقتنا البسيطة،  
2000 كيلو سعرة هي كمية عالية جدًا  
لأغلب الأشخاص.



حرق السعرات الحرارية الزائدة يحتاج  
على -كالعدو السريع الى الرياضة  
سبيل المثال 160 كيلو سعرة هي طاقة  
تكفي لـ 1.6 كيلو متر أو ميل واحد  
جري سريع.

السعرات الحرارية (الطاقة التي يمكن الحصول عليها من الأطعمة) التي تحتاجها للحفاظ على وزن صحي للجسم تعتمد بشكل أساسي على طولك وعمرك؛ على سبيل المثال، النساء التي اعمارهن 18 عام وتزن 60 غرام ويكون طولها 162 سم تحرق 1400 كيلو سعرة كل يوم في أوقات الراحة. وفي أوقات النشاط اليومي يكون الحد المسموح به للحرق 1700 كيلو سعرة يوميًا.

نحن جميعًا لدينا أطوال وأعمار مختلفة، ولأجل الحصول على خطة للحفاظ على وزن صحي للجسم، فإنه يوجد هناك طريقة بسيطة لحساب كمية السعرات التي تحتاج إلى حرقها تقريبًا كل يوم:

عندما يكون طولك أكثر من 162 سم، فإنك تضيف 70 كيلو سعرة إلى 1700 كيلو سعرة لكل 5 سم؛ وعندما يكون طولك أقل من 162 سم، فإنك تطرح 70 كيلو سعرة من 1700 كيلو سعرة لكل 5 سم.

على سبيل مثال، النساء اللاتي طولهن 172 سم عليها إضافة 140 كيلو سعرة إلى 1700 لتصبح 1840 كيلو سعرة.

وعن كل سنة تزيد عن 18 سنة، عليك طرح 5 كيلو سعرة لكل سنة

فعلى سبيل المثال، النساء اللاتي طولهن **172** سم وعمرهن **40** سنة، تكون السرعات كالاتي: **22** سنة **5 X** كيلو سعرة = **110** كيلو سعرة وهي الكمية المطلوبة للطرح. وعليه يكون الطرح كالاتي **1840** كيلو سعرة - **110** كيلو سعرة = **1730** كيلو سعرة وهي الكمية التي يجوز للنساء أكلها يومًا للحفاظ على وزن صحي للجسم

ولكن!! في حالة تناول كمية من السرعات أكثر من المطلوب، فإنك تستطيع أيضًا حساب كمية التمارين التي تحتاجها لحرق السرعات الحرارية الزائدة. فعند تناول **100** كيلو سعرة أكثر من المطلوب، فإنك تحتاج إلى الركض لمسافة **1** كيلو متر.

على سبيل المثال، النساء المولعة بأكل البتزا والمشروبات الخفيفة في أيام معينة قد تأكل **400** كيلو سعرة أكثر من المطلوب، لذا عليها الركض لمسافة **4** كيلوا متر في هذه الأيام وذلك لوقف الوزن الزائد. وهذا صعب جدا

#### الطرق المساعدة:

تناول الحساء قبل الوجبة الرئيسية يؤدي إلى الإحساس بالشبع ويقلل من إجمالي كمية الطعام التي تأكلها بسبب الشعور بالامتلاء.

## الحد من السعرات الحرارية التي تأتي من المشروبات

### لا للمشروبات الغنية بالسعرات الحرارية



جميع أنواع الشاي، والقهوة قليلة الدسم والخالية من السكر، والمياه.



القهوة مع الحليب كامل الدسم والسكر مثل (القهوة اللاتيه والكبشينو) والمشروبات الخفيفة والغازية وعصير الفواكه ومشروبات عصير الفواكه والمشروبات الكحولية

#### المخاطر:

- السعرات الحرارية التي تأتي من السوائل تزيد من وزن الجسم.
- السعرات الحرارية التي تأتي من السوائل تزيد من مخاطر سرطان الثدي وارتفاع ضغط الدم و أمراض شريان القلب التاجي والنوع رقم (2) من مرض السكر.
- تحتوي المشروبات الغازية والخفيفة عادة على نسب عالية من السعرات الحرارية
- السعرات الحرارية التي تأتي من السوائل تقلل من الإحساس بالشبع أكثر من تلك التي تأتي من الأطعمة.

#### الفوائد:

- تناول المياه يزيد من الإحساس بالشبع ويقلل من مستويات الجوع.
- تناول المياه له علاقة بالأكل الصحي.
- شرب المياه بدل من تناول المشروبات المحلاة والعصائر يساعد على تقليل إجمالي الطاقة المتناولة ويقلل من وزن الجسم.