DOCTOR OF PHILOSOPHY

A multiple method approach to economic evaluation in public health: yoga for managing musculoskeletal conditions in the workplace

Hartfiel, Ned

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PhD Thesis

Ned Hartfiel

Centre for Health Economics and Medicines Evaluation

School of Healthcare Sciences

Bangor University

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Thesis abstract

Musculoskeletal conditions contribute to more than 30 million sickness absence days per year in the UK, costing British employers £5.6 billion. Although yoga can be effective for managing musculoskeletal conditions, there is little evidence demonstrating its cost-effectiveness for employers. This thesis explores the cost-effectiveness of yoga in workplace settings using five methods of economic evaluation and taking a broad approach recommended by the NICE Centre for Public Health Excellence (chapter 1).

A comprehensive literature review found no published studies on the *cost-effectiveness* of yoga in workplace settings. Therefore, a systematic review was conducted, which reported promising yet limited evidence for the *effectiveness* of yoga in the workplace (chapter 2).

A randomised controlled trial (n=151) was designed and implemented, comparing yoga with usual care at three hospital sites in North Wales. At end-programme, results showed that yoga generated statistically significant reductions in back pain and improvements in psychological wellbeing (chapter 3). Additional outcomes included enhanced physical flexibility, better posture, improved sleep quality and greater body awareness (chapter 4).

Four scenarios were created in a costing analysis (chapter 5). A cost-consequence analysis compared each scenario with a range of disaggregated outcomes using employer, healthcare and societal perspectives (chapter 6).

From a healthcare perspective, cost-effectiveness analysis reported incremental cost-effectiveness ratios (ICERs) ranging from £21 to £114 per one point reduction in back pain (RDQ) with the probability of cost-effectiveness ranging from 75% to 78% using a threshold of £1,300 (chapter 7). Cost-utility analysis indicated ICERs ranging from £317 to £1,756 per quality-adjusted life year (QALY) with the probability of cost-effectiveness ranging from 87% to 92% using a £20,000 per QALY threshold (chapter 8).

From an employer perspective, return on investment analysis showed that yoga was cost saving with a benefit-cost ratio of 1.35 when yoga instructors were paid £64 per session. With a co-payment scheme, the benefit-cost ratios rose to 2.14. When additional costs of lost production were added, it increased to 2.52 (chapter 9). From a societal perspective, social return on investment analysis reported a social impact of £2.6 to £6.9 for every £1 invested in the yoga programme (chapter 10).

This thesis showed that a multiple method approach to economic evaluation can be effectively applied to public health interventions in workplace settings. This approach provided key stakeholders with a broad range of evidence upon which to base decisions regarding the allocation of scarce resources (chapter 11).

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Chapter 1: Introduction

1.1 Chapter summary

This thesis begins with a personal statement to provide an understanding for why this original research was undertaken. This chapter also includes:

- a review of the effectiveness of yoga for managing musculoskeletal conditions
- an appraisal of yoga's cost-effectiveness
- the mixed-method epistemological approach used in this thesis
- the conceptual framework underpinning methods of economic evaluation
- the costing approach used in this thesis
- the five methodological tools used in this economic evaluation.

Finally, this chapter introduces the principal aim, research questions and novel contributions of this thesis.

1.2 Personal statement

My interest in undertaking an economic evaluation of yoga arises from my own personal experience with back pain. Nearly twenty years ago, I was a student nurse at John Moores University in Liverpool. As a student nurse, I worked in residential care homes for the elderly and first experienced back pain when lifting and transferring patients. I enrolled in yoga classes to alleviate my back pain and found that a regular practice of yoga helped reduce my existing back pain and prevent recurrent back pain. I subsequently enrolled on a Dru Yoga instructor training programme in North Wales. From yoga, I learned the importance of stretching and strengthening exercises, breathing, relaxation, and meditation.

After completing both my nursing and yoga training in 1998, I moved to the United States where I practised nursing in residential homes for the elderly and in a hospice. I also began teaching yoga and observed how people benefited, both physical and mentally, from practising yoga. In 2003, I approached the Mitsubishi Corporation about offering yoga classes to their employees. Based on a free trial class and testimonials from my previous yoga students, I was hired by Mitsubishi. At that time, I was unable to find any published research on the benefits of yoga for employees in workplace settings.

In 2006, I returned to the UK to undertake an MSc at Bangor University in Public Health and Health Promotion. My academic and professional goal was to scientifically study the effect of yoga for improving health and wellbeing in the workplace. If scientific studies confirmed the health benefits of yoga, then this could potentially provide evidence for the wider provision of yoga in society.

Because there were so few published trials of yoga in the workplace in 2006, I decided to design and implement a randomised controlled trial as part of my MSc thesis. The results of this trial indicated that a six-week Dru Yoga programme for university employees could improve emotional wellbeing and resilience to stress. In 2010, the *Scandinavian Journal of Work, Environment and Health* published my paper on 'The effectiveness of yoga for improving wellbeing and resilience to stress in the workplace' (Hartfiel et al., 2011).

After completing my MSc, I was awarded the position of a Knowledge Transfer Partnership (KTP) Associate at Bangor University. In this position, I conducted another randomised controlled trial of yoga in the workplace – this time an eight-week Dru Yoga programme for 74 local government employees. In 2012, Occupational Medicine (UK) published my paper on 'Yoga for reducing perceived stress and back pain at work' (Hartfiel et al., 2012).

It was clear that my next step was to investigate whether yoga could provide a positive return on investment for employers. Since there were no published papers on the financial return of yoga from the perspective of the employer, I began my PhD in 2012 with the aim of investigating this research topic under the guidance of Professor Rhiannon Tudor Edwards.

In summary, my interest in researching the cost-effectiveness of yoga arises from my own personal experience. In the past twenty years, I have experienced many benefits, both physical and psychological, from practising yoga. However, I have also experienced recurring back pain throughout my adult life, mostly when I have lapsed in my daily yoga practice.

My research interest comes from a desire to address the impact of back pain and musculoskeletal conditions and to explore the benefits of a workplace yoga programme in this context. Although research shows that yoga can be effective for managing back pain and musculoskeletal conditions, the cost-effectiveness and financial return of yoga is understudied. I have chosen Dru Yoga because I've experienced benefit from this gentle and flowing style of yoga and my previous research indicates its efficacy.

My aim in this thesis is to conduct an economic evaluation of Dru Yoga in the workplace using a variety of methodological tools. It is my hope that this research can benefit NHS employees and generate cost savings to the NHS as an employer. I take full responsibility for the results presented in this thesis, which, to the best of my ability, are reported accurately, transparently and in accordance with the CONSORT 2010 Statement Checklist for Transparent Reporting of Trials (Schulz et al., 2010) and the CHEERS Economic Evaluation Publication Guidelines (Husereau-et al., 2013).

1.3 Effect of yoga on managing musculoskeletal conditions

Affecting muscles, joints and tendons, musculoskeletal conditions are the most common cause of chronic pain and disability in industrialised countries (Connelly et al., 2006; Ward et al., 2013). The four major musculoskeletal conditions include degenerative conditions such as osteoarthritis and osteoporosis, inflammatory diseases such as rheumatoid arthritis, and soft tissue disorders such as back pain All four of these conditions can lead to impaired physical functioning and a reduction in quality of life (Woolf and Pfleger, 2003; Ward et al. 2013).

Of these musculoskeletal conditions, back pain is the most prevalent and is a major cause of absence from work (Woolf and Pfleger, 2003; Connelly, Woolf and Brooks, 2006). In the UK, most people (80%) experience back pain at some point during their lifetime (Maniadakis and Gray, 2000) and about a third of the population (20 million people) experience back pain each year (NICE, 2009). In 2013, musculoskeletal conditions and back pain resulted in more than 30 million sickness absence days (Office for National Statistics, 2014), costing British employers approximately £5.6 billion (Confederation of British Industry, 2013; Chartered Society of Physiotherapists, 2013).

The National Health Service (NHS) is the largest employer in the UK with approximately 1.3 million employees (Health and Social Care Information Centre, 2014). In 2013, the NHS reported 13.7 million days lost due to sickness absence, resulting in a direct cost of £1.55 billion, of which 40% (£620 million) were attributed to musculoskeletal conditions, including back pain (NHS, 2013; Chartered Society of Physiotherapy, 2013).

In April 2013, NHS leaders met in London to renew their commitment to support the health and wellbeing of their 1.3 million employees (NHS, 2013). In 2009, the Boorman Report made it clear that improving staff wellbeing and reducing sickness absence was an important NHS priority. The Boorman Report found that NHS organisations, which prioritised staff health and well-being, performed better in many areas including greater patient satisfaction, stronger quality scores, higher levels of staff retention and lower rates of sickness absence. Boorman stated that prioritising staff health and wellbeing could reduce NHS sickness absence rates by a third, resulting in 33.4 million additional working days per year for NHS staff with an estimated annual cost saving of £555 million (Boorman, 2009).

The Boorman Report called for early intervention strategies for NHS employees with back problems. According to the National Institute for Health and Care Excellence (NICE), effective early intervention strategies include structured exercise programmes designed to stretch/strengthen muscles and to improve posture (NICE, 2009). The NICE guidance

(2009) suggested group exercise programmes of eight sessions over a twelve week period, with class sizes of up to 10 people.

Although research indicates that few workplace interventions are effective for preventing back pain and musculoskeletal conditions, the workplace provides an ideal setting for health promotion and physical activity (World Health Organization, 1997; van Poppel et al., 2004). For preventing back pain at work, systematic reviews report that exercise programmes are more effective than lumbar supports or education (van Poppel et al., 2004). Workplace exercise programmes are shown to have a moderate effect in preventing back pain, although the evidence is limited due to a lack of high quality studies (van Poppel et al., 2004; Luhman et al., 2006; Bell and Burnett, 2009).

Recent research suggests that yoga is one form of exercise that can reduce musculoskeletal conditions and back pain (Sherman et al., 2011; Tilbrook et al., 2011). Developed in India nearly 3,000 years ago, yoga is considered a means for promoting physical, mental and spiritual wellbeing (Cramer, et al., 2013b). Yoga often includes four main components: physical movement, breathing exercises, relaxation methods and meditation/mindfulness techniques (Collins, 1998; Woodyard, 2011; Ward, et al., 2011; NIH, 2013; Cramer et al., 2013b). The Dru Yoga programme described in this thesis (chapter 3) focused on techniques for movement, breathing and relaxation.

In recent years, yoga has gained popularity as a therapeutic practice for improving mental and physical health. In 2012, approximately 12 million people in the United States practiced yoga with the specific intention to improve their overall health (Yoga Journal Survey, 2012). Today, yoga is practised by approximately 30 million people worldwide. It is now commonplace in western countries and taught in leisure centres, health clubs, schools, hospitals and GP surgeries (NIH, 2013; Cramer, et al., 2013b).

Two recent systematic reviews of 'yoga for musculoskeletal conditions' found yoga to be a safe, acceptable and feasible intervention, superior to usual care in reducing pain and improving functional outcomes (McCaffrey and Park, 2012; Ward et al., 2013). McCaffrey and Park (2012) reviewed the evidence from 31 randomised and non-randomised studies. They found yoga to be 'moderately feasible' and likely to reduce both pain and the use of medication for pain.

Ward et al. (2013) found 17 randomised controlled trials covering yoga for low back pain, osteoarthritis, osteoporosis, rheumatoid arthritis and fibromyalgia. The authors concluded that the yoga produced clinically meaningful reductions in pain and improvements in functional outcomes across a range of musculoskeletal conditions (Ward et al., 2013).

Three additional systematic reviews on 'yoga for back pain' found strong evidence of yoga's effectiveness for relieving short-term back pain and moderate evidence of yoga's effectiveness for reducing long-term back pain (Posadski and Ernst, 2011; Holzman and Beggs, 2013; Cramer et al., 2013a). Posadksi and Ernst (2011) reviewed seven randomised controlled trials and concluded that yoga generated significantly greater reductions in low back pain compared with usual care, education or conventional therapeutic exercise.

Holzman and Beggs (2013) found eight randomised controlled trials of yoga for assessing back pain and functional disability. In their meta-analysis, the authors reported that at post-treatment, yoga had a medium to large effect in reducing both pain (Cohen's d=0.623) and functional disability (Cohen's d=0.645). Although follow-up effect sizes were smaller, they were still significant for both pain (d=0.486) and functional disability (d=0.397).

More recently, Cramer et al. (2013a) found 10 randomised trials on yoga for patients with back pain. Eight of the ten studies were rated low risk of bias and most showed significant reductions in pain when compared with usual care or education groups.

1.4 Cost-effectiveness of yoga for managing back pain

Although these recent systematic reviews indicate that yoga can be effective for managing musculoskeletal conditions and back pain, few studies have explored the cost-effectiveness of yoga. Two recent studies, however, suggest that yoga can be cost-effective, from employer, healthcare and societal perspectives, for patient populations with chronic or non-specific low back pain (Chuang et al., 2012; Aboagye et al., 2015).

The Chuang and Aboagye studies found that a series of 12 yoga classes had a favourable impact on sickness absence days for patients with both chronic low back pain (Chuang et al., 2012) and non-specific low back pain (Aboagye et al., 2015).

Chuang reported that yoga participants missed an average of 3.8 days off work compared to 12.3 in a usual care group over a one-year period. In addition, patients who were offered yoga treatment for their back pain gained 0.037 quality-adjusted life years (QALYs) more than those patients offered usual care.

Similarly, Aboagye reported that patients offered yoga treatment missed an average of 12.4 days of work over a one year period compared to 29.6 days missed by patients offered usual care. Aboagye found that patients offered yoga for their back pain gained 0.036 QALYs more than those patients offered usual care.

Although these findings are promising for patient populations with chronic and non-specific low back pain, further studies are needed to determine if yoga can generate cost savings for employers in workplace settings with relatively healthy employee populations.

1.5 Epistemological approach

Epistemology means *the study of knowledge* and is concerned with how new knowledge is acquired. Three common approaches for investigating knowledge include the positivist, interpretive, and pragmatic paradigms (Mackenzie and Knipe, 2006).

The modern positivist paradigm is based on the ideas of 19th century French philosopher August Comte, who was influenced by empiricists such as Aristotle, Francis Bacon and John Locke (Mackenzie and Knipe, 2006). Comte emphasised that observation and reason are the best means of understanding both natural and human sciences. According to Comte, true knowledge is obtained from the experience of the senses by means of scientific objectivity, observation, measurement, and quantification (Dash, 2005).

The interpretive paradigm, on the other hand, was developed from the ideas of two early 20th century German intellectuals: philosopher Wilhelm Dilthey and phenomenologist Edmund Husserl. They argued that although the primary task of the natural sciences is to arrive at law-based explanations, the core task of the human sciences is to understand human life (Mackenzie and Knipe, 2006).

The interpretive paradigm believes scientific inquiry of the human sciences should focus on understanding meaning and context rather than on trying to determine causal links and predictive laws (Mackenzie and Knipe, 2006). New knowledge of human experience is best obtained not from the positivist method of objectivity, experiment, observation and measurement, but from an interpretive method of seeking to understand the subjective experiences of individuals through qualitative research and interaction with study participants (Mackenzie and Knipe, 2006).

A third approach, the pragmatic paradigm, had its roots in the thinking of early 20th century American philosophers such as Charles Sanders Pierce, William James, George Herbert Mead, and James Dewey (Scheffler, 2012). These pragmatists rejected the idea that knowledge of social reality can be determined from only one scientific method (Mertens, 2005). The pragmatic perspective argues that new knowledge can be obtained from positivist and interpretive paradigms. Methods from both paradigms can be used to more fully answer research questions (Mackenzie and Knipe, 2006). The pragmatic paradigm provides the underlying philosophical framework for mixed-methods research (Mackenzie and Knipe, 2006).

In the last thirty years, mixed methods research in healthcare has become increasingly common in the UK. In the mid-1990s, 17% of health service research in England was classified as mixed methods. By the early 2000s, this percentage had increased to 30% (Tariq and Woodman, 2013). In addition, mixed methods research is appropriate for complex public health interventions, such as yoga in the workplace, where many different processes can interact to produce an effect (Medical Research Council, 2008). Recently, there has also been a growing recognition of the importance not only of the *effects* (positivist paradigm), but also of the *processes* (interpretivist paradigm) involved in determining the effects of public health interventions (O'Cathain et al., 2013).

In this thesis, a mixed method pragmatic approach is used to investigate the cost-effectiveness and financial return of yoga for managing musculoskeletal conditions in the workplace. This approach follows the current format now used in health technology assessment, where a health technology is defined as any intervention that may be used to promote health (Ring et al., 2011).

A mixed-method pragmatic approach can increase the validity of randomised controlled trials by exploring change from both positivist and interpretive perspectives (O'Cathain et al., 2013). In this thesis (chapter 3), a randomised controlled trial was conducted with NHS employees at three hospital sites. Valid and reliable outcome measures were used at baseline, end-programme, and at a six-month follow-up to assess changes in back pain, psychological wellbeing and health-related quality of life. Sickness absence data was also collected from the employer. An intention-to-treat analysis of covariance (ANCOVA) was used to determine the levels of back pain before and after the programme and at 6 months.

In addition to this positivist approach, focus group interviews and open-ended questionnaires were used to collect subjective data from the NHS employees who participated in the yoga programme. Braun and Clarke's (2006) six step method of thematic analysis was then applied to identify the main themes emerging from participant responses. This interpretive approach provided an understanding of how participants actually experienced the programme, the benefits they attained, whether they had any adverse events, and the extent to which they were able to integrate yoga into their daily lives.

1.6 Conceptual framework underpinning economic evaluation

In undertaking a broad economic evaluation of yoga in the workplace, this thesis compared different methodological tools, such as cost-effectiveness analysis, cost-utility analysis, cost-benefit analysis and social return on investment analysis. Each method is underpinned by either a welfarist or extra-welfarist conceptual framework. Whereas cost-benefit analysis

and social return on investment are based on welfarism, cost-effectiveness analysis and cost-utility analysis are derived from extra-welfarism.

Welfarism

Using money as a proxy for measuring social welfare, the aim of welfarism is to generate the greatest happiness for the greatest number (Bentham, 1789; Morris, et al., 2007). According to welfarist theory, total social welfare is the sum of each individual's welfare. When individuals maximise their own welfare, the *invisible hand* of the free market, under conditions of perfect competition, ensures that social welfare is also maximised (Smith, 1776).

The conditions of perfect competition in a free market include (Mwachofi and Al-Assaf, 2011):

- many buyers and sellers entering and exiting easily
- many sellers offering non-differentiated or homogeneous products
- many buyers having complete information about prices and product quality.

Welfarism maintains that under conditions of perfect competition, Pareto efficient outcomes are possible, that is, some people can become better off without others becoming worse off (Hammond, 1997).

In economic evaluation, Pareto efficiency is measured with cost-benefit analysis or return on investment analysis. Using these methods of analysis, social welfare is maximised by investing in interventions that produce the highest net monetary benefit (Drummond et al., 2005). In theory, implementing programmes with the highest benefit-cost ratios should improve Pareto efficiency (Hubin, 1994).

In practice, however, the conditions for perfect competition are rare and market failure often occurs in healthcare (Arrow, 1963; Mwachofi and Al-Assaf, 2011). Reasons for this include:

- non-competitive markets (e.g., a few pharmaceutical companies set prices)
- information asymmetry (e.g., doctors have more information than patients)
- uncertainty (e.g., not knowing when illness may arise).

Because of widespread market failure in healthcare, government intervention is generally necessary to ensure equitable provision of healthcare services (Arrow, 1963). Without government intervention, individuals with limited income are unable to purchase basic healthcare services and the goal of maximising social welfare is not achieved (Sen, 1970).

In its attempt to monetise all outcomes and to base decision-making on benefit-cost ratios, welfarist approaches in economic evaluation cannot guarantee improvement in social welfare (Weimar and Vining, 2005). Therefore, decision-making in healthcare is rarely based on cost-benefit analysis alone, as political, ethical, social and environmental considerations are also considered (Sefton et al., 2002).

Extra-welfarism

Given the limitations of welfarism and measuring social welfare in monetary terms, extra-welfarism advocates maximising social welfare in terms of *health* or *capabilities* (Brouwer, 2008). In the UK, NICE recommends measuring social welfare in terms of *health,* frequently assessed in quality-adjusted life years (QALYs). Among national health systems, the UK has the most developed and consistent approach to using QALYs in resource allocation (Garrison, 2009).

Resource allocation in the UK tends to be extra-welfarist, where resources are allocated according to cost-utility analysis. Using this method, health-related quality of life is assessed using a range of generic preference-based health measures, which include the EQ5D, Short Form 6D (SF-6) and the Health Utilities Index (HUI) (Tolley, 2009; Whitehead and Ali, 2010).

In addition to assessing health-related quality of life, extra-welfarism is concerned about maximising capabilities (Sen, 1987). Capabilities refer not only to physical functioning, but also to individuals having the capability to achieve outcomes they value (Sen, 1987). Capabilities depend on the presence of substantive freedoms, such as the freedom of choice, freedom from poverty, the ability to live to old age, to engage in economic transactions and to participate in political activities (Sen, 2001).

Capabilities also recognise the multi-dimensional nature of being human (Vergunst et al., 2014) as illustrated in Nussbaum's (2003) list of ten basic human capabilities: life, bodily health, bodily integrity, sense, imagination and thought, emotions, practical reason, affiliation, other species, play, and control over one's environment.

1.7 Methods of economic evaluation

The principal methods of economic evaluation in healthcare have been developed mostly in the last fifty years. In the late 1960s, there was a growing consensus that the purpose of healthcare was to maximise *health* and *quality of life*. At that time, there were few methods for determining whether a particular healthcare intervention did more good than harm, or whether one technology did more good than an alternative programme (Gold, et al., 2002; Torrance, 2006).

In 1971, the first cost-benefit analysis in healthcare investigated the costs and benefits of programmes designed to prevent accidents and death (Mishan, 1971). A year later, cost-utility analysis was created when a health utility scale was developed, assigning utility values to health states. Soon after, utility values were officially named QALYs (Torrance, et al., 1972; Zeckhauser and Shepard, 1976). This was an important breakthrough, making it possible to compare the cost-effectiveness of two competing health interventions.

Since the 1970s, cost-utility analysis has been primarily used to evaluate innovative drugs and medical technologies. More recently, however, there has been growing interest in measuring the cost-effectiveness of public health interventions, including workplace physical activity programmes (NICE, 2012).

For public health interventions, cost-utility analysis is the most commonly used method when health-related quality of life is measured (Gold, et al., 2002). Cost-benefit analysis, on the other hand, uses willingness-to-pay techniques in an attempt to place a monetary value on all intangible benefits of public health interventions (McIntosh et al., 2010). Recently, social return on investment (SROI), based on cost-benefit analysis, has been developed as an alternative method for monetising intangible health outcomes generated by public health interventions.

Multiple method approach to economic evaluation

Although healthcare resource allocation in the UK is primarily extra-welfarist, NICE has recently recommended a broader approach to economic evaluation, which includes cost-consequence analysis and cost-benefit analysis. In doing this, NICE recognises the importance of measuring the full spectrum of outcomes in public health interventions. Assessing only health-related quality of life through the five domains of the EQ5D may be too limiting (NICE, 2012).

In addition, this broader approach recommends process evaluation to encourage reporting of adverse events, participant satisfaction, and the delivery of public health interventions. These aspects are often overlooked in many cost-effectiveness and cost-utility analyses (NICE, 2012).

For public health interventions in the workplace, a broad approach to economic evaluation can better meet the needs of key stakeholders (Tompa, et al., 2010; van Dongen, 2014). For employers who want to capture the monetary benefits of an intervention, cost-benefit analysis and return on investment analysis are often the preferred tools. For public policy makers and healthcare providers who are concerned with actual health outcomes, cost-effectiveness analysis and cost-utility analysis are usually favoured (Tompa, et al, 2008).

Recently, the 24-item CHEERS checklist was created to better meet the needs of key stakeholders. This statement provides guidelines for the consistent and transparent reporting of economic evaluation methods (Husereau et al., 2013).

Importance of the perspective

The choice of economic perspective refers to the point of view taken when measuring relevant costs and outcomes. The chosen perspective may be that of a relevant stakeholder (employer or healthcare provider) or an aggregate of stakeholders (societal perspective).

From the employer perspective, only costs paid by the employer and benefits accrued to the employer are taken into account (Tompa et al., 2008; van Dongen et al., 2014). Because decisions to implement workplace interventions are typically made by employers, economic evaluation in the workplace is often undertaken from the employer perspective (Tompa et al., 2008; van Dongen et al., 2014).

In this case study of yoga in the workplace, intervention costs included operational costs and equipment costs. Operational costs were the costs of yoga instructors and equipment costs were for yoga mats, cushions, DVDs and illustrated booklets (chapter 5).

From the healthcare perspective, all costs and benefits are considered from the perspective of the healthcare provider. In this case study, the healthcare perspective included not only intervention costs, but also healthcare resource use costs which were calculated from the number of visits to healthcare professionals (for musculoskeletal conditions) by yoga and usual care participants during the six-month study period (chapter 6).

From the societal perspective, costs and benefits relevant to all key stakeholders are considered, regardless of who pays or benefits. In this study, the societal perspective considered production loss costs in addition to intervention costs and healthcare resource use costs. Production loss costs were calculated from the difference between the yoga and usual care groups in sickness absence days due to musculoskeletal conditions during the six-month study (Chapter 6).

1.8 Costing analysis

In this thesis, a costing analysis and five different methods were presented in a broad economic evaluation of yoga in the workplace (Table 1.1).

Calculating the direct costs of an intervention is the necessary first step in economic evaluation (Charles et al., 2013). Direct costs refer to the costs of resources used in delivering an intervention. A costing analysis is especially useful when a new intervention is being evaluated and when there are no previous cost estimates for delivering the intervention (Sach et al., 2014).

There are three stages in a costing analysis: identifying the resources that required costing, measuring the quantity of resources used and valuing the resources used (Sach et al., 2014). These three stages will be further explored in chapter 5.

Table 1.1: Comparing methods of economic evaluation

Method	Perspective	Outcome	Measurement	Strengths	Limitations
Cost-consequence (chapter 6)	Employer, healthcare and societal	Back pain Wellbeing Resilience Rejuvenation Exhaustion Engagement Tranquillity	Non-monetised	Easy to understand for decision-makers in all sectors	Disaggregated method Benefits not monetised
Cost-effectiveness (chapter 7)	Employer, healthcare and societal	Back pain Sickness absence days	Natural units	Uses primary outcome measure	Measures only one benefit Benefits not monetised
Cost-utility (chapter 8)	Employer, healthcare and societal	Health-related quality of life (HRQoL)	EQ5D-5L QALYs	Uses generic outcome measures Uses incremental cost-effectiveness ratios	Measures one benefit (HRQoL) Outcome measures may lack sensitivity
Return on investment (chapter 9)	Employer	Sickness absence days due to musculoskeletal conditions	Monetisation	Production loss costs are monetised Intangible benefits monetised via willingness-to-pay Estimates benefit-cost ratios	Presenteeism is difficult to measure Willingness-to-pay can be under-sensitive, and influenced by bias and income levels

Method	Perspective	Outcome	Measurement	Strengths	Limitations
Social return-on-investment analysis (chapter 10)	Societal	Back pain, psychological wellbeing, health-related quality of life.	Monetisation through revealed preference (financial proxies) and wellbeing valuation	Identifies relevant and significant benefits to stakeholders Estimates SROI ratios	Lack of standardisation using financial proxies Lack of consensus on wellbeing measures

1.9 Cost-consequence analysis

Cost-consequence analysis is a pragmatic and transparent approach to economic evaluation that does not attempt to monetise benefits. This form of analysis is especially suitable for public health interventions, as it provides a clear descriptive summary of costs and benefits, easily understood by stakeholders in both health and non-health sectors (Trueman and Anokye, 2012). It presents a series of outcome measures alongside costs in the form of a cost-consequence balance sheet, which enables decision-makers to consider the most relevant outcomes (Drummond et al., 2005; Herman, 2012).

In the UK, NICE recommends cost-consequence analysis in addition to cost-utility analysis for evaluating public health interventions (NICE, 2012). Cost-consequence analysis is sometimes referred to as a *disaggregated* approach, because the benefits and costs are not combined in a single ratio such as ICERs in cost-utility analysis or benefit-cost ratios in return on investment analysis (Trueman and Anokye, 2012).

Limitations of cost-consequence analysis

Although cost-consequence analysis can provide clarity and transparency of costs and outcomes in public health interventions, it can only report on the limited number of outcomes measured in a clinical trial. There may be other unexpected outcomes which it is unable to capture. In addition, cost-consequence analysis can only report on the outcomes for the time duration of the clinical trial and may be unable to measure longer-term outcomes (Gage et al., 2006).

1.10 Cost-effectiveness analysis

Although cost-effectiveness has become synonymous with economic evaluation and value for money, cost-effectiveness analysis expresses costs in monetary terms and outcomes in units of health with no attempt to assign monetary values to outcomes. In this method of analysis, the total costs of an intervention are compared with a single common outcome

measure such as back pain reduced (Chapter 7), QALYs gained (Chapter 8) or sickness absence days saved (Appendix 12).

Cost-effectiveness analysis can compare two or more public health interventions with the same condition-specific outcome measures at baseline and end-programme by calculating the difference in costs and the difference in effects (Herman, 2012). This makes it possible to determine incremental cost-effectiveness ratios, enabling competing interventions to be compared (Polinder et al., 2011):

$$\text{ICER} = \frac{\text{Cost of intervention 1} - \text{Cost of intervention 2}}{\text{Effect of intervention 1} - \text{Effect of intervention 2}}$$

Limitations of cost-effectiveness analysis

The main limitation of cost-effectiveness analysis is that it compares total costs with only one primary outcome measure from an intervention, whereas in practice, many public health interventions result in a variety of health benefits. The use of a single outcome measure to capture all the benefits of health interventions invariably precludes other important benefits from being evaluated (Gage et al., 2006).

1.11 Cost-utility analysis

Cost-utility analysis is a type of cost-effectiveness analysis (Phillips, 2005). NICE recommends cost-utility analysis as the preferred method of economic evaluation for public health interventions and suggests that it be undertaken from the healthcare perspective (NICE, 2012).

Both cost-effectiveness analysis and cost-utility analysis compare the costs of competing health interventions with one primary outcome measure. In cost-utility analysis, the primary outcome measure is a generic instrument of health-related quality of life, such as the EQ5D.

Using cost-utility analysis, ICERs are expressed in terms of cost per QALY. ICERs compare the cost of a healthcare intervention with a generic outcome measure assessing health-related quality of life (Moayyedi and Mason, 2004; Drummond et al., 2005; Morris, et al., 2007). ICERs can then be compared with a threshold ICER to estimate the probability of cost-effectiveness (Phillips, 2005).

In the UK, NICE suggests a threshold of £20,000 per QALY, which means that if an intervention costs £20,000 or more for each quality-adjusted life-year gained, then the intervention is not recommended (NICE, 2012). Many decision-makers maintain that interventions with a cost of less than £20,000 per QALY are reasonably cost-effective.

However, recent research suggests that a threshold of £13,000 per QALY may provide an even more accurate measure of cost-effectiveness (Claxton et al., 2015).

Calculating QALYs

QALYs provide a common currency for assessing improvements in quantity and quality of life generated by healthcare interventions (Phillips, 2005). The most widely-used and preferred instrument for calculating QALYs is the EQ5D, which is validated in many different patient populations (Devlin and Krabbe, 2013; Whitehead and Ali, 2010; NICE, 2012).

The EQ5D measures an individual's health state in five domains: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression (Janssen et al., 2012). For each of the five domains, there are three or five levels of response.

The EQ5D-3L includes the following response options:

- no problems
- some problems
- severe problem.

While the EQ5D-5L offers five options:

- no problems
- slight problems
- moderate problems
- severe problems
- extreme problems.

The EQ5D-5L was recently developed to enable greater sensitivity and responsiveness in measuring health-related quality of life (Devlin and Krabbe, 2013).

Individual response profiles for each of the EQ5D domains are scored on a scale where -0.594 is equivalent to a state valued as 'worse than death' and 1.0 is equivalent to 'full health' (Dolan, 1997; van Hout et al., 2012). Based on each individual's response profile, an EQ5D summary score is generated which indicates the health state for that individual. These summary scores are weighted and assigned an index value. There are index values for 243 possible health states using the EQ5D-3L and for 3,125 possible health states using the EQ5D-5L (Devlin and Krabbe, 2013).

In randomised controlled trials, EQ5D summary scores are generated for each individual in both intervention and control groups. The difference in effect between groups is measured by subtracting the mean EQ5D summary scores for the control group from the mean EQ5D

summary scores for the intervention group. This is then compared with the difference in costs between groups to generate the ICERs (Phillips, 2005).

Advantages of cost-utility analysis

By using widely-accepted generic measures such as the EQ5D, ICERs can be estimated. ICERs make it possible to compare the cost-effectiveness of competing healthcare interventions across diseases, populations, and programmes, and thus help to determine health-care priorities (Malek, 2001; Dix-Smith et al., 2009).

Limitations of cost-utility analysis

While QALYs provide an indication of the benefits gained from a healthcare intervention, these benefits are based only on the five dimensions of the EQ5D and therefore other important health benefits may be excluded. This is particularly relevant for public health interventions, which often provide a wider variety of health outcomes compared to medical technologies such as medicines and pharmaceuticals (Culyer and Wagstaff, 1993; Coast, 2004a; Phillips, 2005; Wailoo, et al., 2010).

There is also a concern that the generic instruments used in generating QALYs, (i.e., EQ5D, SF-6, HUI) may lack sensitivity, especially when comparing treatment groups for chronic health conditions, for individuals with less severe health problems and for those with emotional or mental health problems (Coast, 2004a; Phillips, 2005; McCabe, 2009; Wailoo, et al., 2010; Whitehead and Ali, 2012).

In addition, the QALY approach assumes that all QALYs have the same social value. Culyer (1992) referred to this as *QALY egalitarianism*, which can result in limited allocation of health resources to the socially disadvantaged, the severely ill and children (Whitehead and Ali, 2010). Although methods exist for *equity weighting* QALYs, these are rarely used due to insufficient evidence on appropriate weights (Waloo et al., 2010).

Finally, although cost-utility analysis provides a common currency (i.e., cost per QALY) upon which cost-effectiveness can be compared, this common currency often has little resonance with stakeholders from other non-health sectors (Trueman and Anokye, 2012).

In summary, cost-utility analysis relies on one outcome measure enabling some factors to be measured with varying degrees of sensitivity while missing others that are potentially important (McCabe, 2009). Nevertheless, by providing a common currency, cost-utility analysis can be a useful method to help inform decision-makers about the costs and benefits of healthcare interventions (Malek, 2001).

1.12 Return on investment analysis

Return on investment analysis (ROI), also referred to as cost-benefit analysis from the employer perspective, is used by decision-makers to evaluate the economic viability of workplace health promotion programmes (Tompa, et al., 2008). Cost-benefit analysis requires both costs and benefits to be measured in monetary terms. An intervention is considered worthwhile if the benefits exceed the costs (Drummond et al., 2005; McIntosh et al., 2010).

Cost-benefit analysis allows consideration for discounting, that is, including all costs and benefits over time, even those beyond the length of the intervention (Hutton and Rehfuess, 2006). With preventive health interventions, costs are likely to occur at the start and during the programme, while benefits may continue into the future (Rappanage et al., 2010). In this thesis, discounting was not considered since all benefits were measured within one year of baseline measurements.

Cost-benefit analysis explores whether the benefits of an intervention outweigh its costs, and by how much (Hutton and Rehfuess, 2006). An intervention is cost-effective when the net benefit (the difference between benefits and cost) is positive and the benefit-cost ratio is greater than 1.0. Estimating benefit-cost ratios make it possible for decision-makers to rank alternative interventions (Cellini and Kee, 2010; McIntosh et al., 2010).

Valuing benefits in cost-benefit analysis

For employers, an important benefit of workplace health interventions are reduced production loss costs from fewer sickness absence days. Production loss costs are *indirect costs* and defined as costs associated with lost or impaired ability to work due to sickness or illness (Brouwer et al., 1998). Since workplace health programmes may benefit employers by reducing sickness absence days, production loss costs often enter the cost-benefit equation from the benefit side (Gold et al., 1996).

Production loss costs are often measured in two ways: the human-capital approach and the friction-cost approach (McIntosh et al., 2010). The human-capital approach is the conventional method in economic evaluation and takes the perspective of the sick leave employee by counting every day of sick leave as a day of productivity lost (van den Hout, 2010).

The friction-cost approach, on the other hand, takes the perspective of the employer, counting every day of sick leave as a day of productivity lost until a replacement worker is found. Thus, the value of production loss costs using the friction-cost approach is usually less than the value using the human-capital approach. Research indicates that the friction

cost approach generates between 18% and 44% of the costs calculated using the human-capital approach (Hanley et al., 2012). Thus, the two methods can produce widely different results (van den Hout, 2010).

For both methods, production loss costs are conventionally calculated by multiplying the average daily wage rate by the number of sickness days saved (Drummond et al., 2005). However, research suggests that a median multiplier of 1.28 times the daily wage rate more accurately measures such factors as the cost of finding a suitable replacement worker, the time sensitivity of the absent worker's output and the team role played by the absent worker (Nicholson et al., 2006; Aboagye et al., 2015).

In addition to reduced production loss costs, workplace health interventions can produce intangible benefits, such as improved employee wellbeing and quality of life (Maraschke and Mujtaba, 2014). Although the value of intangible benefits can be difficult to estimate in monetary terms, they can be calculated using stated preference methods which attempt to estimate the willingness-to-pay for healthcare services (McIntosh et al., 2010). Interventions are cost-beneficial when the total willingness-to-pay is greater than the total cost of an intervention (Frew et al., 2014).

Advantages of cost-benefit analysis

In monetising benefits, cost-benefit analysis makes it possible to calculate the net benefit, benefit-cost ratio and return on investment of healthcare interventions (van Dongen et al., 2011). Net benefit is the sum of the benefits minus the costs. The benefit-cost ratio is derived by dividing the benefits by the costs. Return on investment is calculated using the formula:

$$\mathrm{ROI} = \frac{(\text{benefits} - \text{costs})}{\text{costs}} \text{x } 100$$

These three metrics make it possible for employers to compare a variety of workplace health promotion interventions (van Dongen et al., 2011). In addition, determining the willingness-to-pay makes it possible to monetise all the intangible benefits of health intervention (Frew et al., 2014; Herman, 2012; Birch and Donaldson, 2003).

Limitations of cost-benefit analysis

In practice, cost-benefit analysis is rarely used in healthcare because of the difficulty in assigning monetary values to intangible health benefits (Arvidson et al., 2010). Although willingness-to-pay is sometimes used to monetise benefits, this approach can be under-sensitive, biased (due in part to the way in which hypothetical questions are asked) and influenced by income levels which can favour interventions and diseases of the rich over the

poor (Gold et al., 1996; Cookson, 2003). Because of such difficulties with willingness-to-pay methods, NICE recommends cost-benefit analysis only as an adjunct to cost-utility analysis, where benefits are measured in costs per QALY (Cookson, 2003).

1.13 Social return on investment analysis

Social return on investment is a relatively new form of adjusted cost-benefit analysis which attempts to monetise the intangible benefits of healthcare interventions (Nicholls et al., 2012). To date, SROI is used primarily by third sector organisations such as social enterprises and charities as a means of comparing costs and benefits, and estimating social impact (Millar and Hall, 2012; Arvidson, et al., 2014). Recognising that intangible benefits are important, SROI takes a societal perspective by assigning evidenced-based values to the benefits accrued to all key stakeholders (Nicholls et al., 2012).

In this thesis, the SROI analysis uses two different methodologies for measuring social impact: a Cabinet Office approach and wellbeing valuation (chapter 10).

Cabinet Office approach

First documented in 2000, the methodology for calculating SROI has been refined and described in the Cabinet Office guide to social return on investment (Nicholls et al., 2012). This approach considers what benefits are relevant and significant to stakeholders and then assigns financial proxies to intangible benefits which do not typically have market values (Nicholls et al., 2012). Using financial proxies, the total benefits are estimated and then compared with the total costs to determine the SROI ratio (Nicholls et al., 2012).

Advantages of the Cabinet Office approach

The Cabinet Office methodology offers several advantages. It helps identify intangible benefits that are relevant and significant to stakeholders, including those which are not usually measured in more traditional forms of economic evaluation (Arvidson et al., 2010; Nicholls et al., 2012; Rauscher et al., 2012). The Cabinet Office approach also places a consistent focus on social impact, allowing for a wider understanding of the cost-effectiveness of interventions (Arvidson et al., 2010; Rauscher et al., 2012). Finally, SROI can be used as an evaluative measure for benchmarking as well as a forecasting tool for comparing possible investments (Arvidson et al., 2010; Rauscher et al., 2012).

Limitations of the Cabinet Office approach

As with cost-benefit analysis, SROI requires the monetisation of all significant and relevant outcomes and there is a lack of standardisation in the use of financial proxies to estimate the value of these outcomes (Arvidson et al., 2010; Rauscher et al., 2012). A scientifically

reliable comparison of SROI ratios is only possible when the same financial proxies are used to assess the same intervention at different time periods (Rauscher et al., 2012).

Wellbeing valuation approach

In order to provide a more standardised valuation method for comparing different programmes, Housing Association's Charitable Trust (HACT) has developed a wellbeing valuation approach. This approach draws on a HACT's Social Value Bank which contains methodologically consistent and robust social values for assessing social impact (Trotter et al, 2014).

Advantages of wellbeing valuation approach

One advantage of using the wellbeing valuation approach is that it provides a single, coherent methodology that enables comparison between SROI ratios. Increasingly, this approach is being used by social enterprises and charitable organisations (Fujiwara, 2014a). Wellbeing valuation is also used by a wide range of UK government departments including the Department for Business Innovation and Skills, and the Department for Work and Pensions (Fujiwara, 2014a). In 2011, this methodology was incorporated by the UK government in the HM Treasury Green Book as a method for appraising and evaluating proposals seeking funding (Fujiwara et al., 2014b).

Limitations of wellbeing valuation approach

Although the wellbeing valuation approach facilitates comparison of SROI ratios, the range of social values offered by the Social Value Bank is limited. With a current total of 53 outcomes, the Social Value Bank covers only the most common outcomes from community improvement programmes (Carpenter, 2015). When outcomes are not listed in the Social Value Bank, it is not possible to use wellbeing valuation (Carpenter, 2015).

In addition to the limitations of the Social Value Bank, the wellbeing valuation approach places less emphasis on stakeholder engagement (Leach, 2014). Without stakeholder engagement, it is likely that relevant and significant outcomes may be overlooked (Fujiwara, 2014a).

Finally, there is a lack of consensus regarding which measure of wellbeing should be used in the wellbeing valuation (Powdthavee and van den Berg, 2011). Different measures can result in different valuations. Frequently, the monetary values of wellbeing are smaller when life satisfaction or cognitive wellbeing measures are used and larger for more affective or domain-specific wellbeing measures (Powdthavee and van den Berg, 2011).

Comparing approaches

Although both the Cabinet Office approach and wellbeing valuation can be used to calculate SROI ratios, these two methods differ in how stakeholders are involved, how change is measured, how outcomes are valued and how deadweight is calculated (Table 1.2)

Table 1.2: Comparing the Cabinet Office approach and wellbeing valuation

Principle	Cabinet office approach	Wellbeing valuation
Involve stakeholders	• Involves stakeholders in identifying and valuing outcomes	• No direct engagement with stakeholders
Measuring what changes	• Uses valid and reliable outcome measures	• Uses outcome measures correlated with large national surveys
Valuing outcomes	• Assigns financial proxies using a revealed preference approach • Includes a risk of bias and over/under-estimation	• Assigns values from the Social Value Bank based on existing national datasets and representing the actual experience of individuals
Calculating deadweight	• Encourages use of control groups • Recommends investigating how much of the outcome was caused by other factors	• Applies a standardised measure of deadweight based on the type of intervention (i.e. health, youth, local employment, environment)

Comparing SROI with cost-benefit analysis

While cost-benefit analysis is a long-established method of economic evaluation used to determine whether an intervention is worthy of investment, SROI is a relatively recent approach undertaken by not-for-profit organisations to measure social impact (Arvidson, 2010).

In cost-benefit analysis, benefit-cost ratios are often calculated to help decision-makers compare competing interventions. In SROI, however, benefit-cost ratios are rarely compared due to the wide variety of financial proxies used in monetising social impact.

In addition, where traditional cost-benefit analysis tends to emphasise only economic costs and benefits, SROI takes a 'triple bottom-line' approach by attempting to place monetary values on all important economic, environmental and social outcomes (Vardakoulias, 2013).

In the cost-benefit analysis section of this thesis (chapter 9), reductions in back pain are monetised by calculating the difference in production loss costs from fewer sickness absence days between the yoga and usual care groups. In the SROI section (chapter 10), reductions in back pain are monetised not only by the difference in production loss costs

between groups, but also by improved employee wellbeing and enhanced health-related quality of life. SROI attempts to provide a framework for incorporating 'wellbeing' into cost-benefit analysis (Vardakoulias, 2013).

1.14 Research questions and novel contributions

The principal aim of this thesis is to undertake a broad economic evaluation, using multiple methods, of yoga for managing musculoskeletal conditions in the workplace. To achieve this aim, the following research questions are addressed and the novel contributions are identified:

Thesis Chapter 1

Research Question 1: *What are the costs of back pain to employers in the UK and how effective is yoga in addressing these costs?*

Novel Contribution: This is the first study to offer a broad economic evaluation of yoga, using multiple methods, for managing musculoskeletal conditions in the workplace.

Thesis Chapter 2

Research Question 2: *Given there are no published cost-effectiveness studies of yoga in workplace settings, what is the existing literature on the effectiveness of yoga in the workplace?*

Novel Contribution: This is the first systematic review, based on PRISMA guidelines, of randomised trials that investigate the effectiveness of yoga in workplace settings.

Thesis Chapter 3

Research Question 3: *Using evidence from the pragmatic randomised controlled trial conducted for this thesis, how effective is yoga for managing back pain in the workplace?*

Novel Contribution: This is the largest randomised controlled trial of yoga in a workplace setting to assess changes in back pain (n=151). In addition, two different back pain scales are used: the Roland-Morris Disability Questionnaire to assess physical symptoms and the Keele STarT Back Screening Tool to measure both physical and psychosocial indicators.

Thesis Chapter 4

Research Question 4: *What is the employee experience of a yoga in the workplace?*

Novel Contribution: This is the first qualitative study of yoga in a workplace setting. It uses focus groups and thematic analysis to understand the experience of employees participating in the yoga programme.

Thesis Chapter 5

Research Question 5: *What are the direct costs to the employer in implementing a workplace yoga programme?*

Novel Contribution: Four different scenarios are used to calculate a range of direct costs for implementing a workplace yoga programme. This yoga programme includes 48 sessions in three NHS hospitals over eight weeks.

Thesis Chapter 6

Research Question 6: *What are the costs and disaggregated consequences of yoga in a workplace setting?*

Novel Contribution: This is the first cost-consequence analysis of yoga in a workplace setting. Four different cost scenarios are compared against a number of disaggregated outcomes including back pain, psychological wellbeing, resilience, physical exhaustion, rejuvenation, tranquillity and positive engagement.

Thesis Chapter 7

Research Question 7: *What is the range of incremental cost-effectiveness ratios of yoga compared with usual care for reducing back pain in the workplace?*

Novel Contribution: Using reduced back pain as the primary outcome measure, this is the first cost-effectiveness analysis of yoga in the workplace. Drawing upon recent research in wellbeing valuation, a novel hypothetical cost-effectiveness threshold of £1,300 per one point RDQ reduction in back pain is used in calculating the ICERs.

Thesis Chapter 8

Research Question 8: *What is the range of incremental cost-effectiveness ratios of yoga compared with usual care for improving health-related quality of life in the workplace?*

Novel Contribution: This is the first cost-utility analysis of yoga for improving the health-related quality of life among employees in a workplace setting.

Thesis Chapter 9

Research Question 9: *What is the return on investment for employers when implementing a yoga-based programme for managing musculoskeletal conditions in the workplace?*

Novel Contribution: This is the first return on investment analysis of yoga for managing musculoskeletal conditions in the workplace.

Thesis Chapter 10

Research Question 10: *What is the social return on investment of yoga for managing musculoskeletal conditions at work?*

Novel Contribution: This is the first social return on investment analysis of a workplace yoga programme. Two different methodologies are used to calculate the SROI ratios: a Cabinet Office approach and wellbeing valuation. Both methods use costs and benefits accrued to the three main stakeholders: NHS employees, NHS as the employer and NHS as the health service provider.

Thesis Chapter 11

Research Question 11: *Using yoga in the workplace as a case study, what is the value and generalisability to the key stakeholders of a multiple method approach to economic evaluation?*

Novel Contribution: This is the first study of yoga in the workplace (or in any setting) to incorporate a broad economic evaluation using five different methodologies. The value of this broad approach to the main stakeholders is explored.

Chapter 2: A systematic review of yoga in the workplace

2.1 Chapter summary

A systematic review was conducted of randomised trials of yoga in workplace settings. A comprehensive search of relevant electronic databases was performed. Eight randomised trials met the inclusion criteria. The results indicated that yoga's effectiveness in the workplace was *strong* for musculoskeletal conditions, *moderate* for perceived stress, *limited* for sleep quality and *conflicting* for heart rate variability. Overall, the evidence was promising, yet limited due to a lack of high quality studies of yoga in workplace settings.

2.2 Introduction

Systematic reviews offer a comprehensive approach to summarising evidence from randomised trials (Freeman et al., 2006). Because the results of randomised controlled trials are often contradicted by subsequent studies, systematic reviews are necessary to increase precision and to minimise bias in measuring the effectiveness of public health interventions. Systematic reviews begin with a specific question, followed by a detailed search for all relevant evidence and then a critical appraisal of evidence using predetermined tools for assessing quality and bias (Freeman et al., 2006).

A systematic review investigating the economic evaluation of yoga in workplace settings yielded no published studies. Two cost-effectiveness papers were found on yoga for patients with back pain, but neither of these studies investigated the financial return for employers implementing yoga for their employees (Aboagye et al., 2015; Chuang et al., 2012).

Due to the lack of economic evaluation on yoga in workplace settings, the specific question addressed in this systematic review is the degree to which yoga can improve the health and wellbeing of employees in occupational settings. Since no previously published systematic reviews were found on yoga in the workplace, a comprehensive search of multiple databases was undertaken by two researchers. Eight randomised trials met the inclusion criteria.

All eight studies were rated by the two reviewers for methodological quality and risk of bias. In addition, quantitative results were extracted from each study to assess the effect of yoga on employee populations. Outcomes for these studies included valid and reliable measurements for back pain, musculoskeletal conditions, grip strength, heart rate variability and perceived stress.

This systematic review is reported using guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Liberati et al., 2009), listed in Appendix 1. A structured abstract is provided in Appendix 2.

2.3 Methods

Search strategy

Four electronic databases - CINAHL, Medline, Pubmed, and Science Direct - were searched from their inception to 11 September 2014. A PICO search strategy was developed and search terms were selected, modified and applied to each database (Table 2.1). For example, the search strategy for Pubmed yielded 32 articles by combining the following key words: 'yoga' and ('occupational health' or 'employee' or 'workplace'). The age group was identified as working age adults between 18 and 65 years, and no limits were placed on language or year of publication.

Table 2.1: Application of PICO search strategy

PICO search strategy	Application	Search terms
Patient/Population	Employees at work (ages 18 – 65)	'occupational health' or 'employee' or 'workplace'
Intervention/Exposure	Yoga	'yoga'
Comparison	Randomised trials	'randomised controlled trial' or 'randomised trial'
Outcome	Improved physical and mental health	'stress' or 'depression' or 'anxiety' or 'mental health' or 'psychological health' or 'physical health' or 'wellbeing' or 'back pain' or 'musculoskeletal' or 'heart rate'.

Inclusion criteria

Studies were included in the systematic review if they met the following criteria:

- primary or comparison intervention was yoga
- population was employees
- study design was a randomised trial
- paper was published in a peer-reviewed journal
- paper was available as a full-text.

When full-text copies of studies were difficult to obtain from the electronic search, direct requests were made to the authors. Reference lists from the included studies were reviewed in order to locate additional studies. All studies were assessed for relevance against the inclusion criteria (Figure 2.3 at end of chapter 2).

Data extraction

Relevant information from the included studies was extracted by the author of this thesis using an adapted data extraction and critical appraisal form (see Appendix 3 for a worked example).

A second reviewer checked the extracted data from each included study. Working together, both researchers assessed each study for methodological quality and risk of bias. Differences of opinion were resolved through discussion and consensus. When consensus was not achieved (one occasion), the final decision was made by the author of this thesis.

Quality assessment

Methodological quality was measured by both reviewers (working together) using two scales: the broader five-item Jadad Scale (1996) and the more detailed eleven-item PEDro Scale (Verhagen et al., 1998). Both scales have been used previously in systematic reviews of yoga interventions and both have been shown to be valid and reliable (Moseley et al., 1999; Maher et al., 2003; Lin et al., 2011; Ward et al., 2013).

The Jadad scale was developed in 1996 by Alejandro Jadad-Bechara and colleagues at the University of Oxford in England. It has become the most commonly-used measure to assess the quality of clinical trials (Olivo et al., 2008). The five-item scale evaluates clinical trials according to randomisation, blinding, and withdrawals/drop-outs, allocating a score of between zero (very poor quality) and five (rigorous quality).

In this systematic review, Jadad scores of $\geq$4 were considered of *high quality*, 3 was considered *medium quality* and scores of $\leq$ 2 were *low quality.*

The PEDro Scale was developed in 1998 by Arianne Verhagen and colleagues at the University of Maastricht in the Netherlands (Sherrington et al., 2000). The eleven-item scale was created to assess the quality of trials on the Physiotherapy Evidence Database (PEDro). This enabled database users to identify trials of high quality (Sherrington et al., 2000).

In this study, a PEDro score of $\geq$ 8 was considered *high quality*, PEDro scores of 6 or 7 were *medium quality* and PEDro scores of $\leq$ 5 were considered *low quality*.

Risk of bias

Risk of bias was assessed by both reviewers working together using the 7-point Cochrane Collaboration tool (Higgins et al., 2011), which has been previously used in the assessment of yoga interventions (Posadski and Ernst, 2011; Cramer et al., 2013a; Ward et al., 2013). The Cochrane tool assesses bias in the seven domains listed in Table 2.2.

Table 2.2: Cochrane Collaboration tool for risk of bias

Random sequence generation (selection bias)	Low risk if all participants had the same possibility of being placed into treatment or wait-list, and if the investigator was unable to predict treatment allocation for each participant.
Allocation concealment	Low-risk if randomisation was assigned using serially numbered, opaque, sealed envelopes, and there appears to be convincing evidence of concealment.
Blinding of participants and personnel	Low risk if another active intervention is used.
Blinding of outcome assessor (detection bias)	Low risk if outcome assessors are blinded.
Incomplete outcome data (attrition bias)	Low-risk if fewer than 20% of participants were lost to follow-up, and reasons for loss were similar in both treatment and wait-list groups. High-risk if more than 20% of participants were lost to follow-up, and reasons for loss differed between treatment arms.
Selective reporting (reporting bias)	Low-risk if free from suggestion of selective outcome reporting. High-risk if suggestive of selective outcome reporting.
Other sources of bias (i.e., financial conflict of interest)	Low-risk if unlikely that other sources of bias influenced the results. Unclear if other sources of bias may have influenced the results. High-risk if likely that other sources of bias influenced the results.

For each of the seven domains of the Cochrane tool, the eight studies in this systematic review were assessed as *low risk* if they scored $\geq$ 4 points, *medium risk* if they scored 3, and *high risk* if they scored $\leq$ 2 points (Higgins et al., 2011).

In general, the characteristics of high quality and low-risk trials include (Jadad et al., 1996; Verhagen et al., 1998; Higgins et al., 2011):

- appropriate randomisation and allocation concealment
- similar characteristics for intervention and control groups
- blinding of participants, instructors and outcome assessors
- complete outcome data from 80% of study participants
- reporting all outcomes and reasons for withdrawals and dropouts
- providing between-group p-values with standard deviations/standard errors.

Overall levels of evidence

The overall strength of evidence for the effectiveness of yoga in the workplace was assessed using the criteria from the Cochrane Collaboration Back Review Group. These criteria identify different levels of evidence (van Tulder et al., 2003): *strong*, *moderate*, *limited*, *conflicting* and *no evidence* (Table 2.3).

Table 2.3: Levels of Evidence

Strong evidence	consistent findings among multiple randomised controlled trials (RCTs)
Moderate evidence	consistent findings among multiple low quality RCTs or controlled clinical trials (CCTs) and/or one high quality RCT
Limited evidence	one low quality RCT or CCT
Conflicting evidence	inconsistent findings among multiple trials (RCTs and/or CCTs)
No evidence	no RCTs or CCTs

2.4 Results

Electronic searches of four databases - CINAHL, Medline, Pubmed and Science Direct - returned 1,594 papers. After duplicate removal, screening and searching of other sources, eight studies remained (Figure 2.1). These eight trials were conducted between 1998 and 2014 in the USA, Australia, India, Sweden, the Netherlands and the UK.

These selected studies included a total of 837 participants and were predominantly conducted at one worksite using a randomised controlled design with an intervention group and a control group. Most studies specified a particular style of yoga: Hatha, Iyengar, Kundalini or Dru. Although these styles were similar in that they offered a programme of movement, breathing exercises and relaxation, they differed in the way these three components were taught.

Heterogeneity was also found in other aspects of the yoga interventions: the number of participants in these eight studies ranged from 37 to 291; the duration of individual yoga sessions ranged from 50 minutes to 90 minutes; the frequency of yoga sessions ranged from 1 to 5 times per week; and the length of studies ranged from 6 weeks to 12 weeks.

Participant completion rates in these eight studies ranged from 41% to 97%. Five studies reported home practice as a component of the intervention. Control groups were mostly passive interventions such as usual care, wait-list or education. Two of the studies included an active comparison intervention: cognitive behavioural therapy (Granath et al., 2006) and mindfulness (Wolever et al., 2012).

The eight studies were mostly heterogeneous in terms of clinical conditions assessed. These included outcome measures for: musculoskeletal discomfort, grip strength, back pain, hip flexibility, heart rate variability, perceived stress, psychological wellbeing, and state-trait anxiety.

The assessments for methodological quality ranged from 2 to 4 on the Jadad scale (Table 2.4) and from 5 to 9 on the PEDro scale (Table 2.5). Assessments for risk of bias ranged from 9 to 19 on the Cochrane scale (Table 2.6).

Table 2.4: Jadad scale

Study	Random sequence generation	Appropriate random methods	Blinding outcome assessors	Blinding participants and personnel	Dropouts	Sum (Jadad score)	Quality rating
Cheema 2013	1	1	1	0	1	4	High
Garfinkel 1998	1	1	1	0	1	4	High
Granath 2006	1	1	0	0	1	3	Medium
Hartfiel 2011	1	1	0	0	1	3	Medium
Hartfiel 2012	1	1	0	0	1	3	Medium
Joshi 2009	1	0	0	0	1	2	Low
Telles 2009	1	1	1	0	0	3	Medium
Wolever 2012	1	1	0	0	1	3	Medium

Table 2.5: PEDro Scale

	Cheema 2013	Garfinkel 1998	Granath 2006	Hartfiel 2011	Hartfiel 2012	Joshi 2009	Telles 2009	Wolever 2012
Eligibility criteria	1	1	1	1	1	1	1	1
Randomisation	1	1	1	1	1	1	1	1
Allocation concealment	1	1	0	0	0	0	0	0
Similar at baseline	1	1	1	1	1	0	1	1
Blinding of participants	0	0	0	0	0	0	0	0
Blinding of instructors	0	0	0	0	0	0	0	0
Blinding of assessors	1	1	0	0	0	0	1	0
80% completion rate	1	1	1	1	1	1	0	1
Intention to treat	1	1	1	1	1	1	1	1
Between-group (p-value)	1	0	1	1	1	0	1	1
Point measure (SD/SE)	1	1	1	1	1	1	1	1
Total	**9**	**8**	**7**	**7**	**7**	**5**	**7**	**7**
Quality rating	**high**	**high**	**med**	**med**	**med**	**low**	**med**	**med**

Table 2.6: Cochrane Collaboration tool for risk of bias

1=low risk; 2=medium risk; 3=high risk

	Cheema 2013	Garfinkel 1998	Granath 2006	Hartfiel 2011	Hartfiel 2012	Joshi 2009	Telles 2009	Wolever 2012
Random sequence generation	1	1	1	1	1	2	1	1
Allocation concealment	1	1	2	2	2	3	2	2
Blinding of participants	3	3	3	3	3	3	3	3
Blinding of assessors	1	1	3	3	3	3	2	3
Incomplete outcome data	1	1	1	1	1	3	3	1
Selective outcome reporting	1	2	2	2	2	3	2	2
Other sources of bias	1	2	1	1	1	2	1	1
Total	**9**	**11**	**13**	**13**	**13**	**19**	**14**	**13**
Risk rating	**low**	**low**	**med**	**med**	**med**	**high**	**med**	**med**

The eight studies are summarised below in alphabetical order:

1) Cheema et al., 2013 examined the effects of a ten-week hatha yoga programme for 37 university employees in Australia. The yoga group (n=18) attended three 50 minute classes per week. The primary outcome measure was heart rate variability. All measures of heart rate variability failed to show a significant change in the yoga group compared with the control group. However, hip flexibility significantly improved in the yoga group. This paper scored high quality on the PEDro and Jadad scales, and low risk of bias on the Cochrane tool.

2) Garfinkel et al., 1998 assessed the effects of an eight-week Iyengar yoga intervention on 51 employees with carpal-tunnel syndrome in the United States. The yoga group attended two 90 minute classes each week. Pre-test/post-test results indicated that participants in the yoga group (n=22), compared to the wrist-splint control group (n=22), showed significant improvements in grip strength and pain reduction. Nine

participants withdrew from the study, no reasons were provided for withdrawal. This paper scored high quality on the PEDro and Jadad scales, and low risk of bias on the Cochrane tool.

3) Granath et al., 2006 measured the effects of a ten-session Kundalini yoga programme for managing stress for 37 employees within a Swedish company. The yoga group (n=18) attended 10 sessions over an eleven week period. Pre-test/post-test results indicated significant reductions in perceived stress and exhaustion for the yoga group. Four participants dropped out of the programme. Due to the lack of blinding of participants and assessors, this paper scored medium quality on the PEDro and Jadad scales, and medium risk of bias on the Cochrane tool.

4) Hartfiel et al., 2011 evaluated the effects of a six-week Dru Yoga programme for improving well-being and resilience among 48 UK university employees. The yoga group (n=20) attended one 60 minute class per week and received a 35 minute yoga CD for home practice. Seven of the eight criteria measuring mood and psychological wellbeing showed significant improvements for the yoga group compared to the wait-list control group. Eight participants dropped out, four from each group. Due to the lack of blinding of participants and assessors, this paper scored medium quality on the PEDro and Jadad scales, and medium risk of bias on the Cochrane tool.

5) Hartfiel et al., 2012 investigated the effects of an eight-week Dru Yoga intervention on perceived stress among a group of 74 local government employees in the UK. The yoga group (n=37) attended one 50 minute class per week and using a CD, practised at home twice per week for 20 minutes. In comparison to the control group, the yoga group reported significant reductions in perceived stress. The drop-out rate was 20% with most of the withdrawals from the wait-list control group. Due to the lack of blinding of participants and assessors, this paper scored medium quality on the PEDro and Jadad scales, and medium risk of bias on the Cochrane tool.

6) Joshi et al., 2009 evaluated the effects of a twelve-week yoga programme on musculoskeletal discomfort in 60 professional computer users in India. The yoga group (n=29) attended three 60 minute classes per week. The authors reported a significant reduction in the Boston Carpal Tunnel Questionnaire and a cervico-thoracic symptom severity score. Two withdrawals were reported. However, due to a general lack of detail about the methods and results of this study, this paper scored low quality on the PEDro and Jadad scales, and high risk of bias on the Cochrane tool.

7) Telles et al., 2009 discussed the effects of an eight-week yoga programme on musculoskeletal discomfort and motor function in 291 professional computer users in India. The yoga group (n=146) attended five 60 minute classes each week. The results indicated that the yoga group experienced significant changes including: decreased musculoskeletal discomfort, increased hand grip strength, increased right hand tapping speed, and increased hip flexibility. However, only 40% of the participants completed the programme. This paper scored medium quality on the PEDro and Jadad scales, and medium risk of bias on the Cochrane tool.

8) Wolever et al., 2012 investigated the effects of a twelve-week Viniyoga stress reduction programme on a group of 239 employees in an American insurance company. The yoga group (n=90) attended one 60 minute class per week and received hand-outs and a DVD for home practice. Wolever found that the yoga group showed significantly greater reductions in perceived stress and improvements in sleep quality than the control group. The drop-out rate was 14%. Due to the lack of blinding of participants and assessors, this paper scored medium quality on the PEDro and Jadad scales, and medium risk of bias on the Cochrane tool.

The results from these eight yoga studies were grouped into four main categories:

- musculoskeletal conditions
- perceived stress
- sleep quality
- heart rate variability.

Musculoskeletal conditions

Five randomised controlled trials assessed the effectiveness of yoga for alleviating musculoskeletal conditions at work. Garfinkel et al. (1998) reported significant pain reduction among 22 yoga participants with carpal tunnel syndrome. Garfinkel and Telles et al. (2009) found that yoga was effective for improving grip strength. Telles and Joshi et al. (2009) reported that yoga was effective for reducing musculoskeletal discomfort among computer users in India.

In the UK, Hartfiel et al. (2012) found that yoga helped to alleviate back pain among government employees. In India and Australia, Cheema et al. (2013) and Telles et al. (2009) reported that yoga significantly improved hip flexibility. These results were promising and provided strong evidence for the effectiveness of yoga for improving musculoskeletal conditions in the workplace (Table 2.7).

Stress reduction

Three randomised trials evaluated yoga for reducing perceived stress. Granath et al., (2006), Wolever et al. (2012) and Hartfiel et al. (2012) all reported significant reductions in perceived stress from practising yoga in the workplace. Both Wolever and Hartfiel used the more common 10-item Perceived Stress Scale, while Granath used the 14-item version (Cohen, 1983).

Different types of yoga were used in these studies and the length of the programmes varied. Granath used a ten-week programme of Kundalini yoga in Sweden, Wolever a twelve-week Viniyoga intervention in the United States and Hartfiel an eight-week Dru Yoga programme in the UK. Although these results were consistently favourable toward yoga, they indicated only moderate evidence for reducing perceived stress at work. This was due to the lack of high quality studies (Table 2.7).

Sleep quality

Two randomised controlled studies measured the effect of yoga on sleep quality. In the Wolever study of 90 Viniyoga participants, significant improvements in sleep quality were reported. In the Garfinkel study of 22 Iyengar yoga participants, reductions in sleep disturbance were noted in participant diaries. However, because the reduction in sleep disturbance was not statistically significant in the Garfinkel study, there appears to be only limited evidence on the effectiveness of yoga for improving sleep quality among employees (Table 2.7).

Heart rate variability

Two randomised trials measured the effects of yoga on heart rate variability. In the United States, Wolever et al. (2012) found a significant improvement in heart rate variability. In Australia, Cheema et al. (2013) reported no significant improvement for the yoga group compared to the control group. Thus, conflicting evidence is reported for the effectiveness of yoga in improving heart rate variability (Table 2.7).

Table 2.7: Comparing studies

Source	Initial (n=)	Age (years)	Yoga style	Control group(s)	Time period	Frequency	Home practice	Rate of completion	Adverse events	Quality rating	Risk of bias	Outcome measures	Mean Difference (SD)	Result
Cheema, 2013	37	mean=38	Hatha	Wait-list	10 weeks	3 x per week 50 min class	No	34 of 37 92%	No	High	Low	Heart rate variability Sit and reach	0.20 (±0.26) 4.1 (±1.04)	p= 0.48 p< 0.001
Garfinkel, 1998	51	24 to 77	Iyengar	Wrist Splint	8 weeks	2 x per week 90 min class	No	42 of 51 82%	Not reported	High	Low	Grip strength Sleep quality	19.2 (± 2.12) Not reported	p= 0.009 p= 0.26
Granath, 2006	37	working age	Kundalini	CBT	10 weeks	1 x per week # of minutes unreported	No	33 of 37 89%	Not reported	Medium	Medium	Perceived stress	-0.39 (± 0.24)	p< 0.01
Hartfiel, 2011	48	mean=39	Dru	Wait-list	6 weeks	1 x per week 60 min class	Yes	40 of 48 83%	Not reported	Medium	Medium	Self-confidence in dealing with stress	1.04 (± 0.32)	p= 0.001
Hartfiel, 2012	74	mean=45	Dru	Wait-list	8 weeks	1 x per week 50 min class	Yes	59 of 74 80%	Not reported	Medium	Medium	Back pain Perceived stress	1.17 (±0.35) -2.40 (±0.66)	p< 0.01 p< 0.01
Joshi, 2009	60	mean=33	Iyengar	Counselling	12 weeks	3 x per week 60 min class	No	58 of 60 97%	Not reported	Low	High	Symptom Severity Functional Status	-0.17 (±0.11) -0.06 (±0.08)	p= 0.002 p= 0.06
Telles, 2009	291	21 to 49	Not specified	Wait-list	8 weeks	5 x per week 60 min class	No	118 of 291 41%	Not reported	Medium	Medium	Musculoskeletal Discomfort Grip strength Sit and reach	-10.07 (±0.54) 0.65 (±0.54) 10.4 (±0.53)	p< 0.001 p< 0.05 p< 0.001
Wolever, 2012	239	mean=42	Viniyoga	Mindfulness Usual care	12 weeks	1 x per week 60 min class	Yes	205 of 239 86%	Not reported	Medium	Medium	Perceived stress Sleep Quality Heart rate variability	-4.01 (±0.14) -1.11 (±0.11) 0.50 (±0.04)	p< 0.001 p< 0.05 p< 0.001

Sensitivity analysis with studies by author removed

Two of the eight studies which met the inclusion criteria (Hartfiel et al., 2011; Hartfiel et al., 2012) were written by the author of this systematic review. To prevent author bias, a sensitivity analysis was performed excluding these two studies (Table 2.8). The results from the remaining six studies were consistent with the findings from the full systematic review in each of the four categories: musculoskeletal conditions, perceived stress, sleep quality, and heart rate variability.

Table 2.8: Sensitivity analysis with studies by author removed

Study	Yoga group (n=)	Control group (n=)	Outcome measures	Mean difference (SD)	Between group P-values
Musculoskeletal conditions					
Garfinkel 1998	26	25	Grip strength	19.2 (± 2.12)	p=0.02
Telles 2009	62	56	CMDQ	-10.07 (±0.54)	p<0.01
Joshi 2009	29	29	BCTQ	-0.17 (±0.11)	p=0.002
Cheema 2013	18	19	Sit and reach test	4.1 (±1.04)	p<0.001
Telles 2009	62	56	Sit and reach test	10.4 (±0.53)	p<0.001
Perceived stress					
Granath 2006	17	17	PSS (14-item)	-0.39 (± 0.24	p<0.01
Wolever 2012	90	53	PSS (10-item)	-4.01 (±0.14)	p<0.01
Sleep quality					
Garfinkel 1998	26	25	Sleep diary	Not reported	p=0.26
Wolever 2012	90	53	PSQI	-1.11 (±0.11)	p<0.05
Heart rate variability					
Cheema 2013	18	19	Sphygmocor	0.20 (± 0.26)	p=0.48
Wolever 2012	90	53	emWave sensor	0.50 (±0.04)	p<0.001

PSS= Perceived Stress Scale; PSQI= Pittsburgh Sleep Quality Index; CMDQ= Cornell Muscular Discomfort Questionnaire; BCTQ= Boston Carpal Tunnel Questionnaire

Meta-analysis of outcome measures used in two or more studies

While there was significant heterogeneity among outcomes measures used in the eight included studies, both Wolever et al. (2012) and Hartfiel et al. (2012) investigated perceived stress using the same 10-item Perceived Stress Scale. In addition, Cheema et al. (2013) and Telles et al. (2009) evaluated hip flexibility with the Sit and Reach Test.

Meta-analysis was used to synthesize the evidence for reducing perceived stress and improving hip flexibility (Dietz et al., 2015). A continuous random effects model was used to weight Log Response Ratio (LnRR) measures from the studies using the OpenMEE meta-analysis software (Dietz et al., 2015).

Table 2.9: Meta-analysis for hip flexibility and perceived stress

Study	Weight	Log Response Ratio (LnRR)	Overall LnRR [95% CI]	SE	p-values for overall effect	Heterogeneity Tests (p-value, I^2)
Hip Flexibility	Telles = 50.7% Cheema = 49.3%	Telles = 3.31 Cheema = 1.54	2.40 [0.7, 4.2]	0.88	0.006	0.001, 90.5%
Perceived stress	Wolever = 52.6% Hartfiel = 47.4%	Wolever = 0.67 Hartfiel = 2.20	1.40 [-0.1, 2.9]	0.76	0.067	0.001, 92.1%

Meta-analysis (Table 8.2) indicated that the overall effect of yoga on hip flexibility was statistically significant (0.006). The overall effect of yoga on perceived stress, however, was marginally non-significant (p=0.067), suggesting that more high quality studies are needed to evaluate the effect of yoga on perceived stress in the workplace (Chong et al., 2011).

Meta-analysis also showed significant heterogeneity between the Wolever and Hartfiel studies evaluating perceived stress (Table 2.8, Figure 2.1) as well as between Cheema and Telles assessing hip flexibility (Table 2.8, Figure 2.2). Statistical heterogeneity was quantified by using p-values and I^2 statistics, where $I^2 > 75\%$ was regarded as considerable heterogeneity (Cramer et al., 2013a).

Figure 2.1: Forest plot of Wolever and Hartfiel studies assessing perceived stress

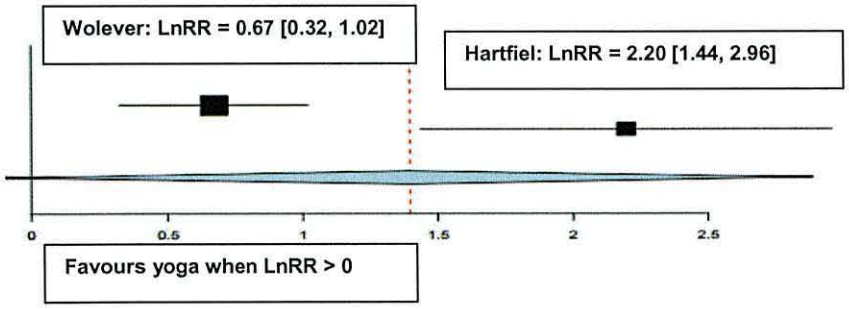
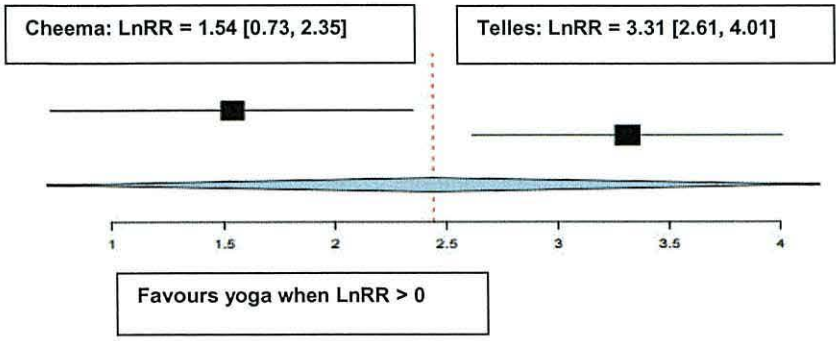


Figure 2.2: Forest plot of Telles and Cheema studies assessing hip flexibility



2.5 Discussion

This systematic review identified eight randomised trials investigating the effectiveness of yoga in workplace settings. The results suggest that yoga's effectiveness in the workplace was strong for musculoskeletal conditions, moderate for perceived stress, limited for sleep quality and conflicting for heart rate variability.

Musculoskeletal conditions

One high quality study (Garfinkel et al., 1998) and one medium quality study (Telles et al., 2009) reported that yoga improved musculoskeletal conditions in terms of grip strength for employees with carpel tunnel syndrome. One high quality study (Garfinkel et al., 1998), two medium quality studies (Telles, et al., 2009; Hartfiel et al., 2012) and one low quality study (Joshi et al., 2009) all reported that yoga helped to reduce musculoskeletal pain, whether in the wrists and hands (Garfinkel et al., 1998 and Telles et al, 2009), the neck and shoulders (Joshi et al., 2009 and Telles, et al., 2009) or in the upper or lower back (Hartfiel et al., 2012 and Telles et al., 2009).

While this evidence is promising, each of these studies used different styles of yoga, different dosages of yoga, and different outcome measures to assess musculoskeletal improvement. Using Iyengar yoga once per week for ten weeks, Garfinkel et al. (1998) measured grip strength with a sphygmomanometer cuff and assessed musculoskeletal pain using a visual analogue scale. Using an undefined style of yoga five times per week for eight weeks, Telles et al. (2009) measured grip strength with a hand grip dynamometer and assessed pain using the Cornell Musculoskeletal Questionnaire.

In addition, Hartfiel et al. (2012) used Dru Yoga, once per week for eight weeks and the Roland Morris Disability Questionnaire (RDQ) to measure musculoskeletal pain, while Joshi et al. (2009) used an undefined style of yoga, three times per week for twelve weeks and the Boston Carpal Tunnel Questionnaire. Cheema et al. (2013) used hatha yoga, three times per week for ten weeks and measured musculoskeletal improvement with a 'sit and reach' test.

While significant results from a variety of outcome measures suggest that yoga can be effective for managing musculoskeletal conditions, more high quality studies using standardised instruments are needed to confirm the results. The variety of outcome measures, combined with different styles and dosages of yoga, make it difficult to compare the effectiveness of these workplace yoga programmes. Future studies could attempt to determine the optimum frequency and dosage of yoga for improving musculoskeletal conditions in the workplace.

Perceived stress

There is moderate evidence in this systematic review for the effectiveness of yoga in reducing perceived stress at work. Using the Perceived Stress Scale (PSS), three medium quality studies (Hartfiel et al., 2012; Wolever et al., 2012; and Granath et al., 2006) reported significant reductions in perceived stress for yoga participants compared with control groups.

Although each of these three studies used the same outcome measure (PSS), they used different styles and dosages of yoga. For example, Granath et al. used Kundalini yoga once per week for 10 weeks; Wolever et al., used Viniyoga once per week for 12 weeks; and Hartfiel et al. used Dru Yoga once per week for 8 weeks. This suggests that, regardless of style, yoga can effectively reduce perceived stress, confirming the findings of West et al. (2004) who reported that even one yoga class can reduce both perceived stress and salivary cortisol. Despite the evidence suggesting that yoga can be effective for reducing perceived stress in the workplace, more high quality studies with sufficiently-powered sample sizes are needed to provide stronger evidence.

Sleep quality

Limited evidence was found in this systematic review to suggest that yoga can improve sleep quality for employees. Garfinkel et al. (1998) asked yoga participants to self-report the number of hours of disturbed sleep each week, while Wolever et al. (2012) used the Pittsburgh Sleep Quality Index (PSQI) a valid and reliable measure for assessing sleep quality.

The Garfinkel study reported that reductions in sleep disturbance were more common in the yoga group, although these results were not statistically significant. Wolever, on the other hand, found a significant improvement in sleep quality ($p<0.05$) for the yoga group after a twelve week programme of Viniyoga. In addition to using a more accurate outcome measure, Wolever assessed a larger sample of 90 yoga participants compared to 22 in the Garfinkel study, giving the Wolever study considerably more weight.

Wolever's findings are consistent with other non-workplace trials that indicate that yoga can significantly improve sleep quality. Halpern et al. (2014), Hariprasad et al. (2013) and Chen et al. (2010) all reported that yoga improved sleep and quality of life for older adults, while Cohen et al. (2004) and Mustian et al. (2013) found that yoga improves sleep quality for people with cancer. This promising evidence suggests that future studies in occupational settings measure the effect of yoga on sleep quality.

Heart rate variability

The evidence for the effectiveness of yoga in improving heart rate variability (HRV) was conflicting. Wolever et al. (2012) reported significant improvements in heart rate variability for 90 Viniyoga participants after a twelve-week programme, while Cheema et al. (2013) found no significant difference in heart rate variability for 18 Hatha yoga participants after a ten-week programme.

Reasons for this conflicting evidence may include:

- different styles of yoga (Hatha versus Viniyoga)
- different types of employees (university staff versus insurance company employees)
- different procedures and instruments for recording heart rate variability.

Of these reasons, the most plausible appears to be the use of different procedures and instruments for recording heart rate variability (HRV). For example, Wolever et al. (2012) used an emWave sensor to record heart rate variability, while Cheema et al. (2013) used ECG recording with a Sphygmocor system and HRV software.

In addition, before post-intervention heart rate variability testing, yoga participants in the Wolever study were invited 'to do a particular practice taught during the yoga classes', and control group participants were asked 'to do whatever you would typically do when faced with a stressful situation'.

Cheema et al. (2013), on the other hand, invited participants in both groups 'to refrain from exercise for 24 hours and then to rest in a supine position for 15 minutes with regular and calm breathing', before heart rate variability testing.

Thus, these two different procedures in preparation for HRV testing may have influenced the results. Since conflicting evidence for heart rate variability is also common in other complementary therapies such as exercise therapy, standardised procedures for measuring HRV could provide more reliable data (Oliviera et al., 2013).

Methodological quality and risk of bias

Although the results from these eight studies are generally promising, there is a shortage of consistent findings from multiple high quality randomised controlled trials (van Tulder et al., 2003). Of the eight studies reported in this systematic review, Cheema et al. (2013) and Garfinkel et al. (1998) were the only trials rated 'high' for quality and 'low' for risk of bias. Although most studies in this systematic review reported appropriate randomisation methods, only Cheema and Garfinkel specified allocation concealment. In addition, these two were the only studies to report blinding of outcome assessors.

Only Cheema et al. (2013) and Telles et al. (2009) provided reasons for drop-outs and withdrawals. Cheema was the only study to mention adverse events, although no adverse events were reported by the 18 yoga participants in that trial. Finally, only Cheema and Wolever made it clear that the principal investigator and the yoga instructor were two different members of the research team, thus minimising the risk of bias. None of the studies mentioned the blinding of instructors or participants, which is rarely possible in randomised trials of yoga (Sadja and Mills, 2013).

Adherence to study protocol

Measuring adherence to the study protocol can help determine the degree to which the frequency and dosage of yoga is related to statistical significance. Cheema et al. (2013), for example, reported that yoga participants who most closely adhered to the study protocol experienced a significant reduction in state and trait anxiety, while those yoga participants who attended fewer classes did not experience the same benefits.

Strategies to improve adherence include providing financial incentives and regular communication with participants (Chu et al., 2014). The Wolever et al. (2012) study achieved a completion rate of 86%, in part due to offering all yoga participants financial incentives of $75 cash and a $75 massage therapy gift card. Financial incentives, however, require adequate trial funding. The 90 yoga participants in the Wolever study received a combined total of US$13,500 in financial incentives, more than the total costs for the 76 yoga participants in the randomised controlled trial conducted for this thesis.

Limitations

Since this systematic review is based on the information provided in published studies, its validity may be limited by incomplete reporting of the evidence by the authors of the eight studies. In addition, only published studies were included in this review which introduces the possibility of publication bias favouring positive results. Finally, two of the eight yoga studies selected were published by the author of this thesis, which potentially introduces a risk of author bias. However, when a sensitivity analysis was performed excluding the author's two publications, the results of the full systematic review remained unchanged.

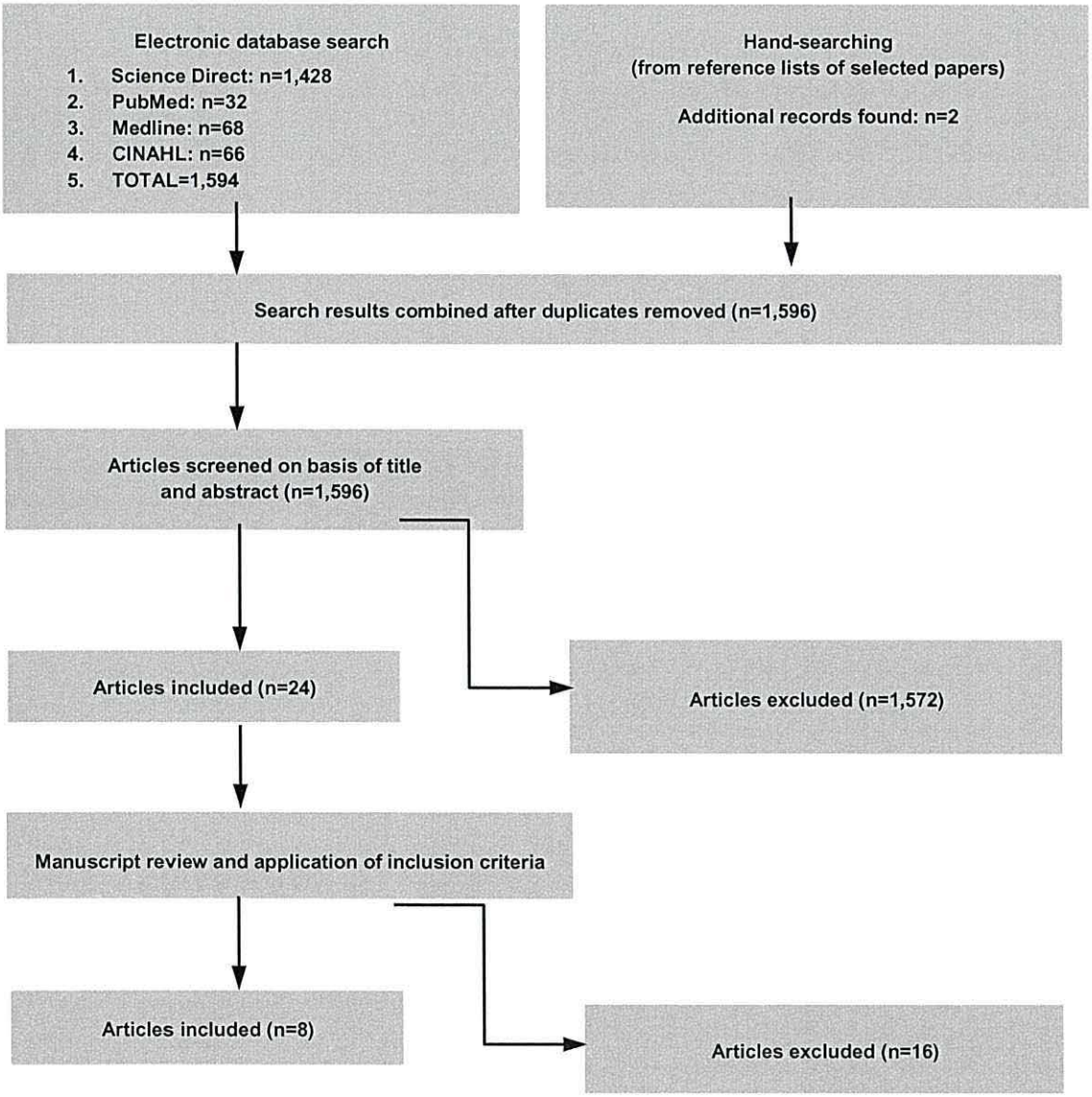
2.6 Conclusion

The results indicate that yoga can be an effective workplace intervention, especially for managing musculoskeletal conditions and perceived stress. Although the evidence was promising, it was limited due to a lack of high quality studies.

In addition, other factors made it difficult to draw definitive conclusions such as the low number of randomised trials (n=8), the small average sample size of yoga participants (n=35), the variability in length of yoga programmes (6 to 12 weeks), the different frequencies of yoga sessions (one to five times per week) and the assorted styles of yoga offered (Hatha, Iyengar, Kundalini, Viniyoga and Dru).

To strengthen the evidence base, more high-quality randomised controlled trials of yoga interventions in different workplace settings are needed. To improve rigour, it is suggested that future studies include the high quality and low-risk factors identified by the Jadad and Pedro scales, and the Cochrane Collaboration tool.

Figure 2.3: Flow diagram of studies selected



Chapter 3: Effect of yoga for managing back pain at work

3.1 Chapter summary

A pragmatic randomised controlled trial (IRAS 114550) was conducted to compare the effectiveness of yoga with usual care in managing back pain for NHS employees at three hospital sites in the United Kingdom. The six month study from March to September 2013 included 151 NHS staff, 76 allocated to the yoga group and 75 to usual care.

The yoga group was offered an eight-week yoga programme delivered by six instructors. The primary outcome measure was back pain and secondary outcome measures were psychological wellbeing, resilience, rejuvenation, tranquillity, physical exhaustion and positive engagement. All outcomes were assessed at baseline, immediately after the eight week yoga programme and at a six-month follow-up.

At eight weeks, 56 (74%) in the yoga group and 53 (70%) in usual care completed the end-programme questionnaires. In comparison with the usual care group, the yoga group reported statistically significantly reductions in back pain and physical exhaustion. In addition, statistically significant improvements at eight weeks (end-programme) were also found for psychological wellbeing, rejuvenation and tranquillity.

At six months, the yoga group had less back pain and higher psychological wellbeing scores than the usual care group, but the differences between groups was not statistically significant. The benefits of yoga were greater immediately after the completion of the eight-week programme.

3.2 Introduction

Recent systematic reviews show strong evidence for the effectiveness of yoga in managing musculoskeletal conditions and back pain (Posadski and Ernst, 2011; Bussing et al., 2012; McCaffrey and Park, 2012; Ward et al., 2013; Cramer et al., 2013; Holzman and Beggs, 2013; Hill, 2013). This evidence is consistent with the systematic review provided in chapter 2 indicating strong evidence for the effectiveness of yoga in managing musculoskeletal conditions in workplace settings.

Of these workplace studies, one randomised controlled trial evaluated the effectiveness of yoga for back pain (Hartfiel et al., 2012). That study was based on data from 37 employees who participated in workplace yoga sessions offered in one location by a single instructor.

In this chapter, the effect of yoga for managing back pain was measured using a larger sample of employees (n=151), in three workplace locations and with six different instructors.

In addition, two back pain scales are used; one measuring physical symptoms, and the other assessing both physical and psychosocial indicators.

The aim of this study was to compare the effectiveness of a workplace yoga programme with usual care for reducing back pain among a cohort of NHS employees. This effectiveness evaluation is reported using guidelines from the CONSORT 2010 Statement Checklist for Transparent Reporting of Trials (Schulz et al., 2010). This checklist and a structured abstract are provided in Appendices 4 and 5.

3.3 Methods

Study sites

This multi-site pragmatic randomised controlled trial was offered to all NHS employees of the Betsi Cadwaladr University Health Board (BCUHB). BCUHB is the largest health organisation in Wales with more than 16,000 staff, and three district hospitals (Ysbyty Gwynedd in Bangor, Ysbyty Glan Clwyd in Bodelwyddan and Wrexham Maelor Hospital) which serve more than 600,000 people in the six counties of Anglesey, Gwynedd, Conwy, Denbighshire, Flintshire and Wrexham (BCUHB, 2013a).

BCUHB employees were eligible to participate in this study if they were able to attend at least one yoga class per week for eight weeks in April/May 2013. To ensure accessibility, weekly yoga classes were held at or near each of the three district hospitals. Health outcomes (e.g., back pain, wellbeing, mood and resilience) for each participant were assessed at baseline, after the eight week yoga programme and at a six-month follow-up.

Recruitment

Six weeks prior to the commencement of yoga classes, the BCUHB Office of Occupational Health and Wellbeing recruited participants via an e-newsletter *Health Matters* (Appendix 6) and an all-staff e-mail (Appendix 7). Staff who replied received a participant information sheet, consent form and a health questionnaire.

Health questionnaire

Baseline health questionnaires were e-mailed to all participants. The questionnaire was used to collect demographic information from participants and to obtain baseline data for all primary and secondary outcome measures. Additional information was obtained on the number of recent visits to healthcare professionals and whether participants had any at-risk health conditions that might prevent safe participation in yoga classes.

Completed questionnaires were reviewed by a physiotherapist and a yoga instructor who assessed the risk and eligibility of each participant.

Inclusion criteria

Participation in this study was open to all NHS staff, age 18 to 65 years, with or without a history of back pain. Although most studies of yoga for back pain recruit only participants with chronic low back pain (RDQ>4), this study took a more prevention-oriented approach by including employees both with and without back pain.

To ensure safety, employees were excluded from the trial if they were pregnant or if they had experienced recent spinal disc problems or major surgery. Some yoga movements, for example, are contra-indicated for women who are pregnant and to others with disc problems or who have had recent surgery. Finally, to avoid confounding and prevent bias, employees were also excluded if they were currently practising yoga or yoga-related activities (such as Pilates or tai chi).

Randomisation

An e-mail-based randomisation specification was developed by the Bangor Trials Unit, a fully registered clinical trials unit in North Wales. To ensure balance in the overall number of women and men at the three hospital sites, an equal allocation of 1:1 was used, with gender and location as stratification variables. Eligible participants were then randomised by the Trials Unit to either the yoga group or to usual care.

To ensure allocation concealment, the Trials Unit then sent a confirmation e-mail to a nominated staff person at the BCUHB Office of Occupational Health and Wellbeing. The nominated staff person then sent an e-mail to each participant with information about their group allocation. Throughout the duration of the trial, the nominated BCUHB staff person served as the main communicator between the principal investigator and the study participants.

Sample size

A statistical power analysis was undertaken for the primary outcome measure, which was the Roland-Morris Disability Scale (RDQ). The power calculation was based on the results of a pilot study of yoga in the workplace, which found that a change in RDQ scores of 1.17 was statistically significant for employees with little disability (Hartfiel et al., 2012). The standard deviation of the difference in change scores in this pilot study was calculated to be 1.95 points. The sample size estimate was then calculated from the equation below (Lloyd-Williams and Edwards, 2015):

$$N = \frac{4\sigma^2\left(z_{crit} + z_{pwr}\right)^2}{D^2}$$

In this equation, *N* was the total sample size needed, σ was the standard deviation (1.95), the z_{crit} value was the value given (1.96) for the relevant significance criterion (.05), the z_{pwr} value was the value given (.842) for the desired statistical power (.80), and D was the minimum expected difference (1.17) between the two means (Lloyd-Williams and Edwards, 2015). Using this formula, the current study required a total sample size of 87 complete cases after attrition. Factoring in a 25% attrition rate, a minimum of 116 participants was required for this study to attain sufficient statistical power.

Yoga intervention

In line with the NICE (2009) guidelines for the early management of non-specific low back pain, this randomised controlled trial offered a structured yoga programme of eight sessions (60 minutes each) over a twelve week period, delivered to a group of up to ten participants.

The yoga intervention also included a back care DVD and an illustrated yoga booklet for home practice. Dru Yoga classes were offered after work from 5.30 to 6.30 pm in three regional hospital locations. Six accredited Dru instructors were recruited to deliver the eight-week programme. Each instructor had successfully completed a 200-hour teacher training course and participated in additional professional development in yoga for back care.

The yoga protocol used in this study was developed by a panel of four health professionals: a physiotherapist, an osteopath and two senior Dru Yoga trainers. This panel agreed on a progressive programme of yoga techniques, appropriate for the workplace, which could be easily learned in a class setting and then practised at home.

Class attendance and the amount of home practice were recorded to measure adherence to the protocol during the study. At the conclusion of the eight-week programme, participants were encouraged to continue with their yoga practice at home using the DVD and illustrated booklet.

Dru Yoga is reported to be a safe and therapeutic form of yoga characterised by graceful movements, directed breathing, and relaxation techniques that include affirmation and visualisation (Barrington et al., 2005). Each Dru Yoga session was divided into four stages (Table 3.1).

Usual care group

Participants in the usual care group received two evidence-based booklets: *The Back Book* (Burton et al., 2002) and *How to Manage Stress* (Darton, 2012). At a six-month follow-up, the usual care group also received a back care DVD, an illustrated yoga booklet, and a four week series of free yoga classes.

Table 3.1: Dru Yoga programme

Dru Yoga programme	Specific techniques	Intended effect
Activation exercises	• pelvic neutral position • shoulder circles • push twist • dynamic twist • figure of eight	• enhances circulation and activates the main physical systems of the body
Energy block release sequences	• energy block release 1 • earth salute	• releases tension from the whole body, especially the shoulders, spine and hips
Back care postures	• cat • extended child • knee to chest • graduated bridge	• develops suppleness in the spine, improves posture and strengthens the back
Relaxation techniques	• diaphragmatic breathing • visualisation • affirmation • deep relaxation	• creates a feeling of positive health and wellbeing and enables the body to rest

Outcome measures

Participants in both the yoga and usual care groups completed health questionnaires at baseline (March 2013), end-programme (June 2013) and six-month follow-up (September 2013). At baseline and six months, health questionnaires were sent electronically to all participants by the BCUHB Occupational Health Team. At end-programme, health questionnaires were sent electronically to all participants who did not complete a health questionnaire immediately after the final yoga class.

The health questionnaires included five valid and reliable outcome measures: Roland-Morris Disability Questionnaire (RDQ), Keele STarT Back Screening Tool, WHO-5 Wellbeing Index, Exercise-Induced Feeling Inventory (EFI) and Resilience Scale (RS-14).

The primary outcome measure was RDQ, a commonly-used self-report questionnaire for assessing back pain (Roland and Fairbank, 2000).

All outcome measures were pre-specified in a published trial protocol (Hartfiel, et al., 2014) and their psychometric properties are listed below.

Table 3.2: Outcome measures

Outcome measure	Description	Psychometric properties: Reliability, validity, responsiveness
1. RDQ	24-item questionnaire to determine whether a particular daily activity or function is limited by back pain.	The RDQ has been found to have good psychometric properties - valid, reliable, responsive with high internal consistency with Cronbach's alpha estimated at 0.93 0.90 and 0.84 (Roland and Fairbank, 2000).
2. Keele STarT	9-item questionnaire to measure the impact of back pain on individuals. Used for initial assessment as well as to measure recovery from back pain (Wideman et al., 2012)	Tested for psychometric properties including reliability and validity, the Keele STarT has been shown to perform well both as a screening tool and as outcome measure in clinical trials (Hill et al., 2008; Hill et al., 2011, Wideman et al., 2012).
3. WHO-5	5-item self-report measure to screen for depression and to assess subjective psychological well-being. Used as a generic scale for wellbeing in a wide variety of clinical trials (Topp et al., 2015).	The WHO-5 is a short, psychometrically sound measure of emotional well-being with adequate validity both as a screening tool for depression and as an outcome measure for subjective psychological wellbeing. (Hajos et al., 2013; Topp et al., 2015).
4. EFI	12 item questionnaire that captures four distinct feeling states: revitalisation, tranquillity, positive engagement, and physical exhaustion.	The four subscales of the EFI have been shown to have good internal consistency and to be sensitive and responsive to different exercise interventions in a variety of contexts (Gauvin and Rejeski, 1993).
5. Resilience-14	14 item questionnaire to evaluate the levels of resilience in the general population.	RS-14 has presented reliable internal consistency and external validity (Wagnild and Young, 1993). In addition, confirmatory factor analyses have been shown to verify the underlying variables that comprise resilience (Damasio et al., 2011).

Statistical analysis

All enrolled participants (n=151) were included in the analyses following the intention-to-treat principle. To determine if there were any significant differences between the yoga and usual care groups at baseline, t-tests were performed for all outcome measures. Baseline and end-programme data was tested for the parametric assumptions of normality, outliers, linearity, homogeneity of variance and homogeneity of regression slopes.

General linear modelling was used to determine the effectiveness of the yoga programme for primary and secondary outcomes. To achieve this, the difference in change scores between the yoga group and usual care group were calculated from baseline to end-programme (primary endpoint) and from baseline to six-month follow-up (secondary endpoint). Results were reported for both groups using mean scores and standard deviations at baseline, end-programme and six-months.

Among general linear models, ANCOVA is a preferred method of analysis for pre-test/post-test data (Dimitrov and Rumrilll, 2003). ANCOVA was used in this study to assess between-group effects. End-programme and six-month mean scores were analysed, using baseline scores as the covariate. Statistical significance was assessed at $p<0.05$.

Missing data

Complete case analysis was used to determine the mean RDQ scores for participants who responded to both baseline and end-programme questionnaires. However, when more than 5% of data is missing, complete case analysis can lead to biased conclusions (Briggs et al., 2003; White et al., 2011). To deal with uncertainty around missing values, multiple imputation is recommended (Sterne et al., 2009).

Multiple imputation creates several imputed data sets and then pools the results. It is considered more statistically valid than other approaches such as using the last measured value or using the mean of observed values (Sterne et al., 2009).

In this study of yoga in the workplace, 28% of the data was missing for end-programme RDQ scores (i.e., at eight weeks). Since it is recommended that the number of imputed datasets should be equal to the percentage of incomplete cases, 28 imputed data sets were created using SPSS Statistics 20.0 (White et al., 2011) which uses multiple linear regression for imputing continuous variables such as the RDQ (Briggs et al., 2003). Missing RDQ values at end-programme were randomly generated and imputed from baseline RDQ scores.

Ethical approval

Ethical approval for this trial was obtained from the School of Sport, Health and Exercise Sciences at Bangor University. Research and development approval was granted by the BCUHB Internal Review Panel. This study was conducted in compliance with ethical guidelines as set out by this panel and in line with recommended guidelines for good clinical practice.

3.4 Results

Consent forms and baseline health questionnaires were completed by 163 BCUHB employees. Of these, 12 employees did not meet the inclusion criteria. Eight were excluded because they were already practising yoga once per week or more, and four were excluded for medical reasons such as being pregnant or reporting an at-risk health condition.

Of the 151 employees selected to participate, 76 were allocated to the yoga group, 75 to the usual care group, 93% were women, the mean age was 44 years, the mean education level was equivalent to a Diploma of Higher Education and the mean NHS band level was five which included registered general nurses, midwives and clinical audit facilitators (Table 3.3).

Table 3.3: Comparison of baseline characteristics between groups

Demographic characteristics	Yoga group (n=76)	Usual care group (n=75)
Mean age	44.12 (10.38)	43.60 (11.71)
Gender	Female = 70 (92%); Male = 6 (8%)	Female = 70 (93%); Male = 5 (7%)
Mean education level (1 = GCE O Level; 8 = PhD)	4.85 (2.01)	4.85 (2.12)
Mean NHS band level (1 to 9)	5.13 (1.98)	5.04 (1.89)

Normality

For the yoga and usual care groups, the distribution of change in RDQ scores from baseline to end-programme was non-normal (Table 3.4).

Table 3.4: Tests for normality

	Group	Participants	Kolmogorov-Smirnov	Shapiro-Wilk
			Significance	Significance
Distribution of change in RDQ mean scores from baseline to end-programme	Yoga	n=56	0.000	0.007
	Usual care	n=53	0.000	0.000

However, for large sample sizes, formal tests of normality can be overly conservative, and ANCOVA is generally robust to violations of the assumption of normality (Barrett, 2011; Olejnik and Algina, 1984).

Consequently, in randomised controlled trials with more than 30 participants, parametric procedures are commonly used (Ghasemi and Zahediasl, 2012; Pallant, 2010). Importantly,

the distribution of change scores (Figure 3.1) and the normal Q-Q plots (Figure 3.2) show similar distributions of the data for both groups, and therefore the outcomes of ANCOVA are unlikely to have been influenced by differences in distributions of data between the two groups.

Figure 3.1: RDQ distribution of change scores: baseline to end-programme

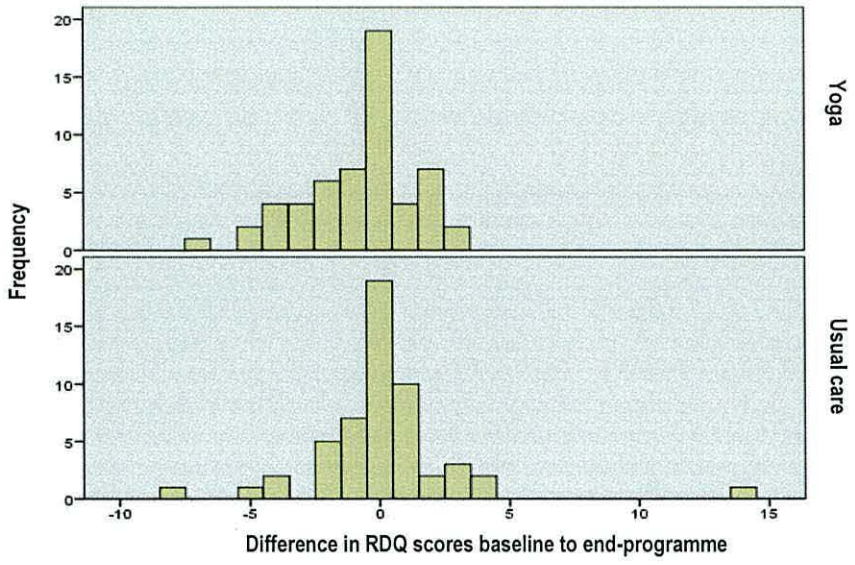
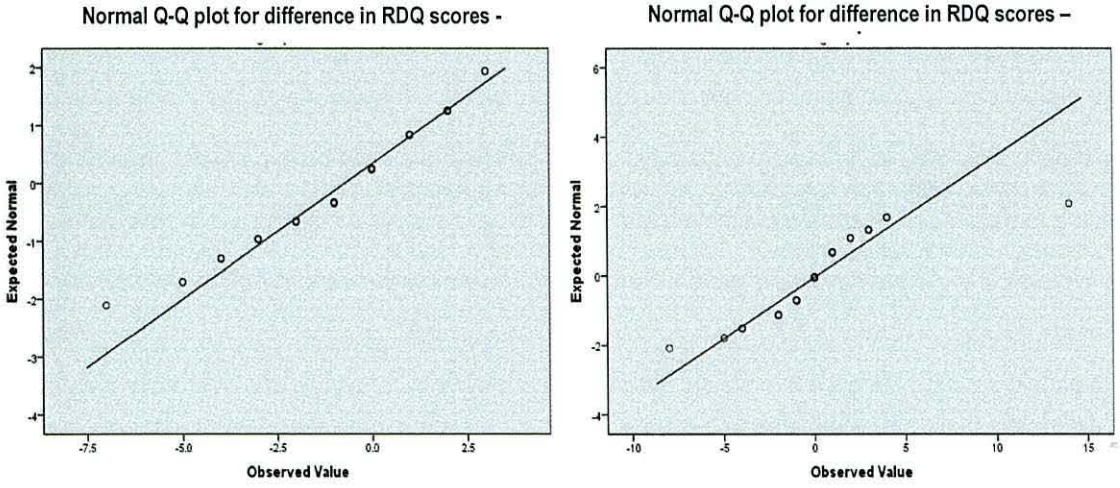


Figure 3.2: RDQ distribution of change scores (normal Q-Q plots)



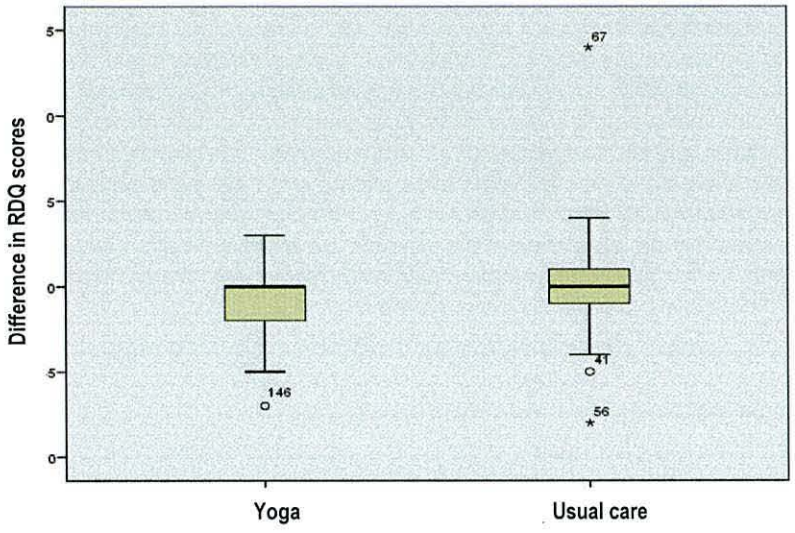
Outliers

Although the sample size (n=151) in this study was large enough (i.e., >30) to minimise the influence of outliers (Pallant, 2010), inspection of the box plots indicated two extreme outliers for the RDQ change scores. The two extreme outliers were cases 56 and 67 in the usual care group (Figure 3.3).

Case 67 was a usual care participant who reported RDQ scores of 0 (no back pain) at baseline and 14 at end-programme, representing an increase in back pain of 14 points. Case 56 from the usual care group reported RDQ scores of 8 at baseline and 0 at end-programme, indicating an 8 point reduction in back pain from baseline to end-programme.

In order to determine the effect of outliers on the study results, ANCOVA was conducted both with and without the two extreme outliers. The results of this comparison showed a non-significant effect on study results. At end-programme, the difference in mean RDQ scores between groups was p=0.035 with outliers and p=0.043 without outliers.

Figure 3.3: RDQ distribution of change scores (box plots)



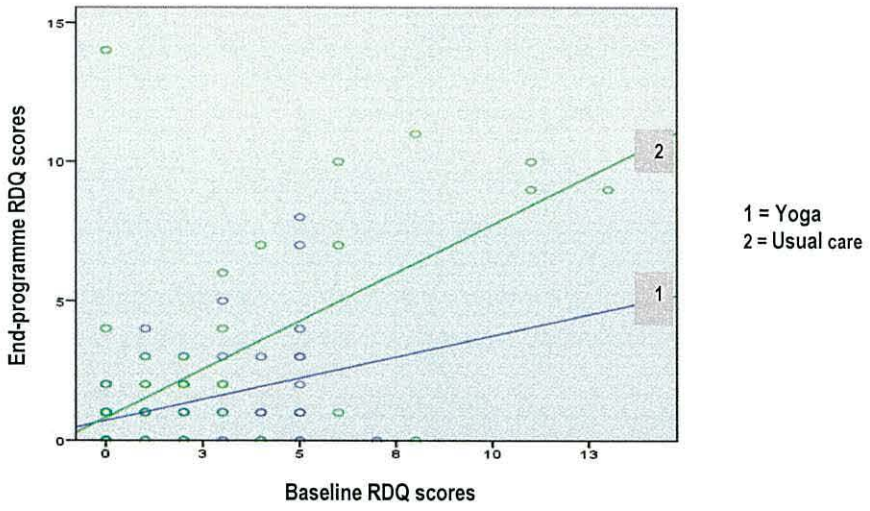
Homogeneity of variance

Levene's test indicated no significant heterogeneity of variances (p=0.139) in the RDQ change scores between the yoga and usual care groups. If the variances were significantly different, the results of parametric testing could be misleading if difference in variances were misinterpreted as difference in means.

Linearity

ANCOVA assumes a linear relationship between the dependent variable (end-programme RDQ scores) and the covariate (baseline RDQ scores). Visual inspection of the data indicated considerable scatter and a broadly linear relationship between the yoga and usual care groups.

Figure 3.4: Linearity of RDQ scores between groups (scatterplot)



Homogeneity of regression slopes

Homogeneity of regression slopes was determined by testing for a statistically significant interaction between the covariate (baseline RDQ scores) and the dependent variable (end-programme RDQ scores) for both groups. ANCOVA showed that this interaction was statistically significant (p=0.030), indicating that the regression slopes between the covariate and dependent variable were not homogeneous between the yoga and usual care groups.

Although theoretically a violation of the assumption of homogeneity of regression slopes, the test for homogeneity of regression slopes, in this case and with this study design, was used to assess the effect of the yoga programme on RDQ scores for both groups. ANCOVA analysis determined whether the yoga programme influenced end-programme RDQ scores, using baseline scores as the covariate. Lower RDQ scores of yoga participants at end-programme indicated that the effect of the eight week intervention was significantly different between the two groups.

End-programme results

Of the 76 participants allocated to the yoga group, 56 completed both baseline and end-programme questionnaires, and 20 withdrew. The 56 yoga participants attended an average of 6.2 yoga sessions during the programme and practised at home an average of 64 minutes per week.

Of the 20 yoga participants who dropped-out, 14 withdrew within the first four weeks and 6 never came to a class. Reasons given by the 14 participants who withdrew were: unknown (n=7), childcare commitments (n=3), adverse events unrelated to yoga (n=2), holiday commitments (n=1) and adverse events related to yoga (n=1).

The yoga-related adverse event was associated with a muscle spasm when one participant was practising at home after the first week of classes.

Adherence to programme

Of the 56 yoga participants who completed the end-programme questionnaire, 67% attended six or more classes, and 49% reported practising at home for 60 minutes or more per week (Table 3.5). Of these 49%, the mean reduction in RDQ scores was -1.04 from baseline to end-programme. This compared favourably to -0.41 mean reduction in RDQ scores for those who practised at home for less than 60 minutes per week. This suggests that for yoga participants, the amount of home practice made a substantial difference in reducing back pain (Table 3.5).

Table 3.5: Adherence to yoga programme (n=56)

Number of classes attended	Number (%) of participants	Reduction in back pain (RDQ)
2	2 (4%)	**-0.69**
3	1 (2%)	
4	4 (7%)	
5	11 (20%)	
6	12 (21%)	**-0.77**
7	14 (25%)	
8	12 (21%)	
Amount of home practice minutes per week	**Number of participants**	**Reduction in back pain**
0 to 20	7 (13%)	**-0.41**
20 to 40	13 (22%)	
40 to 60	9 (16%)	
60 to 80	9 (16%)	**-1.04**
80 to 100	7 (13%)	
100 to 120	4 (7%)	
120 or more	7 (13%)	

Complete cases analysis

Using complete case analysis, ANCOVA showed that compared to the usual care group, the yoga group at end programme reported statistically significant reductions in back pain (RDQ, $p=0.035$; Keele STarT, $p<0.001$) and in physical exhaustion ($p=0.001$), as well as statistically significant improvements in rejuvenation ($p<0.001$), tranquillity ($p<0.001$) and psychological wellbeing ($p=0.014$).

Although the yoga group showed more resilience (p=0.198) and positive engagement (p=0.096) than the usual care group at end-programme, the difference between groups was not statistically significant (Table 3.7).

Multiple imputation

After the eight-week yoga programme, 20 yoga participants and 22 in the usual care group did not complete end-programme questionnaires. Therefore, missing data for end-programme RDQ scores were imputed using SPSS Statistics 20.0 through a standard multiple linear regression method, which assumed that the missing data were random.

Twenty-eight imputed datasets were created. The mean scores for the imputed full data set were compared with the mean scores for the complete cases to determine the degree to which the complete cases were representative of the imputed full data set. Using complete case data, there was a significant difference in RDQ mean scores (p=0.035) between the yoga and usual care groups at end programme (Table 3.6). For RDQ scores at end-programme, 23 of the 28 imputed datasets resulted in statistically significant differences between yoga and usual care participants at end-programme:

Table 3.6: Imputed datasets

Imputation number	Significance
Original	**.035***
1	**.001***
2	.088
3	**.037***
4	**.009***
5	**.042***
6	**.023***
7	**.003***
8	**.002***
9	**.000***
10	.181
11	**.026***
12	**.018***
13	**.028***
14	**.012***
15	.066
16	**.016***
17	.103
18	**.012***
19	.073
20	**.001***
21	**.009***
22	**.025***
23	**.004***
24	**.032***
25	**.005***
26	**.007***
27	**.008***

***indicates statistical significance**

When the 28 imputed datasets were pooled, the change in RDQ mean scores between groups was slightly greater for the pooled imputed cases (0.99) compared with complete cases (0.84). This shows that the yoga intervention was slightly more effective in reducing back pain using multiple imputation than with complete cases (Table 3.6).

Table 3.7: Complete cases and imputed cases: differences in mean scores between groups

Measure	Yoga	Usual care	Difference in mean scores (yoga - usual care)	Change in mean scores between groups (end-programme - baseline)
RDQ – complete cases				
1. Baseline	2.05, n=56	2.23, n=53	-0.18	0.84
2. End-programme	1.34, n=56	2.36, n=53	-1.02	
RDQ – imputed cases (pooled from 28 imputations)				0.99
1. Baseline	2.09, n=76	1.93, n=75	0.16	
2. End-programme	1.34 n=76	2.17, n=75	-0.83	

Six-month follow-up results:

At the six month follow-up, ANCOVA showed that the yoga group reported lower mean scores for back pain (RDQ, p=0.196; Keele STarT, p=0.071) and higher mean scores for psychological wellbeing (p=0.132) than the usual care group. However, at six months, there were no statistically significant differences between the two groups for all primary and secondary outcomes (Table 3.8).

Table 3.8: Mean scores (SD), mean differences, confidence intervals and p-values

		Yoga group					Usual care group						Between groups			
Domains	**Baseline** all cases	**Baseline** complete cases	**End programme** (8 weeks)	**Mean change @ 8 weeks**	**Follow-up** (6 mos)	**Mean change @ 6 mos**	**Baseline** all cases	**Baseline** complete cases	**End programme** (8 weeks)	**Mean change @ 8 weeks**	**Follow-up** (6 mos)	**Mean change @ 6 mos**	**Mean difference** 8 weeks [95% CI]	**Mean difference** 6 mos [95% CI]	**P-value @ 8 weeks**	**P-value @ 6 months**
1. RDQ Back pain	2.09 (2.44) n=76	2.05 (2.33) n=56	1.34 (1.72) n=56	-0.71	1.26 (2.05) n=43	-0.83	1.93 (2.97) n=75	2.23 (3.12) n=53	2.36 (3.44) n=53	0.13	2.03 (3.30) n=32	-0.20	-0.84 [-1.78,-0.06]	-0.63 [-1.78,0.48]	**p=0.035***	P=0.196
2. Keele Back pain	1.37 (1.16) n=76	1.32 (1.03) n=56	0.76 (0.77) n=55	-0.56	0.95 (1.17) n=42	-0.37	1.41 (1.40) n=74	1.57 (1.39) n=55	1.62 (1.36) n=53	0.05	1.50 (1.30) n=32	-0.09	-0.61 [-1.19,-0.39]	-0.28 [-0.97,0.07]	**p<0.001***	P=0.071
3. EFI-PHY Physical exhaustion	5.62 (2.85) n=71	5.62 (2.77) n=53	3.29 (2.58) n=51	-2.33	3.98 (2.98) n=43	-1.64	5.43 (2.72) n=72	5.74 (2.72) n=53	5.00 (3.22) n=52	-0.74	3.75 (2.93) n=32	-1.99	-1.59 [-2.97,-0.74]	0.35 [-1.44,1.36]	**p=0.001***	P=0.912
4. EFI-RV Rejuvenation	3.70 (2.60) n=71	3.51 (2.63) n=51	6.96 (2.51) n=53	3.45	4.95 (2.89) n=43	1.44	3.80 (2.60) n=71	3.54 (2.56) n=52	4.94 (2.95) n=52	1.40	5.48 (3.05) n=31	1.94	2.05 [1.10,3.15]	-0.50 [-1.88,0.97]	**p<0.001***	P=0.447
5. EFI-TQ Tranquillity	5.71 (2.30) n=72	5.69 (2.26) n=54	8.62 (2.64) n=55	2.93	6.95 (2.59) n=43	1.26	5.80 (2.64) n=70	5.67 (2.41) n=51	6.87 (2.73) n=53	1.20	7.39 (2.43) n=31	1.72	1.73 [0.91,2.73]	-0.46 [-1.53,0.55]	**p<0.001***	P=0.297
6. EFI-PE Positive engagement	5.73 (2.29) n=71	5.56 (2.34) n=52	7.68 (2.40) n=54	2.12	6.63 (2.76) n=43	1.07	5.61 (2.78) n=71	5.57 (2.82) n=53	7.09 (2.64) n=53	1.52	7.23 (3.05) n=31	1.66	0.60 [-0.14,1.69]	-0.59 [-1.87,0.57]	p=0.096	P=0.268
7. WHO-5 Well-being	13.45 (4.44) n=74	13.70 (4.09) n=54	17.27 (4.09) n=55	3.57	16.42 (4.54) n=43	2.72	13.57 (5.15) n=75	13.38 (5.06) n=53)	15.29 (4.26) n=49	1.91	15.22 (5.20) n=32	1.84	1.66 [0.37,3.16]	0.88 [-0.63,3.16]	**p=0.014***	P=0.132
8. Res-14 Resilience	77.15 (13.10) n=73	78.81 (9.72) n=54	83.41 (9.66) n=56	4.60	81.10 (9.48) n=42	2.29	78.31 (11.89) n=72	77.40 (12.33) n=52	80.16 (11.94) n=51	2.76	78.74 (13.43) n=31	1.34	1.84 [1.17,5.55]	0.95 [-1.70,8.07]	p=0.198	P=0.197

***indicates statistical significance**

3.5 Discussion

This trial showed that an eight week yoga programme, for a randomised group of NHS employees, resulted in statistically significant reductions in back pain and physical exhaustion, and statistically significant improvements in psychological wellbeing, rejuvenation and tranquillity when compared with usual care. Yoga participants also reported reduced back pain and improved psychological wellbeing at the six-month follow-up, although the benefits were greater immediately after the eight-week programme. This suggests that the longer-term benefits of yoga may depend on weekly classes.

The results from this trial are consistent with other randomised trials of yoga for employees in workplace settings (chapter 2) indicating that yoga can be effective for improving musculoskeletal conditions (Garfinkel et al., 1998; Telles et al., 2009; Joshi et al., 2009; Hartfiel et al., 2012; Cheema et al., 2013).

In addition, systematic reviews of randomised trials of yoga for patients with chronic or non-specific low back pain have confirmed the benefits of yoga for reducing back pain (Posadski and Ernst, 2011; Bussing et al., 2012; Cramer et al., 2013; Holzman and Beggs, 2013; Hill, 2013).

Where previous studies have focused on yoga as a treatment for *patient* populations, this current study explored the effectiveness of yoga for both treating and preventing back pain among a relatively healthy *employee* population.

In this workplace study, 36% of the yoga participants and 40% of the usual care participants reported no back pain at baseline. Among these, usual care participants reported more back pain at end-programme (mean RDQ score = 1.19) than yoga participants (mean RDQ score =0.55). This difference in back pain scores at end-programme suggests that the yoga programme was more effective than usual care for preventing back pain among those participants with no back pain at baseline.

Back pain

In this study, two outcomes measures for back pain were applied: the RDQ and Keele STarT. While both are reliable and valid measures, RDQ focuses almost exclusively on the loss of physical function and the Keele STarT assesses both physical function and psychological factors such as fear, worry, loss of hope and the displeasure associated with back pain.

While the RDQ has been widely used since the mid-1980s, the Keele STarT was developed after the publication of the 2006 European guidelines for the management of acute non-

specific low back pain. These guidelines recommend that psychosocial factors such as fears, anxiety, mood, motivation and work situation be assessed when measuring back pain (van Tulder et al, 2006).

In this study of yoga in the workplace, the difference in end-programme mean scores between the two groups was statistically significant for both the Keele STarT ($p<0.001$) and for the RDQ ($p=0.035$). This suggests that the Dru Yoga programme offered in this study effectively addressed both the psychological and physical components of back pain.

Psychological wellbeing

End-programme results indicated significant improvements in the psychological wellbeing of yoga participants compared with usual care ($p=0.014$). This is consistent with other workplace yoga studies that have investigated the benefit of yoga for improving wellbeing and reducing perceived stress (Granath et al., 2006; Wolever et al. 2012; Hartfiel et al, 2011; Hartfiel et al, 2012). In addition, a recent systematic review of 35 trials reported overall promising results for the effect of yoga on reducing stress and anxiety (Li and Goldsmith, 2012).

Resilience

The yoga group reported higher levels of resilience than usual care at end-programme on the Resilience Scale (RS-14), but the difference was not statistically significant. This contradicts an earlier study by Hartfiel et al. (2011) which found that yoga participants experienced a significant improvement in resilience to stress using the Inventory of Positive Psychological Attitudes (IPPA). This conflicting result could be due to the difference in how resilience was measured using the RS-14 and the IPPA.

Feeling states

End-programme results from the Exercise-Induced Feeling Inventory indicated that yoga participants, compared with usual care, experienced significantly improved feeling states of rejuvenation, tranquillity and less physical exhaustion. Yoga participants also reported more positive engagement, although the difference was not statistically significant. These significant results are consistent with other studies showing the positive effect of yoga on mood states (Yoshihara et al., 2011; Hartfiel et al., 2012; Noggle et al., 2012)

Strengths

This pragmatic randomised controlled trial was designed using three different workplace sites and six different yoga instructors. This compares favourably with most studies of yoga which feature only one setting with a single yoga instructor (Elwy et al., 2014).

In addition, this study reported on reasons for withdrawals and adverse events which are often underreported in clinical trials of yoga (Cramer et al., 2013b). Although yoga was a safe form of activity for most participants (97%), two participants (3%) reported muscle spasms when practising yoga at home.

Of these two, one dropped out after the first week, while the other completed the eight week programme. Nevertheless, the presence of two yoga-related adverse events indicated that for employees with back pain, yoga must be practised with care, especially when unsupervised outside of class sessions.

Limitations

Although these results are promising, several factors limit the conclusions that can be drawn from them. First, interested employees self-selected to participate in workplace yoga and therefore the sample was not representative of all employees. In addition, improvement in yoga group scores may have been caused by other factors such as increased social support from participating in a new group, positive interaction with yoga instructors and from increased attention offered by the employer to employees (i.e., Hawthorne effect).

Lower end-programme scores in the usual care group could also have been caused by disappointment bias from not being able to participate in yoga classes (Homer, 2002). While NHS employees joined this study with the understanding that they may not be randomised into the yoga group, a higher number of participants in the usual care group withdrew (3% more at end-programme and 16% more at 6 months). Disappointment bias may help explain the higher withdrawal rate among usual care participants.

Although randomisation was conducted independently by the Bangor Trials Unit, participants and yoga instructors were not blind to treatment allocation. In addition, the author of this thesis played the roles of both principal investigator and data analyst. In order to ensure the smooth running of the trial, the author became un-blinded after randomisation.

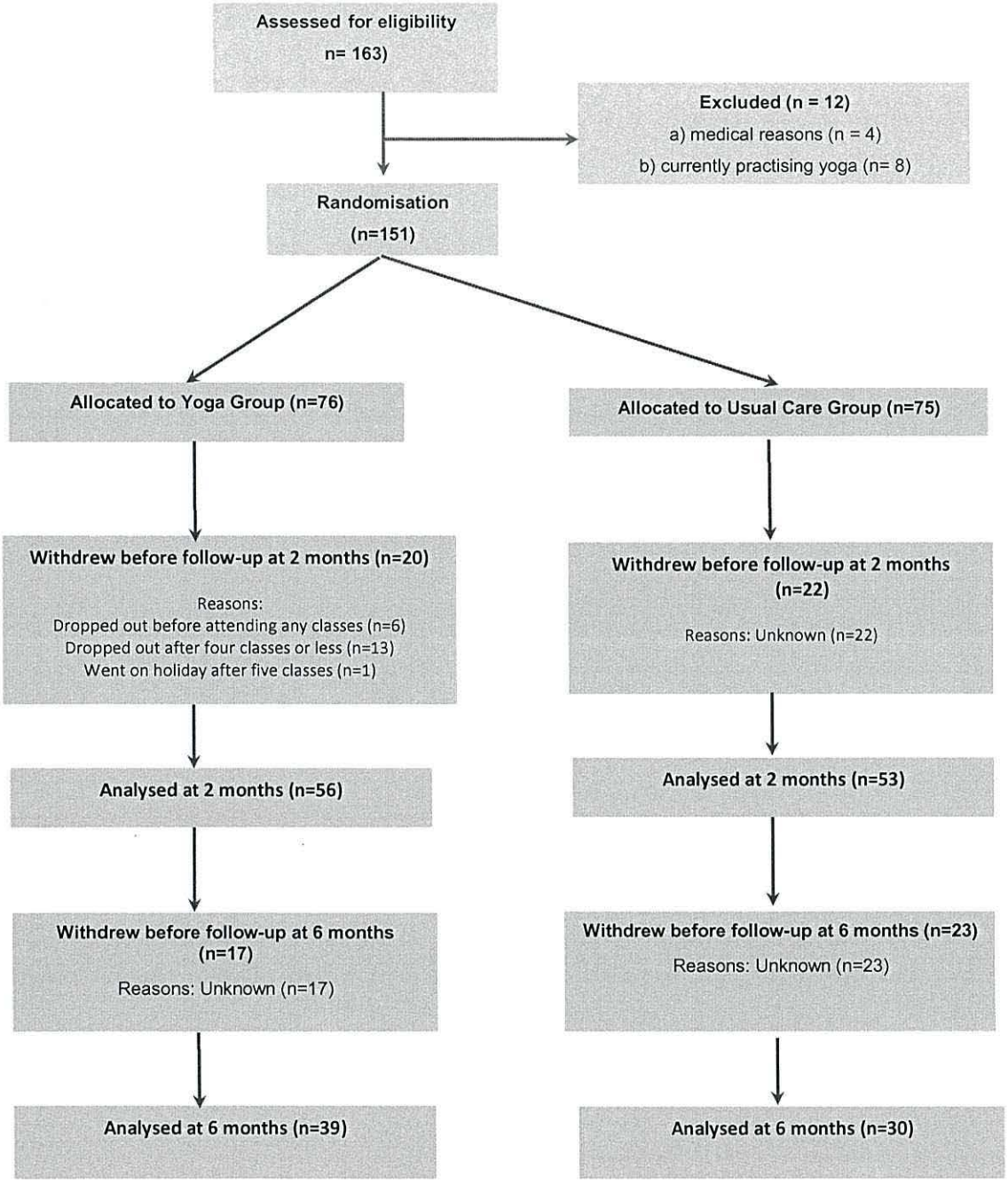
Finally, seven yoga participants withdrew for unknown reasons. Although a follow-up e-mail was sent to each of the seven to determine reasons for dropping out, no reply was received. Since large surveys show that less than 5% of people who practice yoga experience adverse events, it is unlikely (although possible) that one or more of these seven participants withdrew due to an adverse event (Cramer et al., 2013b). To determine reasons for withdrawals (and to encourage adherence to the programme), future studies should ensure that the principal investigator can contact participants directly rather than through a nominated staff person.

3.6 Conclusion

At eight weeks, yoga participants (in comparison with usual care) reported statistically significant reductions in back pain and physical exhaustion, and statistically significant improvements in psychological wellbeing, rejuvenation and tranquillity. Substantial reduction in back pain was found using both the RDQ and the Keele STarT scales, suggesting that the Dru Yoga programme used in this study was effective for managing both the physical and psychological components of back pain.

At six months, the yoga group reported less back pain and more psychological wellbeing than the usual care group. However, the differences between the two groups were not statistically significant at six months, suggesting that ongoing classes or periodic booster sessions may be necessary to sustain the physical and psychological benefits gained from an eight-week yoga programme in the workplace.

Figure 3.5: Participant flow diagram



Chapter 4: Qualitative study of yoga in the workplace

4.1 Chapter summary

The qualitative evaluation explored the perceived influence of an eight-week yoga programme on 56 NHS employees in three hospital sites. The qualitative data was obtained using focus groups (n=32) and end-programme questionnaires (n=56). The focus groups were held one week after the completion of the eight-week programme. Semi-structured interviews were used to elicit the employees' experience of the yoga programme.

Using an inductive thematic approach, qualitative results indicated that yoga participants experienced both physical and psychological benefits. Physically, most participants cited less back and neck pain, more flexibility and improved posture. Psychologically, participants reported feeling more relaxed and confident, less stressed and anxious and more body-aware from practising yoga. In addition, some participants described being able to integrate yoga into their daily life.

4.2 Introduction

Increasingly, qualitative methods are being used to complement quantitative methods in healthcare research (Coast et al., 2004b). The qualitative component of this thesis yielded insight into how NHS employees experienced an eight-week Dru Yoga programme. Whereas the quantitative results (chapter 3) were derived from valid and reliable questionnaires assessing back pain, psychological wellbeing, resilience and various feeling states, the qualitative results made it possible to investigate the experiences of the yoga participants unconstrained by pre-designed questionnaires. Qualitative data was iterative rather than fixed and emergent rather than pre-structured (Watkins, 2012). Yoga participants became active participants rather than subjects and the interviewers became instruments in the research process (Ulin et al., 2005).

4.3 Methods

The qualitative data was derived primarily from transcripts of focus group interviews (n=32) and end-programme questionnaires (n=56) as well as from e-mail correspondence with participants who withdrew (n=8). In addition, telephone interview transcripts were collected from participants with adverse events (n=2) and from NHS managers who supervised the programme (n=2). Inductive thematic analysis was used to explore how participants experienced the yoga programme.

Data collection

Qualitative data was collected using:

- ***Focus groups***. One week after completion of the yoga programme (week 9), six focus groups were held in the same venue and at the same time as the yoga classes (see Appendix 8 for recruitment e-mail).
- ***End-programme questionnaires***. Immediately after the programme, yoga participants were asked to comment about their experience of the programme. The end-programme questionnaire stated: *'We would be grateful for your comments about your experience of the yoga programme'* (Appendix 9, page 206).
- ***Telephone interviews***. Two NHS managers who supervised the yoga programme were interviewed via telephone. In addition, telephone interviews were arranged with two participants with adverse events who were not able to attend the focus group sessions.
- ***E-mail.*** During the programme, yoga participants were sent reminders to attend classes. Those not attending classes were e-mailed so that reasons for non-attendance could be determined.

Focus groups and end-programme questionnaires

Near the completion of the eight week programme, all yoga participants were invited to attend one of six focus groups (Appendix 8). Two focus groups were held at each of the three hospital sites. Each focus group lasted approximately 30 minutes.

Discussion was guided by the principal investigator or yoga instructor using a set of open-ended questions developed from a 'question route template' (Halcomb et al., 2006). This template suggests approximately eight questions, beginning with an introductory question to stimulate discussion, followed by key questions and completing with a final question (Halcomb et al., 2006).

The eight questions used in this study were selected by the research team to determine how the yoga intervention (i.e., classes, DVD, illustrated booklet) was experienced by participants, how successfully it was integrated into the daily lives of participants and how it could be improved in the future (Table 4.1).

The setting for each focus group was interactive with four to six participants sitting in a circle to facilitate dialogue. As the questions were asked by the facilitator, a hand-held recorder was used as a 'talking stick' to draw out more quiet participants, to prevent anyone from dominating the discussion and to create a safe atmosphere for participants to share their experiences and feelings about the programme (Seeds for Change, 2013).

Although one-to-one interviews may enable some participants to share more personal information (Gibbs, 1997; Hopkins, 2007), focus groups can generate more participants and are generally considered an invaluable methodology in healthcare research by capturing the subjective experiences of key stakeholders (Halcomb et al., 2006; Willis et al., 2009). In this study, the purpose of the focus groups was (Gill et al., 2008; Leung and Savithiri, 2009):

- to generate a richer understanding of participants' experiences
- to facilitate an exchange between participants of experiences and ideas
- to encourage 'piggybacking' whereby participants could build on each other's ideas
- to confirm, extend or challenge data collected from quantitative methods.

While the focus groups made it possible for participants to interact and exchange their experiences, the end-programme questionnaire provided an opportunity for each participant to describe their own experience without being influenced by the group (Gibbs, 1997). Since focus group participants interacted in a specific context within a specific group culture, it could not be assumed that individuals expressed their own definitive view (Gibbs, 1997). Taken together, the focus groups and end-programme questionnaire enabled participants not only to share their experiences with one another, but also to reflect and describe their own personal perspective of the programme.

Table 4.1: Focus group questions

1	What attracted you to join this study?
2	What was your experience of the yoga classes?
3	How effective was the back care DVD and illustrated booklet for helping you learn the Dru back care programme?
4	Describe any benefits you may have experienced from practising yoga during the last eight weeks.
5	Describe any adverse effects you may have experienced from practising yoga during the last eight weeks.
6	Describe any aspects of this yoga programme that you think could be improved.
7	Describe the extent to which you have been able to integrate yoga into your daily life.
8	Is there anything else you would like to say about this yoga programme?

Data analysis

Inductive thematic analysis is a qualitative research tool that reports on the experiences, meanings and realities of participants. In this qualitative evaluation, the data was analysed using a six-phase method for determining the final themes from end-programme questionnaires and focus groups (Braun and Clarke, 2006) (Table 4.2).

Qualitative data from end-programme questionnaires and from audio-recorded focus groups were transcribed verbatim. Initial codes were created from these transcripts by two researchers working independently. Then, working together, the researchers developed the preliminary themes from the two sets of codes (Table 4.3). Disagreements over preliminary themes were discussed until consensus was reached

The preliminary themes were selected based on the prevalence and relevance of theme (Braun and Clarke, 2006). Prevalence related to the number of participants throughout the entire data set who offered similar responses. Relevance focused on the pertinence of responses to the overall research question of how employees experienced the yoga programme.

Table 4.2: Six-phase method of thematic analysis

Phase	Description
Transcribing	Transcribing the data and becoming familiar with the data by actively reading and re-reading the transcripts.
Coding	Generating codes from the transcripts by organising the data into meaningful categories.
Searching for themes	Sorting through codes, considering how different codes may be combined to form initial themes and ensuring that all relevant data extracts are included in each theme.
Reviewing and refining initial themes	Reviewing and refining initial themes to achieve good internal and external homogeneity.
Defining and naming final themes	Describing the scope and content of each theme and what aspect of the data each theme captures.
Writing the report	Using appropriate data extracts for each theme and telling the story of the dataset, both within and across themes and how each theme relates to the research question.

Participant quotations were assigned a number consisting of their hospital-based worksite (i.e., 1, 2 or 3) followed by their randomisation number for that worksite and then the source of the quotation (i.e., focus group = FG and end-programme questionnaire =EQ).

Table 4.3: Generating initial codes from transcripts

Data source	Transcripts	Initial codes	Preliminary themes
Participant 3-53-FG	*I found the classes very helpful with my back. My back pain has actually settled to the point where I'm no longer having daily pain. The relaxation has helped, it's given me self-confidence. So I've really enjoyed it.*	• Helpful with my back • Back pain has settled • No daily pain • Relaxation has helped • Self-confidence • Enjoyed it	• Less back pain • Feeling relaxed • Enjoyment of programme
Participant 1-46-FG	*I found in work, especially when it's hectic, that I sort of go still, and I just listen to my breathing and I do neck exercises and I also do the arm raising stretch exercises. For the sleeping at home, I am sleeping longer.*	• Go still • Listen to breathing • Neck exercises • Arm raising stretches • Sleeping longer	• Feeling calm • Body-awareness • Neck and arm exercises • Sleeping better
Participant 2-10-EQ	*I have found the yoga programme to be a wonderful experience. I no longer struggle with back pain at night in bed, which has caused me sleepless, restless nights for over 10 years. I feel energized after the class.*	• Wonderful experience • No longer struggle with back pain which caused me sleepless nights • Energized after class	• Enjoyment of programme • Less back pain • Sleeping better • Feeling energised

Four final themes emerged: *reducing pain, enjoying the programme, feeling relaxed and sleeping better* and *becoming body-aware* (Table 4.4). Each final theme captured a different aspect of the dataset. NVivo9 was used to verify the internal consistency of each final theme.

Table 4.4: Generating final themes

Preliminary themes	Final themes
• Enjoyment of programme • Less pain • Feeling relaxed • Sleeping better • Body-awareness	1. Reducing pain 2. Enjoying the programme 3. Feeling relaxed and sleeping better 4. Becoming body-aware

Once final themes were selected, NVivo9 was used to verify the internal consistency for each theme (Table 4.5). Because of the exploratory nature of the end programme questionnaire and the focus group questions, terms such as 'all', 'most', 'many', 'some', 'a few' and 'one' are used in reporting the results (Conboy et al., 2013).

Table 4.5: Verification of internal consistency using NVivo9

Theme	Search terms	NVivo9 results	NVivo9 results (Adjusted)**
Enjoying the programme	enjoy* OR wonderful* OR excellent* OR positive*	58 coded references	52 coded references
Reducing pain	pain* OR tension* OR flexible* OR supple* OR back* OR neck* OR shoulder*	97 coded references	69 coded references
Feeling relaxed and sleeping better	stress* OR calm* OR relax* OR sleep* OR energy*	64 coded references	50 coded references
Becoming body-aware	aware* OR posture* OR integrate* OR use* OR incorporate*	60 coded references	32 coded references

*** indicates wildcard search term**
****after manual inspection for internal consistency**

4.4 Results

Four themes emerged from inductive thematic analysis: enjoying the programme, reducing pain, feeling relaxed and sleeping better, and becoming more body-aware.

Theme 1: Enjoying the programme

Most participants reported enjoying the programme. Comments included: "wonderful", "good fun", "most rewarding", "refreshing and energising", "very positive experience", "great programme", "very pleasant and beneficial", "lovely and relaxing", "incredibly valuable". Participants enjoyed various aspects of the programme: the classes, instructors, the DVD and illustrated booklet.

Movement, breathing, and relaxation

Participants commented on enjoying and benefiting from all three components of yoga: movement, breathing and relaxation. Responses included: *"greatly enjoyed learning new ways to move freely and energise my body" (*3-27-EQ) and *"I enjoyed most of the exercises with great benefits to my lower back, making it feel more flexible and stronger and also neck exercises of great benefit" (3-6-EQ).*

Breathing techniques were an important component of the yoga programme and a few participants commented on this: *I found it very useful to learn the basics, core strength, stretching and breathing (*1-47-EQ). Another stated*: "Life is so fast-paced and hectic. I found it very refreshing and energizing to be still and concentrate on breathing and stretching…the yoga has helped my flexibility and 'breathing' control" (1-21-EQ).*

Each yoga class ended with a guided relaxation with participants lying on their mats. One commented: *"I found the classes very relaxing. I didn't initially think about the relaxing side of yoga. But what I have learned is, it is important. It took me a few classes to appreciate the relaxing side of it, and I think it is an important aspect of the class" (*3-56-FG). Another participant said: *"I found the relaxation very therapeutic and beneficial, even energising afterwards" (*3-38- FG).

The classes

One participant who withdrew after week four said: "*I thoroughly enjoyed the first 3 to 4 weeks that I attended…and would recommend this form of yoga to help with tension, relieve the stresses of the day and stretch out the body especially the back in a more gentle way*" (1-8-EQ).

Another said: *"I enjoyed the classes because we got to see how well we were all doing and learn off each other; so if you weren't sure about how you were doing something at home you could check it out when you came back …. it was really good" (*2-5-FG).

The instructors

There were also favourable comments from the focus groups about the quality of instruction including: *"All the people involved in teaching the yoga programme were fantastic" (2-18-FG)* and *"I thought the instructor was very, very good. The way that we've been able to transfer things we've learned within the class to everyday life…she's encouraged us to think in certain ways, we feel strong and that's been really important to me" (3-32-FG).*

The DVD

Those who attended the yoga classes were given a DVD and an illustrated yoga booklet as a guide for practising at home, with many participants responding favourably. One said: *"I found the DVD really good and it was at the right pace, it was easy to follow"* (1-11-FG). Another participant commented: *"I did enjoy the DVD…and my husband was joining in as well"* (2-37-FG).

Another participant explained that the DVD helped her learn the 'cat' (a specific yoga posture for spinal flexibility). She said: *"The video was slow enough…like the 'cat'…I didn't actually catch it from the class, I actually caught it from the video"* (1-19-FG). Similarly, another commented: *"The DVD was good in that you can look at how they are doing it, you can rewind" (*2-45-FG).

The illustrated booklet

Others valued the illustrated booklet: "*I actually took the booklet to work after the first class…I read how I was supposed to do it and then I did it again. So for me the booklet was an added extra" (*3-53-FG).

Another participant reported: "*I had the booklet, just carried it around with me so I could look at it at odd times to familiarise myself, just to feel I could get the most out of it" (*3-32-FG).

Theme 2: Reducing pain

Most participants reported on the physical benefits they received from the yoga programme. Sub-themes included:

- reduced back pain
- less neck pain
- increased body flexibility
- relief from arthritis
- pain management.

Reduced back pain

Most found the yoga classes very helpful for relieving back pain with comments such as: *"it's really helped my back" (3-12-FG), "very helpful with my back"* (3-53-FG) and *"my back pain is still there but has decreased in frequency" (*2-5-FG). Some also commented that their back pain had entirely disappeared.

One participant wrote that "*my back pain has actually settled to the point where I'm no longer having daily pain" (*3-53-FG). Another said "*I no longer struggle with back pain at night in bed, which has caused me sleepless/restless nights for over 10 years*" (2-10-EQ).

Less neck pain

Less pain and more movement in the neck were also commonly reported. One participant wrote that *"I've found that I can turn my head far more to the left now, and without pain, than I could before" (*1-22-FG).

Another said: "*I sometimes clicked my neck. I used to do it probably about 10 times a day. Now I don't think I've done it at all if I practise yoga. It has really made a big difference*"… (2-30-FG). One participant who had been having *"a lot of neck, shoulder and upper back problems"* commented: "*These are much better*" (2-47-FG).

Increased body flexibility

Many who took part commented about feeling "looser" and "walking freer." One said: *"I have found the yoga programme very beneficial, to the extent that my spine will stiffen if I do not keep up with it…It definitely makes a difference*" (2-7-EQ). Another commented, *"My back's just more fluid and stuff" (*3-13-FG). One participant who said she had had *"back pain for as long as [I could] remember"* stated: *"I realise I am getting older, I am losing flexibility. …Since I started the yoga it has helped me, it has made me feel loose limbed …" (*2-25-FG).

Relief from arthritis

A few participants suffered from arthritis and mentioned how the yoga programme helped. One said: "*I have arthritis and the postures and movement, helped increase my flexibility" (*2-25-EQ). Another commented: "*I have really bad arthritis in my neck and shoulders…this has been fantastic. It reminded me of the things that I learned years ago about posture and about how to hold myself and breathe" (*2-14-FG).

Improved pain management

It was evident that the yoga programme provided skills and techniques for more effectively managing pain. One stated that, *"yoga has given me the confidence to manage my back and hip pain and a way to keep fit and be able to relax" (*2-27-EQ).

Another who had experienced back pain for many years said that *"since 2001, I have suffered with back pain especially at night in bed. I tend to stiffen up and then wake up on and off through the night…I have to say that since I have been doing this yoga I have had no back pain at night and I have been sleeping a lot better so I am really pleased and will continue to do it*" (2-10-FG).

Theme 3: Feeling relaxed and sleeping better

Most who took part in the programme reported mental benefits from the yoga. Sub-themes included: feeling calm and more relaxed, better sleep, more energy and improved confidence.

Feeling calm and more relaxed

Many said they benefited mentally from the yoga. A few participants commented on feeling calmer: "*I have benefited mentally. I feel calmer, clearer in my mind and have found a way to relax at those times when things get too much" (3-13-FG).*

Another commented: "*I definitely feel calmer since I have been doing yoga. I feel I can control my anxiety and my stress a little bit better from learning some of the techniques that I have been taught in these classes"* (2-18-FG).

For one participant the yoga offered "*moments of calm in a stressful world…Dru Yoga was a peaceful way to help me relax"* (2-25-EQ). Another described how engaging with the programme had helped her to develop *"coping mechanisms"* (3-13-FG), which enable her to remain more relaxed when dealing with stressful situations both at home and at work.

Sleeping better

Many participants reported improved sleep after practising yoga. One said, *"My mood and sleeping pattern has also improved with yoga practice"* (2-55-EQ). Another participant said, "*I am sleeping longer. I can sleep now maybe 6 hours and I notice that if I don't do regular exercises at home it shortens again, so it is forcing me to do more regular exercises" (*1-46-FG).

More energy

Some respondents noticed having more energy from practising yoga. Comments included, "as *someone who has struggled with time and energy to get moving (exercising) on a regular basis, it has been most rewarding. I feel energised after the class and also after working with the home DVD" (*2-10-EQ) and "*I think the best thing was feeling like I've got enough energy to carry on with the evening work tasks. After a full day at work, the best thing for me is just the energy (I feel) afterwards"* (1-11-FG).

Improved confidence

A few participants reported feeling greater self-confidence, and confidence in managing pain. One said "*the relaxation has helped; it's given me self-confidence. I've really enjoyed it…the programme has given me the confidence to ask for and accept help with the re-occurrence of my depression and anxiety" (*3-53-EQ).

Another responded, *"I feel more body confident. I feel stronger and I have more confidence in using my body in postures, in everyday life, in handling and managing things without straining my body. So everything is in alignment" (*3-38-FG).

A third described a renewed confidence from learning yoga: *"My son came home, he's in the RAF, and I said look at what I can do now and he's going 'wow mum that's brilliant' and I was like yeah. I was so chuffed with myself I was showing everybody. So something like that to me is a big thing because I was never able to do it, so yeah" (*3-48-FG).

Theme 4: Becoming body-aware

A few participants commented on how they had become more aware of their bodies (e.g. posture, recognising the onset of pain) and recognised the need for 'me' time to stay healthy and centred.

Several mentioned how they had integrated yoga into their daily lives.

Improved posture

There were many reports of improved posture from practising yoga. One participant said: "*I've definitely been aware of my posture in the day. I'll find if I'm standing on the ward I'll double check myself and put my posture right. Then I will realise how badly I was standing before and it's definitely helped my shoulder" (*2-30-FG).

Others revealed*: "I find when I am walking down a corridor I find myself holding myself better. I've always had really bad posture and I find myself straightening up and making sure I am walking straight"* (2-27-FG) and, *"yoga just helps you look after your body better and makes you more aware of it" (*1-23-FG).

More 'me' time

As illustrated in the following responses, some participants found that engaging with the programme was a means of making time for oneself: *"I feel like it's been a chance to invest something in myself and we don't generally do that enough, a lot of us. So it's reminded me how important it is to do that, which helps me and I am going to carry on with it*" (3-32-FG).

A similar response came from another participant speaking about the benefits of the programme: "*Making time for yourself and feeling the difference …*" (1-29-FG).

Integrating into daily life

Some participants explained how they had been able to integrate yoga into their daily life, improving their self-awareness, health and wellbeing. One wrote that, "*if I feel uncomfortable or in slight pain I am able to use some of the exercises to help when at work or in the car*" (2-31-EQ).

Others reported practising yoga techniques at work to alleviate tension and pain. One responded: "*When sitting at my computer, I'll do the neck turns because I do get quite a lot of problems in my shoulders and my neck…If your neck's aching, you can do the side-to-side neck exercises…Sometimes if my back is really sore, I bend forwards and that helps"* (2-5-FG).

Another said: *"I've actually integrated yoga into my working day, to help me cope. In the time it takes somebody to go to the loo, or to go and have a cigarette, I can do just a couple of postures, something that helps me stretch the muscles gently and stops me getting stiff. Yoga helps me take a few breaths and to keep myself centred"* (3-38-FG).

Improving the programme

Overall, most employees who took part expressed interest in an on-going yoga programme, saying that they would recommend the programme to others and that they would be willing to pay. There was broad recognition of the importance of having a regular yoga practice to maintain the benefits experienced from the programme.

On-going yoga programme

Interest in an on-going yoga programme was high. One participant said "*I will carry on with this yoga programme always – it has helped very much"* (3-55-EQ).

An NHS manual handling manager who observed most of the classes said: *"People were disappointed that the programme stopped when it did. I think an on-going programme would be very much what people would be interested in"* (telephone interview).

Another participant said: *"The programme has been beneficial notably for aiding relaxation, relieving muscular aches and pains, increasing energy levels, alertness, combating tiredness/fatigue, increasing sense of wellbeing. I always felt more relaxed, awake, energised following classes especially after a tough day at work. It would be good to make weekly yoga classes routinely available to staff"* (2-9-EQ).

Most stated they were willing to pay between £3 and £6 per class for on-going yoga classes. One participant reported, "*I used to access reflexology through occupational health which I think was £10 for an hour which was taken out of your wages at the end of the month…perhaps introducing something like this on a similar basis where we are charged for it because I would certainly come" (*3-12-FG).

Another stated: "*I would definitely come and I would pay"* (1-11-FG).

Providing childcare

A few participants offered suggestions for how an on-going yoga programme could be improved, such as providing childcare and offering classes at different times during the day.

There were three withdrawals due to childcare commitments. One wrote: "*Unfortunately I am going to have to pull out of the yoga study. My personal circumstances have changed and having to juggle an extra commitment is going to be too much for me at the moment.*

With childcare, I'm really sorry…I thoroughly enjoyed the session yesterday" (1-9-email). Another stated that: *"I will not be able to turn up again tonight. It's what happens when you have grandchildren, always on their beck and call. So I will pull out"* (1-23-email).

Offering classes at different times

Although some participants said that holding the yoga classes from 5.30 pm to 6.30 pm at a hospital location was *"convenient", "ideal"* and *"well-timed"*, one would have preferred the yoga classes to start later in the evening around 7 pm (3-1-FG). Another suggested offering classes during the lunchtime break (3-38-FG).

Adverse events

While most participants reported improvements in physical and mental health from practising yoga, two experienced back spasms while practising yoga at home. In addition, one other mentioned a period of sickness absence during the programme due to depression and anxiety.

Of these three, one of the participants who experienced a back spasm after the first week said: *"I attended the session last Tuesday and did a session at home on Thursday and my back has gone into spasm. I don't think it's a good idea for me to continue"* (2-24-email).

The other two with adverse events completed the end-programme questionnaire and offered a more detailed explanation of their experience of the yoga programme, as described in the two case studies below.

Case study 1

One of the participants, who experienced a back spasm after week four of the yoga programme, continued to practise yoga at home using the DVD and illustrated booklet. She wrote:

"My physiotherapist felt that as I already had a weakness in my back some of the exercises probably inadvertently caused the back to go into a spasm. He has since had a look at the book that accompanied the DVD and suggested some of the routines I can do at the moment and then progress onto the others when my core muscles are stronger…Although I was not able to complete the yoga programme due to my back going into a spasm, I thoroughly enjoyed the first 3-4 weeks that I attended. At the end of the sessions, I felt more relaxed, and I slept a lot better" (1-8-EQ).

In addition, this participant learned that her back spasm may have even been instigated by the medication she was taking for depression and anxiety.

She said: "*After a little bit of research I have discovered that it could be the medication that I take (venlafaxine I've been on them for 6 + years) that is causing my muscles to tighten which then is affecting my back and neck. Currently I am in the process of trying to come off this medication but it isn't easy. My husband and I really love doing the yoga but I have to be very careful. Fingers crossed, and if I manage to come off the medication, this will help*" (1-8-telephone interview).

Case study 2

Another participant reported an extended period of sickness absence during the six-month study due to depression and anxiety.

She stated: "*During the programme and within the last year, I have had episodes of sickness relating to my depression and anxiety. During the programme, when I was off sick, I was able to use my yoga practice to provide me with the confidence to talk to people and it helped me manage my anxiety*" (3-53-telephone interview)

This participant was able to use yoga as a means of alleviating the negative effects of depression and anxiety.

She continued: "*My experience during the classes was excellent. The instructor was calm and serene and after being in the class for a few minutes, even before the start, I would start to feel refreshed and re-energised…By the end of the class I could feel myself smile, something which I used to find difficult to do, and I felt more confident*" (3-53-telephone interview).

"The programme has given me the confidence to ask for and accept help with the re-occurrence of my depression and anxiety" (3-53-EQ). "The relaxation has helped; it's given me self-confidence. I've really enjoyed it…my only wish was that the study would have been longer" (3-53-telephone interview).

4.5 Discussion

This qualitative evaluation explored the experiences of NHS employees participating in an eight-week yoga programme. Using thematic analysis, four main themes were generated: *reducing pain, enjoying the programme, feeling relaxed and sleeping better* and *becoming more body-aware*. Overall, participants enjoyed the programme and benefited both physically and mentally. Those who practiced yoga reported less back and neck pain, improved flexibility and suppleness, increased energy and confidence, more body-awareness and better sleep quality.

Thematic analysis indicated that yoga provided a holistic approach to health (Desikachar et al., 2005). Rather than focusing on treating one illness or disease, yoga seemed to generate numerous physical and mental benefits. This finding was consistent with previously published qualitative studies of yoga.

Although a literature search yielded no qualitative studies of yoga for employees in workplace settings, several studies were found on yoga for people with chronic pain (Tul et al., 2010), people recovering from stroke (Garrett et al., 2011), people with cancer (Galantino et al., 2012, van Uden-Kraan et al., 2013), people suffering from neck pain (Cramer et al., 2013c), young people in a high school setting (Conboy et al., 2013) and people with stress-related symptoms (Anderzen-Carlsson et al., 2014).

Enjoying the programme

In this workplace study, four factors helped to maintain high participation rates: participant enjoyment of the programme, free classes conveniently located to main hospital sites and management support from the regional NHS Office of Occupational Health and Wellbeing (Quintiliani et al., 2007; Hassard et al., 2012).

Blackford et al. (2012) identified enjoying the programme as an important factor in ensuring high participation rates in workplace physical activity programmes. Most participants in this workplace study reported enjoying some aspect of the yoga programme including movement, breathing, relaxation and the quality of instruction.

In addition, 74% of participants completed the yoga programme. Marcus et al (2006) and Strijk et al (2013) point out that, on average, nearly half of those who enrol in workplace physical activity programmes drop-out at some point. The favourable retention rate in this yoga study could be due in part to participants' enjoying the programme.

Reducing pain

Results from this qualitative analysis are consistent with findings from other quantitative studies that substantiate the effectiveness of yoga for reducing back and neck pain (Cramer et al., 2013c).

Participants in this workplace study reported a variety of physical benefits, including reduced back and neck pain, increased body flexibility, and improved posture. A few participants reported that their back pain disappeared completely and others said that they were able to sleep better at night due to reduced back pain.

In other qualitative studies of yoga, van Uden-Kraan et al. (2013) reported that yoga helped people with cancer to cope with pain, improve body flexibility, and sleep better. Cramer et

al. (2013c) found that yoga helped people with chronic neck pain to gain greater acceptance of their pain and to strengthen their perceived control over their health. Tul et al. (2010) reported yoga to be an effective coping strategy for pain management.

Feeling relaxed and sleeping better

The majority of participants in this study reported mental benefits such as feeling calm, more relaxed and confident. Other qualitative studies have found that yoga helps improve mental health. Van Uden-Kraan et al. (2013) reported that yoga helped cancer patients cope better with stress and to feel more confident. Cramer et al. (2013c) found that yoga participants with chronic neck pain became more relaxed and less irritable.

Anderzen-Carlsson et al. (2014) noted that yoga enabled people under stress to gain an improved sense of wellbeing, calmness, and a tendency to worry less. Conboy et al. (2013) found that for high school students yoga helped improve sleep quality and increased their ability to cope with stress.

In this study of yoga in the workplace, participants reported being able to cope better at work and manage their stress and back pain more effectively. A number of them felt more confident in managing their back pain and one said that the yoga programme gave her the confidence to seek professional help for her recurring depression and anxiety.

A large number of participants in this workplace study reported improved sleep quality and enhanced energy levels due to their yoga practice. Other randomised controlled trials have found a positive link between yoga and sleep quality (Khalsa, 2004; Mustian et al., 2013), and between yoga and energy levels (Galantino et al., 2012; Hartfiel et al., 2011).

In qualitative studies, Garrett et al. (2011) reported that yoga improved sleeping patterns for people recovering from stroke, and Galantino et al. (2012) noted improved energy levels from women with breast cancer.

Becoming body-aware

Increased body-awareness is a common theme from qualitative studies of yoga. Van Uden-Kraan et al. (2013) reported that cancer patients 'regained contact with their body and learned to rediscover their body' when practising yoga. Tul et al. (2010) found that yoga promoted a 'renewed awareness of the body' for people with chronic pain.

Cramer et al. (2013c) also found that yoga participants with neck pain gained a 'renewed awareness of their body's parts and functions'. Garrett et al. (2011) reported that 'improved body awareness' was a common response among yoga participants recovering from a

stroke. Conboy et al. (2013) found that high school students reported 'a greater kinaesthetic awareness of their body's feelings and physical states' from practising yoga.

In this workplace study, participants became more body-aware, developed the capacity to improve their posture and integrated yoga into their working day. They were able to apply therapeutic movements and breathing techniques when needed, knowing what to do when they felt tension in their back, or when they felt stressed and under pressure. Tul et al. (2010) also reported participants incorporating yoga stretches into work breaks to cope with stress.

Improving the programme

Participants offered suggestions for how to improve the yoga programme. A few would have preferred lunchtime or evening classes, especially those with child-care commitments immediately after work. For others, the eight-week programme was too short. Although the 2009 NICE Guidelines recommend eight sessions over a twelve week period for treating low back pain, recent research suggests that twelve sessions may be more effective (Sherman et al., 2011; Tilbrook et al., 2011; Cramer et al., 2013a).

Although the yoga classes provided in this study were provided at no cost to NHS employees, future yoga programmes in the NHS may require employees to partially pay for the service. Employees in this study indicated a willingness to make a co-payment of £3 to £6 per yoga class. With recent financial cutbacks in the NHS, this is an encouraging finding which could make the roll-out of a workplace yoga programme more practical, timely and cost-effective.

Offering worksite yoga to NHS staff is consistent with the NHS Constitution (April 2013), which pledges NHS employers to provide a high-quality working environment for NHS staff and to 'provide support and opportunities for staff to maintain their health, wellbeing and safety.'

Adverse events

In this study, two participants reported back spasms when practising at home. One dropped-out of the programme; however, the other continued to practise Dru Yoga under the guidance of her physiotherapist. Although adverse events among yoga participants may suggest a negative short-term effect, qualitative follow-up with participants and NHS managers indicated a more positive long-term effect.

One NHS manager who observed most of the classes stated that *"a couple of people in the group were a little bit worried...and I think initially they had some increase in pain, but certainly the ones who stuck with it did go on to improve"* (telephone interview).

The two case studies illustrated that ongoing yoga practice led to more effective strategies for coping with back pain and stress. The participant in case study 1 said that the yoga classes helped her to feel more relaxed and to sleep better. She used the illustrated yoga booklet to develop stronger core muscles in order to prevent future back pain.

The participant in case study 2 stated that the yoga classes helped her feel refreshed, re-energised and more self-confident, which gave her the courage to ask for help in dealing with her depression and anxiety.

Limitations

Although the findings are favourable toward the benefits of yoga, the convenience sample of focus group participants may not be representative of all yoga group participants. Of the 76 NHS employees randomised into the yoga group, 57% took part in the focus groups.

In addition, focus groups were led by either the principal investigator or one of the yoga instructors. To minimise observer bias, it would have been preferable for the focus group facilitator to be from the target population (i.e., an NHS employee) rather than affiliated with the research team (Leung and Savithiri, 2009).

Data obtained from focus groups may also have been biased by 'social desirability.' For example, because yoga participants were interviewed by yoga researchers and instructors, they may have overstated the benefits of the programme if they perceived their responses would be received favourably by others (van Dongen et al., 2013b).

This qualitative sample also included few men. Only 5% of those who completed end-programme questionnaires and 6% of those who participated in focus groups were men. These figures need to be taken in the context of the gender mix of the population from which the sample was taken. At the time when the yoga classes were offered, BCUHB employees were approximately 80% female and 20% male (BCUHB, 2013b). Even after taking this into account, the sample was not generally representative of the study population.

For workplace yoga to be adopted more widely, recruitment strategies will need to attract more men. The Unites States Army has successfully introduced therapeutic yoga by using the term 'integrative restoration' for veterans with post-traumatic stress disorder (Bingham et al., 2011).

4.6 Conclusion

The findings from this qualitative evaluation suggest that yoga can improve the physical and mental health of employees. Most participants experienced reduced pain levels, more relaxation, increased body-awareness, enhanced coping ability and they enjoyed the programme.

Participants were positive about the intervention and most reported that they would recommend the yoga programme to others. Of two reported adverse events, one reported beneficial longer- term benefits from continued yoga practice.

Future programmes should find suitable yoga facilities as close to the workplace as possible. Offering yoga classes before work, during lunch and after work may enable more employees to attend, especially staff who work shifts and those with childcare responsibilities.

Importantly, employees in this workplace study expressed a willingness to make a co-payment for yoga classes, which would enhance the cost-effectiveness and financial return for employers.

Chapter 5: A costing analysis of yoga in the workplace

5.1 Chapter summary

A costing analysis from the employer perspective considered the operational and equipment costs for an eight-week yoga intervention for 76 NHS staff at three UK hospital sites. Operational costs included costs for hiring the yoga instructors, paying for the venue and recruiting participants. Equipment costs were the costs for yoga mats and cushions, DVDs and illustrated yoga booklets.

Four different cost scenarios were calculated using a variety of pricing for equipment, yoga teachers and venues. Total costs to the employer ranged from £2,491 to £6,211, or approximately £33 to £82 per person for the eight-week programme.

5.2 Introduction

Costing analysis is typically undertaken from the perspective of the stakeholder who purchases and implements the intervention. In the UK, the purchaser and implementer is usually the *NHS as a health service provider*. Therefore, costing analysis is often reported from the NHS perspective in clinical guidance and technology appraisals (NICE, 2011).

In this chapter, however, the costing analysis was conducted from the employer perspective since the implementer of the yoga programme was the *NHS as an employer*. Only the direct costs to the employer for implementing the programme were considered (Proper et al., 2004). Determining the direct costs of the yoga intervention at the micro-level was the necessary first step in conducting a broad economic evaluation (Charles et al., 2013).

The costing analysis in this study involved (Sach et al., 2014):

- identifying relevant resources
- measuring the quantity used
- calculating the value of resource utilisation
- performing sensitivity analyses with four cost scenarios.

In this case study of workplace yoga, a costing analysis was especially useful because a new programme was being evaluated, and there were no previous cost estimates for delivering this intervention (Sach et al., 2014).

5.3 Methods

The costing analysis from the employer perspective considered the following categories:

- *equipment costs*: purchase of yoga mats and cushions, the instructional DVD and the illustrated booklet for home practice;
- *instruction costs*: the cost for six yoga instructors to deliver the programme. This consisted of costs for teaching, travel, room set-up and administration.
- *recruitment costs*: incurred in recruiting employees to participate in the eight week yoga programme. This included the labour cost to write an all-staff e-mail and to sign-up interested employees;
- *venue costs*: fee for hiring the teaching room which included overheads. Note that in this study there was no fee for hiring the teaching room since the yoga classes were held in NHS manual handling rooms on weekdays after 5 pm.

After identifying the cost categories, four scenarios were created to generate a range of total costs for delivering the yoga programme in different real-life settings (Table 5.1). Scenario 1 represents the actual costs accrued during the eight-week programme. Scenarios 2 and 3 depict when yoga instructors were paid at £64 and £40 per session. These rates were based on the suggested upper- and lower-end range of payments for yoga teachers in the UK as reported by the National Careers Service.[1] Scenario 4 illustrates the maximum cost scenario when venue costs and retail prices were included.

In this analysis, all costs were presented in 2013 British Sterling prices. Discounting for changes in pricing over time was not necessary given that the eight week yoga programme and follow-up period was completed within one year.

Overhead costs such as electricity and heating were included only in scenario 4 when a venue hire cost of £15 per session was included. For scenarios 1, 2 and 3, overhead costs would have been minimal. Additional electricity was used only for lighting during the classes. No additional heating was required in the manual handling rooms where the yoga classes were held.

The opportunity costs of lost productivity were also not included in this analysis. Since the yoga sessions did not compete with the working hours of employees or with alternative uses of the venues, the opportunity costs were minimal.

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[1] [1] https://nationalcareersservice.direct.gov.uk/advice/planning/jobprofiles/Pages/yogainstructor.aspa (accessed 21 December 2014)

Table 5.1: Four cost scenarios

Cost scenarios	Description of costs
Scenario 1 (actual study cost scenario)	• Instruction costs at £91 per session (£60 teaching, £15 travel, £10 room prep, £6 admin) • Equipment costs at wholesale prices • Recruitment costs at £19 • No venue costs
Scenario 2 (instruction costs – upper end)	• Instruction costs at £64 per session (£40 teaching, £8 travel, £10 room prep, £6 admin) • Equipment costs at wholesale prices • Recruitment costs at £19 • No venue costs
Scenario 3 (instruction costs – lower end)	• Instruction costs at £40 per session (£40 teaching, £0 travel, £0 room prep, £0 admin) • Equipment costs at wholesale prices • Recruitment costs at £19 • No venue costs
Scenario 4 (maximum cost scenario)	• Instruction costs at £91 per session (£60 teaching, £15 travel, £10 room prep, £6 admin) • Equipment costs at retail prices • Recruitment costs at £19 • Venue costs at £15 per session

5.4 Results

Equipment costs

For this study, equipment costs included the purchase of 36 yoga mats and 36 yoga cushions (12 of each for each of the three venues). The yoga mats were purchased at £5 per mat, and the cushions at £4 each.

Supplementary instructional materials included 76 yoga DVDs and 76 illustrated yoga booklets, one per person at a wholesale cost of £2 each and £1 each, respectively.

Equipment costs totalled £552 (wholesale prices) and the mean equipment cost per participant was £7.26 (Table 5.2).

Table 5.2: Costs of equipment (n=76)

		Cost scenario 4						
Cost component	Unit price £	Qty	Equipment cost/ person £	Total equipment costs £	Qty	Unit price £	Equipment cost/ person £	Total equipment costs £
Yoga DVD[1]	2.00	76	2.00	152.00	76	4.00	4.00	304.00
Illustrated booklet[2]	1.00	76	1.00	76.00	76	2.00	2.00	152.00
Yoga mats[3]	5.00	36	2.37	180.00	36	10.00	4.74	360.00
Yoga cushions[4]	4.00	36	1.89	144.00	36	8.00	3.79	288.00
Total equipment costs			**£7.26**	**£552.00**			**£14.53**	**£1,104.00**

1 Duplicationcentre.co.uk, unit cost of £1.78 per DVD (n=76)
2 Bangor University Print Unit, unit cost of £1.28 per booklet
3 Yogamatters.com, unit cost of £5 per yoga mat (ex-yoga show)
4 Wilko.com at unit cost of £4 per cushion

Instruction costs

Instruction costs were the costs for teaching, travel, room set-up and administration.

Teaching costs

Yoga instructors were paid for their teaching time at a base rate of £60 per session in scenarios 1 and 4, and £40 per session in scenarios 2 and 3. At these rates, the teaching costs for six instructors over eight weeks was £2,880 in scenarios 1 and 4 and £1,920 in scenarios 2 and 3 (Table 5.5).

Travel costs

Travel time and mileage were estimated for each instructor using the postcodes for their home and the venue. Mileage was recorded and averaged for each instructor using Google Maps. A standard mileage rate of 40 pence per mile was used giving an mean cost of £15 per week (37.50 miles at £0.40 per mile). This was based on the mileage allowance payment specified by the UK government in 2013.[1]

The total travel costs for six instructors over the eight weeks were £720 (Table 5.3, 5.4).

[1] https://www.gov.uk/expenses-and-benefits-business-travel-mileage/rules-for-tax.

Table 5.3: Travel costs for yoga instructors

Yoga instructor	Mileage per week (round trip)	Total miles	Total travel cost per week £	Total travel costs £
Yoga instructor 1	73	584	29.20	233.60
Yoga instructor 2	23	184	9.20	73.60
Yoga instructor 3	64	512	25.60	204.80
Yoga instructor 4	29	232	11.60	92.80
Yoga instructor 5	18	144	7.20	57.60
Yoga instructor 6	18	144	7.20	57.60
Totals	**225**	**1,800**	**£90.00**	**£720.00**

Room set-up costs

Yoga classes were held in manual handling training rooms at each of the three worksites. Yoga instructors spent an average of 15 minutes preparing the training rooms for yoga, which involved moving and stacking chairs and placing yoga mats and cushions on the floor.

At the end of class, yoga instructors spent on average another 15 minutes storing the yoga mats and cushions, and returning chairs to their original placement in the training rooms. This 30 minute activity was valued at £10 based on the £20 per hour fee for room set-up in town halls in the UK.[1] Over the eight weeks, the total cost for room set-up was £480 (Table 5.4).

Administration costs

Administration time was the time taken to send e-mails to participants who missed a session and to all participants as a reminder of upcoming classes. These activities were paid at £10 per hour, based on a typical fee for an administrative assistant in the UK.[2] On average, yoga instructors recorded 36 minutes per week communicating with participants resulting in a cost of £6 each per week for administration. The total cost of administration for six yoga instructors during the programme was £288 (Table 5.4).

[1] https://www.torbay.gov.uk/btcbookingform.pdf

[2] http://www.totaljobs.com/JobSeeking/%28Admin%20Assistant%29.html

Table 5.4: Yoga instructor costs for travel, room preparation and administration

Yoga instructor	Travel (per session)	Room prep (per session)	Admin (per session)
1	73 miles @ 0.40 per mile = £29.20	43 minutes at site 1	36 minutes
2	23 miles @ 0.40 per mile = £9.20	43 minutes at site 1	32 minutes
3	64 miles @ 0.40 per mile = £26	32 minutes at site 2	30 minutes
4	29 miles @ 0.40 per mile = £12	32 minutes at site 2	40 minutes
5	18 miles @ 0.40 per mile = £7.20	15 minutes at site 3	44 minutes
6	18 miles @ 0.40 per mile = £7.20	15 minutes at site 3	34 minutes
Average for 6 instructors	37.5 miles	30 minutes per site	36 minutes
@ (Rate)	0.40 per mile	£20/hour	£10/hour
Mean costs	£15 per session	£10 per session	£6 per session
Total costs*	**£720.00**	**£480.00**	**£288.00**

*** mean costs x 6 instructors x 8 weeks**

Recruitment costs

Recruitment costs involved writing an all-staff e-mail to inform NHS employees about the yoga programme and preparing an announcement for the monthly e-newsletter from the Office of Occupational Health and Wellbeing. Recruitment was an administrative task and the responsibility of an NHS Band 3 Occupational Health administrative assistant who was paid at a rate of £9.50 per hour.[1] Two hours were recorded, generating a total recruitment cost of £19.

Venue costs

Rooms were provided free of charge by the NHS, as the yoga classes were held after working hours in the manual handling training rooms of three hospitals. A typical room hire rate in the UK (outside of London) for yoga classes ranges from £10-£15 per hour.[2] In the sensitivity analysis (below), venue hire was estimated at £15 per class (in cost scenario 4). The total cost of venue hire calculated in that scenario was £720 for the 48 yoga sessions (2 sessions per week for 8 weeks in 3 locations).

[1] http://jobs.personneltoday.com/

[2] http://liverpool.gov.uk/

Table 5.5: Operational costs (n=76)

		Scenario 1			Scenario 2			Scenario 3			Scenario 4		
Cost component	Units	Unit price £	Op cost/ person £	Total op costs £	Unit price £	Op cost/ person £	Total op costs £	Unit price £	Op cost/ person £	Total op costs £	Unit price £	Op cost/ person £	Total op costs £
Recruitment	2 hours	9.50 per hour	0.25	19.00	9.50 per hour	0.25	19.00	9.50 per hour	0.25	19.00	9.50 per hour	0.25	19.00
Teaching	48 sessions	60.00 per session	37.89	2,880.00	40.00 per session	25.26	1,920.00	40.00 per session	25.26	1,920.00	60.00 per session	37.89	2,880.00
Travel	48 sessions	15.00 per session	9.47	720.00	8.00 per session	5.05	384.00	NA	NA	NA	15.00 per session	9.47	720.00
Room prep	48 sessions	10.00 per session	6.33	480.00	10.00 per session	6.32	480.00	NA	NA	NA	10.00 per session	6.33	480.00
Admin.	48 sessions	6.00 per session	3.79	288.00	6.00 per session	3.79	288.00	NA	NA	NA	6.00 per session	3.79	288.00
Venue hire	48 sessions	NA	NA	NA	NA	NA	NA	NA	NA	NA	15.00 per session	9.47	720.00
Total Op Costs			**£57.72**	**£4,387.00**		**£40.97**	**£3,091.00**		**£25.51**	**£1,939.00**		**£67.19**	**£5,107.00**

Sensitivity analysis

Four cost scenarios were created to generate a range of total costs for delivering the yoga programme. The total costs by scenario ranged from £2,491 to £6,211 or between £32.78 and £81.72 per person, taking account of both operational and equipment costs (Table 5.2).

Table 5.6: Intervention costs (n=76)

Scenario	Equipment costs £	Operational costs £	Intervention costs £	Equipment costs per person £	Operational costs per person £	Intervention costs per person £
1	552.00	4,387.00	4,939.00	7.26	57.72	64.98
2	552.00	3,091.00	3,643.00	7.26	40.67	47.93
3	552.00	1,939.00	2,491.00	7.26	25.51	32.77
4	1,104.00	5,107.00	6,211.00	14.53	67.19	81.72

Scenario 1 considered the actual costs incurred in this study. In this scenario, the total intervention cost was £4,939 which included £4,368 for instruction (£91 per session), £552 for equipment, and £19 for recruitment (Table 5.6).

In scenario 2, when yoga instructors were paid £64 per session, a 28% reduction in total costs from scenario 1 was generated. In this setting, the total cost of the intervention was £3,643 (£3,072 for instruction, £552 for equipment and £19 for recruitment).

In scenario 3, instructors were paid £40 per session and there were no additional costs for room set-up, travel or administration. This reduced the total costs by 50% from scenario 1. With this adjustment, the total intervention cost in scenario 3 was £2,491 (£1920 for instruction, £552 for equipment and £19 for recruitment).

In scenario 4, yoga teachers were paid at £91 per session and a venue hire cost of £720 was included. Equipment costs were calculated at retail prices, effectively doubling the costs (£1,104) for yoga mats, cushions, DVDs and illustrated booklets. The total cost from scenario 1 was increased by 26%. In this maximum cost scenario, the total intervention cost was £6,211.

5.5 Discussion

The four scenarios present a range of costs to be considered for instruction, equipment and venue hire. Such a range reflects real-life situations in which employers invariably operate within budgetary constraints.

Instruction costs

The National Careers Service (NCS) in the UK estimates that yoga instructors are typically paid at a rate of approximately £40 to £60 per session. Although compensation for travel, room set-up, and administration are usually included in this per-session rate, these additional costs were added as extras in scenarios 1, 2 and 4 to compensate for the extra responsibilities involved in delivering yoga within a randomised controlled trial. However, if this yoga intervention were to be implemented more widely, then the extra costs of travel, room set-up and administration would invariably be included in the per-session rate.

In scenarios 1 and 4, the per-session rate for yoga instruction was £91 per session (£60 for teaching, £15 for travel, £10 for room set-up and £6 for administration); in scenario 2, the rate was £64 per session (£40 for teaching, £8 for travel, £10 for room set-up, and £6 for administration); and in scenario 3, instructors were paid £40 per session with no extra compensation for travel, room set-up or administration.

The instruction costs of £64 per session in scenario 2 and £40 per session in scenario 3 were congruent with the typical session rates identified by the National Careers Service.

Equipment costs and venue hire

The actual equipment costs and venue costs for this study were used in scenarios 1, 2 and 3. Equipment was purchased at wholesale rates of £5 per yoga mat and £4 per cushion (36 mats and 36 cushions, 12 of each for three venues). DVDs and illustrated booklets were purchased (one for each yoga group participant) at an approximate replication price of £2 per DVD and £1 per booklet (Table 5.2). Total equipment costs totalled £552. In addition, there were no venue hire costs since the yoga sessions were held in employer facilities outside of working hours.

In scenario 4, however, equipment was purchased at retail prices and a venue hire cost of £15 per session was included. At this rate, the total venue cost for the 48 yoga sessions offered during the study was £720.

Assuming retail prices are generally double wholesale prices, total equipment costs at retail prices were estimated at £1104, representing an additional cost of £552.

Purchasing equipment at retail prices (additional £552) and including the cost of venue hire (additional £720) added an additional £1,272 to the total cost (scenario 4).

Limitations

Child-care costs were not considered in this costing analysis. Of the seven participants who dropped out of the yoga programme for 'known' reasons, three withdrew because of childcare commitments. It is possible that other yoga participants (n=13) who did not complete end-programme questionnaires also withdrew due to childcare responsibilities. To meet the needs of employees with young children, employers could offer additional yoga classes at lunchtime or provide childcare support after work. This, of course, would mean additional costs to the employer.

Cost savings from the employer perspective

In this workplace yoga study, cost savings were achieved by purchasing yoga equipment at wholesale prices and by acquiring the venue at no cost in employer-owned facilities. Further savings for the employer could be achieved in the following ways:

- Paying yoga instructors at standard rates of £40 to £60 per session as suggested by the National Careers Service (scenarios 2 and 3).
- Requiring yoga instructors (as independent contractors) to furnish electronic marketing materials for recruitment purposes at no extra fee.
- Adopting a co-payment scheme, in which participants pay a subsidised price for the yoga programme with the remainder funded by the employer.
- Asking participants to provide their own yoga mat and cushion and to purchase the yoga DVDs and/or illustrated yoga booklet.
- Including more participants in each yoga class. However, the NICE guidance for the early management of low back pain recommends a class size of no more than 10 participants (NICE, 2009).
- Investing in professional training for internal staff to deliver the yoga programme, thus averting the cost for independent contractors.

Although these suggestions may be desirable, they should be applied only after careful consideration to ensure the potential positive effect of the programme is not compromised. For example, if participants are not provided with equipment such as mats, cushions, DVDs and illustrated booklets, then the employer may derive a reduced benefit from the programme because of lower employee participation.

In addition, a co-payment scheme for employees must be consistent with an amount that employees are willing to pay. A useful method of co-payment may be a regular automatic deduction from the employees' salary. Ideally a co-payment system would be established in a way that provides income tax benefits for both the employer and the employee, although this will depend on national tax laws.

Finally, larger employers may be prepared to invest in professional training for internal staff to become qualified to deliver yoga programmes in their workplace. Although this represents a higher initial investment for the employer, the long-term costs would likely be lower.

5.6 Conclusion

This costing analysis made it possible to measure and value the resources required to deliver an eight-week yoga programme in the workplace. Using four different scenarios, the total cost of the programme ranged from £33 to £82 per participant.

To achieve further cost savings, employers could consider paying yoga teachers at typical rates identified by the National Careers Service, establish an employee co-payment scheme or require participants to purchase their own yoga equipment. In addition, employers may choose to offer additional training for internal staff to deliver yoga in the workplace.

Chapter 6: Cost-consequence analysis

6.1 Chapter summary

Cost-consequence analysis was performed from the perspectives of the employer, healthcare provider and society. The employer perspective considered intervention costs and production loss costs. The healthcare perspective incorporated intervention costs and healthcare resource use costs. The societal perspective took account of all three categories: intervention costs, production loss costs and healthcare resource use costs.

For each perspective, the total costs were compared with the outcomes of the yoga programme. Outcomes were measured at six months using valid and reliable outcome measures.

The cost-consequence analysis showed that from the employer and societal perspectives, the yoga programme was less costly than usual care due to substantially less production loss costs from fewer sickness absence days.

One usual care employee, however, missed 29 days due to musculoskeletal conditions. When this outlier was winsorised, the yoga programme was more expensive than usual care in all scenarios from the employer perspective and from three of the four scenarios from the societal perspective. From the healthcare perspective, the yoga programme was more costly than usual care due to the higher intervention costs of the yoga programme.

Although the differences in outcomes between the two groups were not statistically significant at six months, the yoga programme, compared to usual care, was more effective for reducing back pain, improving psychological wellbeing and increasing health-related quality of life.

6.2 Introduction

Cost-consequence analysis is well-suited for public health interventions, including complementary medicine programmes such as yoga, which frequently generate a wide array of consequences (Herman, 2012). Herman (2012) recommends that all economic evaluations of complementary and integrative medicine include cost-consequence analysis using one or more perspectives.

In cost-consequence analysis, total costs and health outcomes are compared in a cost-consequence balance sheet. This balance sheet provides a clear descriptive summary of the costs of delivering an intervention and the various outcomes from which value for money judgements can be made (Trueman and Anokye, 2012).

6.3 Methods

The outcomes of the eight-week yoga programme were measured at the six-month follow-up using valid and reliable measures that assessed back pain, psychological wellbeing, resilience, physical exhaustion, rejuvenation, tranquillity and positive engagement (chapter 3). Health outcomes at six-months were then compared to the total costs calculated for each perspective - employer, healthcare and societal.

Employer perspective

Total cost from the employer perspective consisted of intervention costs and production loss costs. Intervention costs for the eight-week yoga programme included the costs for instructors, equipment, recruitment and venue hire.

These ranged from £33 to £82 per person depending on the cost scenario (Table 5.5). The intervention cost for the usual care group was £2 per person based on the costs for the 'Back Book' and 'How to Manage Stress'.

Production loss costs were defined in this study as the absenteeism costs attributed to musculoskeletal conditions. The number of sickness absence days due to musculoskeletal conditions was compared between the yoga and usual care groups during the six-month study period.

The production loss costs for other health conditions such as colds, coughs, flu, respiratory illness, ear/nose/throat conditions, gastrointestinal problems, migraine headaches, stress, anxiety and depression were also calculated (Appendix 10).

Total production loss costs were calculated by multiplying the number of sickness absence days by the mean cost per day (£113.84) for an NHS employee in 2013.[1]

Healthcare perspective

The total costs for the healthcare perspective consisted of intervention costs (as above) and the healthcare resource use costs during the six-month study. Healthcare resource use costs were collected from all participants at three time points: baseline, end-programme and six-month follow-up.

At each of these time points, participants completed a questionnaire asking how often in the previous two months they had visited healthcare professionals in primary care such as GPs, practice nurses, occupational health nurses, physiotherapists, osteopaths, counsellors or massage therapists. Participants were also asked to provide reasons for these visits.

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[1] http://www.nhsemployers.org/

The data from these questionnaires made it possible to calculate the healthcare resources used by yoga and usual care participants at each time point. The unit costs associated with healthcare resource use were obtained from national averages published in the NHS Reference Costs (Department of Health, 2013) and the Personal Social Services Research Unit (Curtis, 2013). Since the trial was conducted between April and September 2013, the chosen reference year for pricing was 2013.

Healthcare resource use costs in this analysis were calculated for all musculoskeletal and back pain related visits to the GP, physiotherapist, osteopath and massage therapist. For the purpose of this economic evaluation, visits for non-musculoskeletal conditions were not included in healthcare resource use costs. However, they are included in Appendix 11.

Societal Perspective

Total costs from the societal perspective incorporated intervention costs, production loss costs and healthcare resource use costs.

6.4 Results

Outcomes

Mean scores at baseline and six-month follow-up were compared between groups for all outcome measures (Table 6.1).

The results showed that at the six-month follow-up, the yoga group had less back pain, more psychological wellbeing and greater resilience than the usual care group, although the differences between groups were not statistically significant.

The yoga group, however, reported lower scores for rejuvenation, tranquillity and positive engagement. They also reported more physical exhaustion than the usual care group at six-months. Once again, the differences between the two groups were not statistically significant (Table 6.1).

Table 6.1: Differences in outcomes between groups: mean scores (SD) based on Table 3.8

	Yoga group			Usual care group			Between groups	
Domains	Baseline	6 months	Mean change	Baseline	6 months	Mean change	Mean difference 6 months	P-value 6 months
Back pain RDQ	2.09 (2.44) n=76	1.26 (2.05) n=43	-0.83	1.93 (2.97) n=75	2.03 (3.30) n=32	0.10	-0.93	0.196
Back pain Keele STarT	1.37 (1.16) n=76	0.95 (1.17) n=42	-0.42	1.41 (1.40) n=74	1.50 (1.30) n=32	0.09	-0.51	0.071
Psychological wellbeing WHO-5	13.45 (4.44) n=74	16.42 (4.54) n=43	2.97	13.57 (5.15) n=75	15.22 (5.20) n=32	1.65	1.32	0.132
Resilience RS-14	77.15 (13.10) n=73	81.10 (9.48) n=42	3.95	78.31 (11.89) n=72	78.74 (13.43) n=31	0.43	3.52	0.197
Rejuvenation EFI-RV	3.70 (2.60) n=71	4.95 (2.89) n=43	1.25	3.80 (2.60) n=71	5.48 (3.05) n=31	1.68	-0.43	0.447
Tranquillity EFI-TQ	5.71 (2.30) n=72	6.95 (2.59) n=43	1.24	5.80 (2.64) n=70	7.39 (2.43) n=31	1.59	-0.35	0.297
Positive engagement EFI-PE	5.73 (2.29) n=71	6.63 (2.76) n=43	0.90	5.61 (2.78) n=71	7.23 (3.05) n=31	1.62	-0.72	0.268
Physical exhaustion EFI-PHY	5.62 (2.85) n=71	3.98 (2.98) n=43	-1.64	5.43 (2.72) n=72	3.75 (2.93) n=32	-1.68	0.04	0.912

Costs

The total costs from employer, healthcare and societal perspectives were calculated for the 69 participants who completed six-month questionnaires.

Employer perspective

Total costs from the employer perspective included intervention costs and production loss costs. Intervention costs for the yoga group ranged between £32.77 and £81.72 per person depending on the cost scenario (Table 6.2).

Intervention costs for the usual care participants were £2 per person for the 'Back Book' and 'How to Manage Stress' (Table 6.2).

Table 6.2: Differences in intervention costs between groups

Scenario	Equipment costs per yoga participant £	Operational costs per yoga participant £	Total intervention costs per yoga participant £	Total intervention costs per usual care participant £	Difference in total costs per participant between groups £
1	7.26	57.72	**64.98**	**2.00**	**62.98**
2	7.26	40.67	**47.93**	**2.00**	**45.93**
3	7.26	25.51	**32.77**	**2.00**	**30.77**
4	14.53	67.19	**81.72**	**2.00**	**79.72**

Production loss costs were the monetary value of the sickness absence days due to musculoskeletal conditions. NHS electronic staff records (ESR) showed that yoga group participants missed 2 calendar days, while the usual care group missed 43 days due to musculoskeletal conditions (Table 6.3 and 6.4).

The production loss costs for yoga participants were £3 per person compared with £65.27 per person for usual care participants. This difference in production loss costs between the two groups over the six month study was £4,667.44 or £62.27 per person (Table 6.4).

Table 6.3: Yoga group: sickness absences due to musculoskeletal conditions

Group	Participant ID	NHS Band	Yoga classes attended	Sickness absence calendar days	Total cost (£113.84/day) £	Total cost per person £
Yoga	2-44	Band 2	7	2	227.68	3.00
Yoga total				**2**	**227.68**	**3.00**

Table 6.4: Usual care group: sickness absences due to musculoskeletal conditions

Group	Participant ID	NHS Band	Yoga classes attended	Sickness absence calendar days	Total cost (£113.84/day) £	Total cost per person £
Usual care	1-12	Band 4	0	5	569.20	7.59
Usual care	1-14	Band 5	0	1	113.84	1.52
Usual care	1-16	Band 7	0	29	3,301.36	44.02
Usual care	2-13	Band 6	0	3	341.52	4.55
Usual care	3-14	Band 4	0	5	569.20	7.59
Usual care total				**43**	**4,895.12**	**65.27**
Yoga total				**2**	**227.68**	**3.00**
Difference between groups				**41**	**4,667.44**	**62.27**

From the employer perspective, the yoga programme was more costly than usual care in scenarios 1 and 4, and less costly per person in scenarios 2 and 3 (Table 6.5).

Table 6.5: Employer perspective: differences in costs between groups

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £
Intervention costs per person	64.98	2.00	47.93	2.00	32.77	2.00	81.72	2.00
Production loss costs per person	3.00	65.27	3.00	65.27	3.00	65.27	3.00	65.27
Employer perspective per person	**£67.98**	**£67.27**	**£50.93**	**£67.27**	**£35.77**	**£67.27**	**£84.72**	**£67.27**

Employer perspective: sensitivity analysis with outlier winsorised

Although five usual care participants missed a total of 43 working days, one person (Participant ID 1-16) reported 29 days of sickness absence due to musculoskeletal conditions (Table 6.4).

When this outlier was winsorised from 29 to 5 days, the difference in sickness absence between the two groups was 17 days rather than 41, the difference in costs between the two groups was £1935.28 compared with £4,667.44, and the difference in production loss costs per person was £25.46 (Table 6.6) rather than £62.27 (Table 6.6).

Note that 'winsorising' (replacing) differs from 'trimming' (excluding). Rather than discarding outliers, winsorising replaces extreme outliers with less skewed values within the range of the other sample values (Ghosh and Vogt, 2012).

Table 6.6: Usual care group: sickness absences with outlier (ID# 1-16) winsorised

Group	Participant ID	NHS Band	Yoga classes attended	Sickness absence calendar days	Total cost (£113.84/day) £	Total cost per person £
Usual care	1-12	Band 4	0	5	569.20	7.59
Usual care	1-14	Band 5	0	1	113.84	1.52
Usual care	1-16	Band 7	0	5	569.20	7.59
Usual care	2-13	Band 6	0	3	341.52	4.55
Usual care	3-14	Band 4	0	5	569.20	7.59
Usual care total				**19**	**2,162.96**	28.46
Yoga total				**2**	**227.68**	**3.00**
Difference between groups				**17**	**1,935.28**	**25.46**

With the outlier winsorised, the yoga programme was more costly than usual care in all four scenarios from the employer perspective (Table 6.7

Table 6.7: Employer perspective: differences in costs between groups with outlier winsorised

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Yoga £	Usual care £	Yoga £	Usual care £	Yoga £	Usual care £	Yoga £	Usual care £
Intervention costs per person	64.98	2.00	47.93	2.00	32.77	2.00	81.72	2.00
Production loss costs per person (outlier winsorised)	3.00	28.46	3.00	28.46	3.00	28.46	3.00	28.46
Employer perspective per person	**£67.98**	**£30.46**	**£50.93**	**£30.46**	**£35.77**	**£30.46**	**£84.72**	**£30.46**

Healthcare perspective

From the healthcare perspective, the total costs included both intervention costs and healthcare resource use costs. During the six-month study period, usual care participants visited healthcare professionals for musculoskeletal conditions more than twice as often as yoga participants.

Yoga participants averaged 0.13 visits per person compared with 0.30 visits per person for usual care participants. The healthcare resource use cost (due to musculoskeletal conditions) for each yoga participant was £5.87 compared with £25.87 for each usual care participant (Table 6.8 and 6.9).

Table 6.8: Healthcare resource use costs: yoga group (n=39)

Heath care professional	Cost per visit £	Visits baseline to end-programme	Visits per person at end-programme Frequency (SD)	Costs baseline to end-programme £	Visits end-programme to six months	Visits per person at six months Frequency (SD)	Costs end-programme to six months £	Total costs baseline to six months £	Total costs per person £
GP[1]	53.00	0	0	0.00	1	0.03 (0.16)	53.00	53.00	1.36
Physiotherapist[2]	44.00	0	0	0.00	4	0.10 (0.45)	176.00	176.00	4.51
Osteopath[3]	43.00	0	0	0.00	0	0	0.00	0.00	0.00
Yoga totals		**0**	**0**	**£0.00**	**5**	**0.13** (0.47)	**£229.00**	**£229.00**	**£5.87**

Table 6.9: Healthcare resource use costs: usual care (n=30)

Heath care professional	Cost per visit £	Visits baseline to end-programme	Visits per person at end-programme Frequency (SD)	Costs baseline to end-programme £	Visits end-programme to six months	Visits per person at six months Frequency (SD)	Costs end-programme to six months £	Total costs baseline to six months £	Total costs per person £
GP[1]	53.00	1	0.03 (0.18)	53.00	2	0.07 (0.37)	106.00	159.00	5.13
Physiotherapist[2]	44.00	1	0.03 (0.18)	44.00	2	0.07 (0.37)	88.00	132.00	4.26
Osteopath[3]	43.00	7	0.23 (0.82)	301.00	4	0.13 (0.73)	172.00	473.00	15.26
Massage therapist[4]	38.00	0	0	0.00	1	0.03 (0.18)	38.00	38.00	1.22
Usual care totals		**9**	**0.29** (0.84)	**£398.00**	**9**	**0.30** (0.88)	**£404.00**	**£802.00**	**£25.87**

1 Curtis, L. (2013). Unit costs of health and social care. University of Kent: Personal Social Services Unit.

2 Department of Health. (2013). Reference costs 2012-13.

3 http://www.osteopathy.org.uk/visiting-an-osteopath/what-to-expect/

4 https://nationalcareersservice.direct.gov.uk/advice/planning/jobprofiles/Pages/massagetherapist.aspx

From the healthcare perspective, the yoga programme was more costly than usual care in each cost scenario due to higher intervention costs for the yoga programme (Table 6.10).

Table 6.10: Healthcare perspective: differences in costs between groups

yoga (n=39); usual care (n=30)

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £
Intervention costs per person	64.98	2.00	47.93	2.00	32.77	2.00	81.72	2.00
Healthcare resource use costs per person	5.87	25.87	5.87	25.87	5.87	25.87	5.87	25.87
Healthcare perspective per person	**£70.85**	**£27.87**	**£53.80**	**£27.87**	**£38.64**	**£27.87**	**£87.59**	**£27.87**

Societal perspective

Intervention costs, production loss costs and healthcare resource use costs were considered in the societal perspective. When considering all reported sickness absence days due to musculoskeletal conditions, the yoga programme was less costly than usual care in each cost scenario (Table 6.11).

Table 6.11: Societal perspective: difference in costs between groups

	Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £	Yoga group £	Usual care £
Intervention costs per person	64.98	2.00	47.93	2.00	32.77	2.00	81.72	2.00
Production loss costs per person	3.00	65.27	3.00	65.27	3.00	65.27	3.00	65.27
Healthcare resource use costs per person	5.87	25.87	5.87	25.87	5.87	25.87	5.87	25.87
Societal perspective cost per person	**£73.85**	**£93.14**	**£56.80**	**£93.14**	**£41.64**	**£93.14**	**£90.59**	**£93.14**

Cost-consequence balance sheet

When all reported sickness absence days were considered, the cost-consequence balance sheet showed the yoga programme to be less expensive than usual care in all four scenarios from the societal perspective and more expensive than usual care in all scenarios from the healthcare perspective.

From the employer perspective, however, the yoga programme was more expensive than usual care in scenarios 1 and 4, and less costly in scenarios 2 and 3.

The decision to implement the yoga programme from each perspective will depend on the values assigned to the outcomes of yoga, which included reduced back pain, improved psychological wellbeing, and increased resilience (Table 6.12).

6.5 Discussion

The results suggest that the yoga programme was less costly than usual care from the societal perspective. The key factor here was the difference in production loss costs between the two groups. Yoga participants reported only two sickness absence days due to musculoskeletal conditions over the six-month study, while usual care participants missed 43 working days. From this difference, a cost saving of £4,667, or £62 per person, was attributed to the eight-week yoga programme.

The yoga programme, however, was more expensive than usual care from the healthcare perspective. This was mainly due to the difference in intervention costs between the two groups. The cost of the yoga programme ranged between £33 and £88 per participant compared with only £2 per person for usual care.

During the six month study, the yoga group reported healthcare resource use costs of approximately £6 per person for musculoskeletal conditions compared with £26 per person for the usual care group. This can be attributed to 11 more visits for osteopathic treatment by usual care participants. Although the yoga group used healthcare resources (for musculoskeletal conditions) less than the usual care group, this was not enough to offset the intervention costs.

From the employer perspective, the yoga programme was less costly than usual care in scenarios 2 and 3, and more expensive in scenarios 1 and 4. This difference was mainly due to instruction costs. In scenarios 1 and 4, yoga teachers were paid £91 per session, whereas in scenarios 2 and 3, instructors were paid £64 and £40 per class, respectively.

On the consequences side, the yoga programme at six-months was more effective than usual care for lowering back pain and for improving psychological wellbeing and resilience.

However, the yoga programme at six months was less effective than usual care at improving rejuvenation, tranquillity, positive engagement, and at reducing physical exhaustion – all four domains of the Exercise-Induced Feeling inventory.

It is possible that the increases in the feeling state scores for usual care participants at six months were influenced by 'outcome expectancy' (Williams, 2010), since these participants completed questionnaires only one week before starting their four week series of free yoga classes, which was offered as an incentive for their continued participation in the study.

Limitations

The cost-consequence analysis did not assign monetary values to health outcomes such as back pain, psychological wellbeing and resilience. Given that the yoga programme was more expensive than usual care from the healthcare perspective and in two scenarios from the employer perspective, it is difficult to judge whether funding the programme could be justified.

In addition, cost-consequence analysis was limited in its ability to capture all important consequences due to the limited number of reliable and valid outcome measures used in this trial. This study, for example, did not measure sleep quality, flexibility or body awareness, which were identified by yoga participants as relevant health outcomes in the qualitative evaluation (chapter 4).

6.6 Conclusion

The yoga programme, in comparison with usual care, was worthy of funding for all cost scenarios from the societal perspective, and for scenarios 2 and 3 from the employer perspective.

However, for all cost scenarios from the healthcare perspective and for scenarios 1 and 4 from the employer perspective (where the costs of yoga were greater than usual care), it was difficult to determine whether the benefits gained were substantial enough to justify the costs.

Since cost-consequence analysis does not place a monetary value on health outcomes, the judgement of value for money depends on which key stakeholder(s) pay for the programme.

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Table 6.12: Cost-consequence balance sheet

COSTS	Scenario 1 £	Scenario 2 £	Scenario 3 £	Scenario 4 £
Employer perspective (yoga)	67.98	50.93	35.77	84.72
Employer perspective (usual care)	67.27	67.27	67.27	67.27
Healthcare perspective (yoga)	70.85	53.80	38.64	87.59
Healthcare perspective (usual care)	27.87	27.87	27.87	27.87
Societal perspective (yoga)	73.85	56.80	41.64	90.59
Societal perspective (usual care)	93.14	93.14	93.14	93.14

CONSEQUENCES	back pain (RDQ)	back pain (Keele STarT)	psychological wellbeing	resilience	rejuvenation	tranquillity	positive engagement	physical exhaustion
Mean difference between groups	-0.93	-0.51	1.32	3.52	-0.43	-0.35	-0.72	0.04
p-value	p=0.196	p=0.071	p=0.132	p=0.197	p=0.447	p=0.297	p=0.268	p=0.912

Chapter 7: Cost-effectiveness analysis

7.1 Chapter summary

A cost-effectiveness analysis of yoga for managing back pain in the workplace showed that from a societal perspective (all scenarios) and from an employer perspective (scenarios 2 and 3), the yoga programme at six-months was *dominant*, that is, both less costly and more effective than usual care for managing back pain.

Since the yoga intervention was dominant from the societal perspective, ICERs were only calculated from the healthcare perspective (all scenarios) and the employer perspective (scenarios 1 and 4).

ICERs showed that the additional cost needed to achieve a one point RDQ reduction in back pain ranged between £21 and £114 per person from the healthcare perspective, and between £1 and £33 from the employer perspective.

With a ceiling ratio of £1,300 per one-point reduction on the RDQ scale, the cost-effectiveness of the yoga programme compared to usual care ranged between 75% to 78% from the healthcare perspective and from 84% to 85% from the employer perspective (scenarios 1 and 4).

7.2 Introduction

Cost-effectiveness analysis is the most common type of economic evaluation in healthcare (Elliott and Payne, 2005). In cost-effectiveness analysis, the total costs of an intervention are compared with a single primary outcome.

In this study of yoga in the workplace, two relevant and significant outcomes were chosen for cost-effectiveness analysis: back pain (measured by the RDQ) and sickness absence (assessed by electronic staff records). Cost-effectiveness analysis using sickness absence as the primary outcome is reported in Appendix 3, while this chapter uses back pain (RDQ) as previously specified in the trial protocol (Hartfiel et al., 2014).

To begin, the difference in total costs per participant were determined for the yoga and usual care groups from the employer, healthcare and societal perspectives (Chapter 6).

From the societal perspective and from cost scenarios 2 and 3 of the employer perspective, the yoga programme was less costly and more effective than usual care. The yoga programme was dominant and cost-effectiveness analysis was not required.

However, from the healthcare perspective and scenarios 1 and 4 of the employer perspective, the yoga programme was more costly. ICERs were required to determine if the benefits gained in reduced back pain were enough to justify the higher costs of the yoga programme.

ICERs were calculated using the following formula:

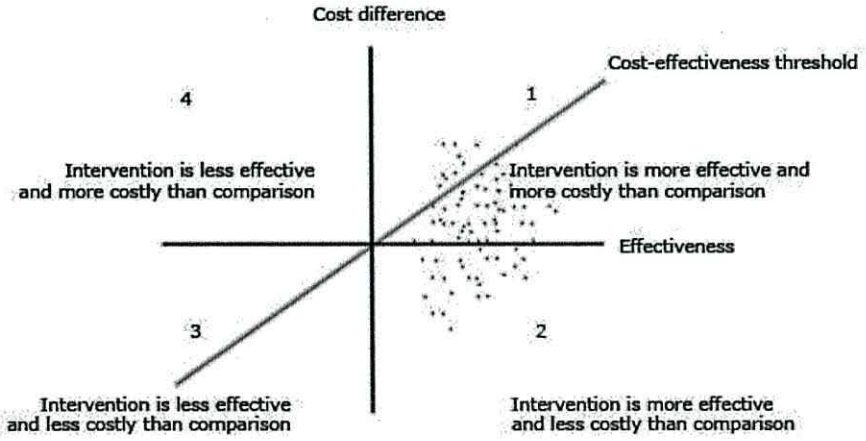
$$\text{ICER} = \frac{\text{Cost of yoga (per participant)} - \text{Cost of usual care (per participant)}}{\text{Outcome of yoga (per participant)} - \text{Outcome of usual care (per participant)}}$$

Once the ICERs were determined, incremental cost and incremental effect were presented visually through cost-effectiveness planes and cost-effectiveness acceptability curves.

Cost-effectiveness planes

The cost-effectiveness planes in this analysis were graphs with a thousand bootstrap replications comparing the incremental gains with the incremental costs of the yoga intervention (Figure 7.1). Bootstrapping is necessary to correct the biases of highly-skewed cost data (Barber and Thompson, 2000; Flynn and Peters, 2005).

Figure 7.1: Cost-effectiveness plane



The horizontal axis divides the plane according to incremental cost (more costly above, less costly below). The vertical axis divides the plane according to incremental effect (more effective to the right, less effective to the left).

Cost-effectiveness acceptability curves

Cost-effectiveness acceptability curves were used to illustrate the probability that the yoga programme was cost-effective when compared to a specific monetary threshold. A cost-

effectiveness threshold is the maximum amount that decision-makers are willing to pay to achieve the benefits of an intervention (Fenwick et al., 2006).

If the ICER is below the threshold, then the intervention is considered cost-effective. When choosing between competing programmes, the intervention with the lowest ICER is most likely to be selected if it is below the cost-effectiveness threshold (Fenwick et al., 2006).

Cost-effectiveness threshold for back pain

Although NICE has recommended a cost-effectiveness threshold of £20,000 per QALY gained, there are no established thresholds for a one-point RDQ reduction in back pain. Although there is significant debate about how cost-effectiveness thresholds should be determined, one approach is to use the value of health improvement applied in other areas of public sector resource allocation (McCabe et al., 2008).

Using a wellbeing valuation approach, an improvement in good overall health is valued at £20,141 per person per year (Trotter et al., 2014), nearly the same as the threshold value of £20,000 per QALY recommended by NICE.

Similarly, using wellbeing valuation, a reduction in back pain is valued at £1,306 per person per year (Fujiwara, 2013). Since there is no established NICE threshold for a one-point reduction in back pain, £1,300 was selected as an approximate cost-effectiveness threshold for back pain. This represents the maximum amount that decision-makers are willing to pay for a one-point RDQ reduction in back pain.

7.3 Methods

The cost-effectiveness analysis in this chapter followed five steps:

- identify the cost perspective (employer, healthcare, or societal)
- determine the difference in costs per participant between groups
- calculate the difference in RDQ scores per participant between groups
- compute ICERs
- create cost-effectiveness planes and cost-effectiveness acceptability curves.

Identifying cost perspective

From the healthcare perspective (all scenarios) and from the employer perspective (scenarios 1 and 4), the yoga programme was more costly than usual care, indicating a need for cost-effectiveness analysis.

Difference in costs between groups

From the employer perspective, total costs were the sum of the intervention costs and production loss costs. In this study, the total costs from the employer perspective were £36 to £85 per person for yoga participants and £67 per person for usual care (Table 7.1).

Table 7.1: Employer perspective: costs per participant between groups (see Table 6.5)

Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Employer (yoga)	£67.98	£50.93	£35.77	£84.72
Employer (usual care)	£67.27	£67.27	£67.27	£67.27
Employer: difference between groups	**£0.71**	**-£16.34**	**-£31.50**	**£17.45**

From the healthcare perspective, total costs were the intervention costs plus the healthcare resource use costs. In this study, the total costs from the healthcare perspective were £39 to £88 per person for yoga participants and £28 per person for usual care (Table 7.2).

Table 7.2: Healthcare perspective: costs per participant between groups (see Table 6.10)

Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Healthcare (yoga)	£70.85	£53.80	£38.64	£87.59
Healthcare (usual care)	£27.87	£27.87	£27.87	£27.87
Healthcare: difference between groups	**£42.98**	**£25.93**	**£10.77**	**£59.72**

From the societal perspective, total costs were intervention costs plus healthcare resource use costs plus production loss costs. In this study, the total costs from the societal perspective ranged from £42 to £91 per person for yoga participants and £93 per person for usual care (Table 7.3).

Table 7.3: Societal perspective: costs per participant between groups (see Table 6.11)

Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Societal (yoga)	£73.85	£56.80	£41.64	£90.59
Societal (usual care)	£93.14	£93.14	£93.14	£93.14
Societal: difference between groups	**-£19.29**	**-£36.34**	**-£51.50**	**-£2.55**

Difference in effect (RDQ) between groups

The primary outcome was reduced back pain assessed from both complete cases and imputed cases at the six-month time point.

The mean difference in RDQ scores between yoga and usual care group participants at six months was 0.52 points for complete cases (Table 7.4) and 0.41 points for imputed cases (Table 7.5).

Table 7.4: RDQ mean scores: complete cases

Measure	Yoga	Usual care	Difference in mean scores between groups	Change in mean scores between groups*
RDQ (complete cases)	**(n=39)**	**(n=30)**		
Baseline	1.97	2.07	0.10	
Six-month	1.28	1.90	0.62	0.52 (six-month)

***adjusted for baseline differences**

Table 7.5: RDQ mean scores: imputed cases

Measure	Yoga	Usual care	Difference in mean scores between groups	Change in mean scores between groups*
RDQ (imputed cases)	**(n=76)**	**(n=75)**		
Baseline	2.09	1.93	0.16	
Six-month	1.45	1.70	0.25	0.41 (six-month)

***pooled mean scores from 54 imputations**

7.4 Results

Computing ICERs

From the healthcare and employer perspectives, comparing the difference in costs and effects between the two groups made it possible to calculate the ICERS (Tables 7.6). Scenario 1 reflected the actual prices used in this study, with yoga instructors paid at £91 per session. In scenarios 2 and 3, instructors were reimbursed at £64 and £40 per session, respectively. In scenario 4, yoga teachers were paid £91 per session, equipment costs were calculated using retail prices, and venue hire was included.

Table 7.6: Healthcare and employer perspectives: differences in costs and outcomes

Healthcare Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Difference in costs between groups bootstrapped 95% confidence interval	£42.98 £13 to £64	£25.93 -£6 to £48	£10.77 -£21 to £32	£59.72 £29 to £82
Difference in effect between groups (complete cases) bootstrapped 95% confidence interval	0.52 -0.82 to 1.89	0.52 -0.79 to 1.87	0.52 -0.85 to 1.87	0.52 -0.74 to 1.96
ICER (cost per one point reduction in RDQ)	£82.00	£49.00	£21.00	£114.00
Cost-effectiveness probability*	76%	77%	78%	75%
Employer Perspective	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**
Difference in costs between groups bootstrapped 95% confidence interval	£0.71 -£329 to £52	-£16.34 Dominant	-£31.50 Dominant	£17.45 -£306 to £74
Difference in effect between groups (complete cases) bootstrapped 95% confidence interval	0.52 -0.70 to 1.97	0.52 Dominant	0.52 Dominant	0.52 -0.74 to 1.85
ICER (cost per one point reduction in RDQ)	£1.00	Dominant	Dominant	£33.00
Cost-effectiveness probability*	85%	Dominant	Dominant	84%

*** at a willingness-to-pay of £1,300 for a one RDQ point reduction in back pain**

Cost-effectiveness acceptability curves

Using a threshold of £1,300 per one point reduction in RDQ, the cost-effectiveness acceptability curves indicated that the probability of the yoga intervention being cost-effective was approximately 75% to 78% from the healthcare perspective and 84% to 85% from the employer perspective (Figure 7.2; Figure 7.3).

Figure 7.2: Healthcare perspective: cost-effectiveness acceptability curve, Scenario 1

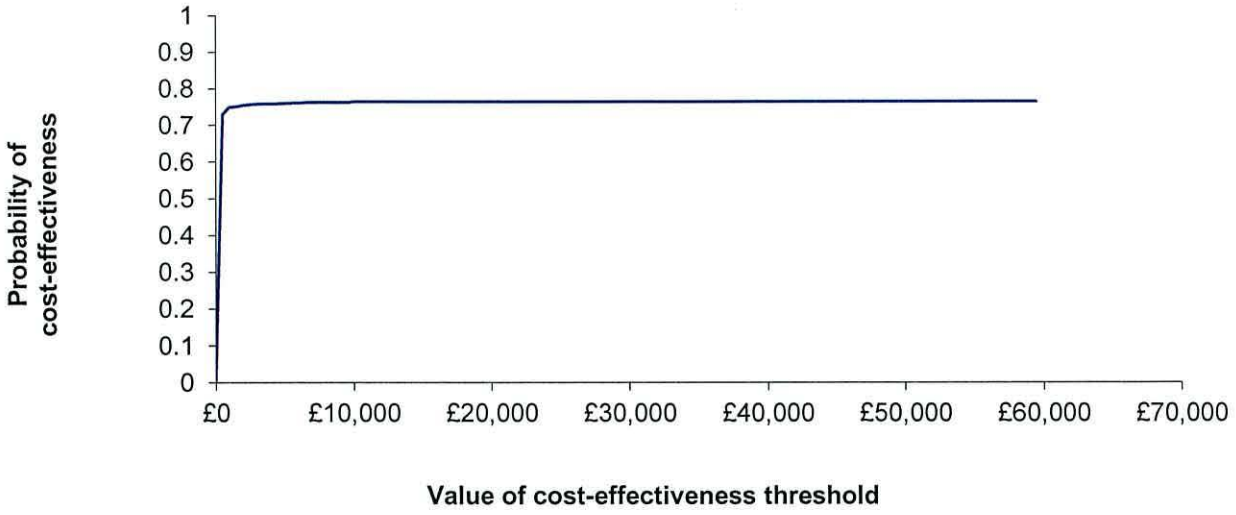
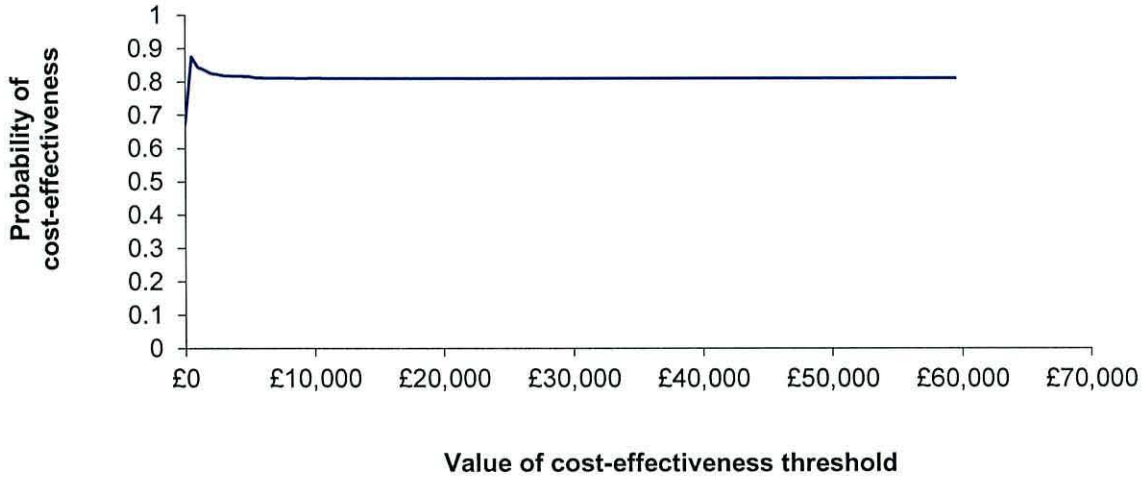


Figure 7.3: Employer perspective: cost-effectiveness acceptability curve, Scenario 1

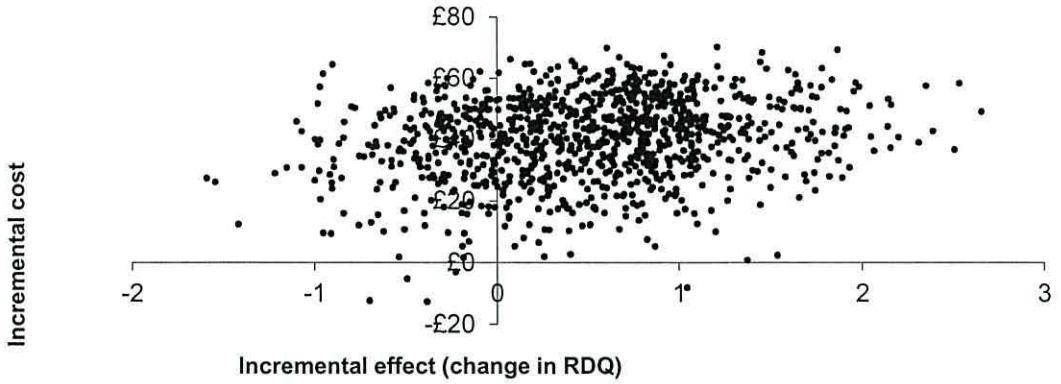


Healthcare perspective: cost-effectiveness planes

In scenario 1, the ICER was £82 per one point reduction in RDQ. The cost-effectiveness plane showed that most replicated cost-effect pairs (77%) were located in the northeast quadrant, indicating that the yoga intervention was both more costly and more effective than usual care for reducing back pain.

A smaller percentage of replicated cost-effect pairs (23%) were located in the northwest quadrant suggesting that in some cases, the yoga intervention was both more costly and less effective than usual care for reducing back pain (Figure 7.4).

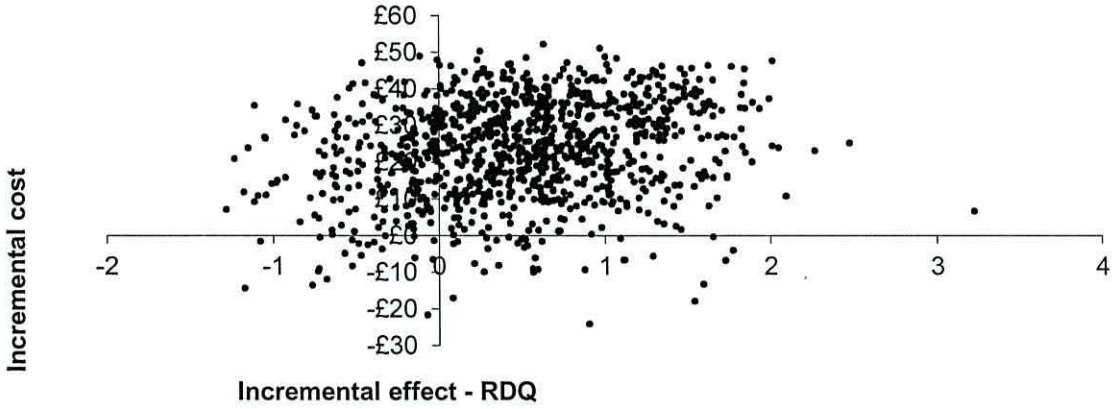
Figure 7.4: Healthcare perspective: cost-effectiveness plane, Scenario 1



Sensitivity analysis was carried out in scenarios 2, 3 and 4. In scenario 2, the ICER was £49 per one point reduction in RDQ. The cost-effectiveness plane showed that most replicated cost-effect pairs (74%) were located in the northeast quadrant, 21% in the northwest, 3% in the southeast and 2% in the southwest (Figure 7.5).

This suggests that in most cases, the yoga intervention was both more costly and more effective, and in some cases, yoga was more costly and less effective. In only 5% of the cases was yoga less costly than usual care.

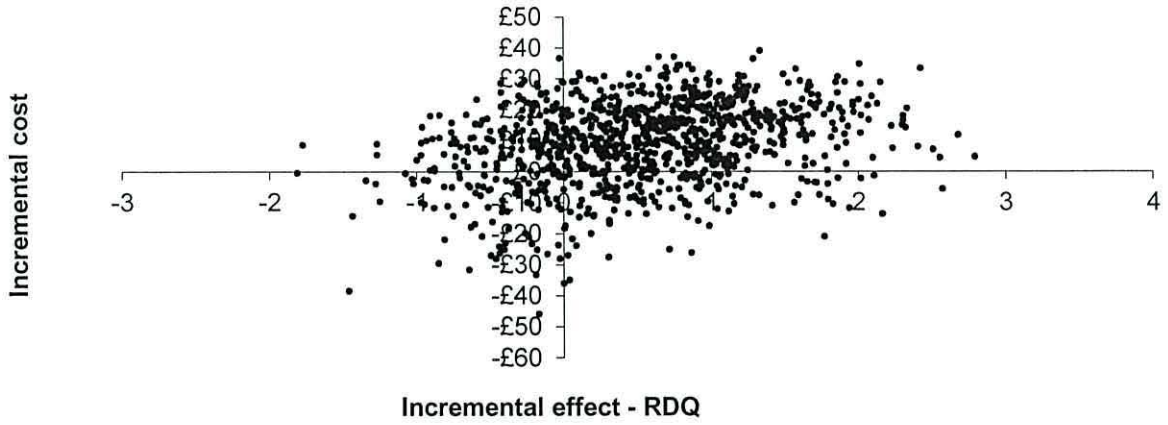
Figure 7.5: Healthcare perspective: cost-effectiveness plane, Scenario 2



The ICER in scenario 3 was £21 per one point reduction in RDQ. The cost-effectiveness plane showed that most replicated cost-effect pairs (62%) were located in the northeast quadrant, 15% in the northwest, 14% in the southeast and 9% in the southwest (Figure 7.6). This scenario differs from scenario 2 by indicating that in 23% of the cases, yoga was less costly than usual care.

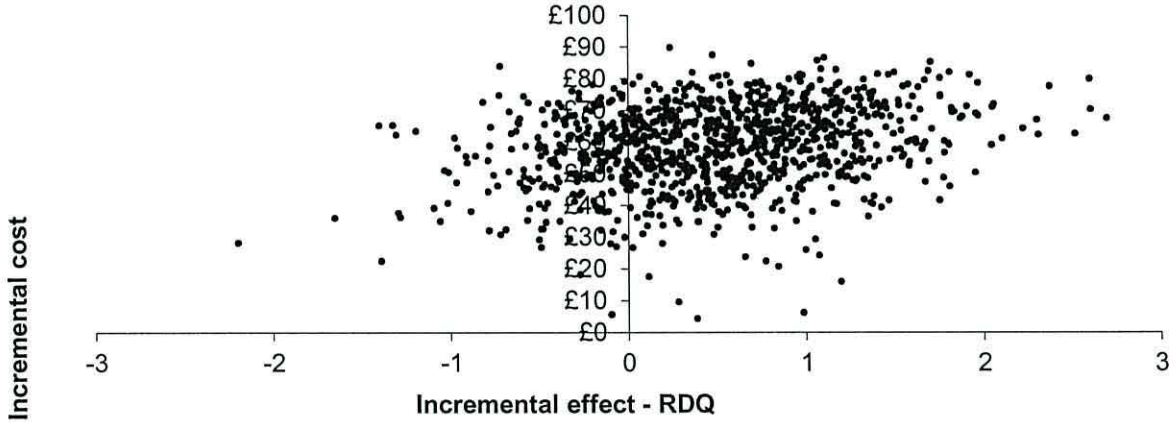
Of the four scenarios, this particular scenario had the largest number of cost-effect pairs in the southeast quadrant, demonstrating that yoga was more effective and less costly when instructors were paid £40 per session.

Figure 7.6: Healthcare perspective: cost-effectiveness plane, Scenario 3



In scenario 4, the ICER was £114 per one point reduction in RDQ. The cost-effectiveness plane showed that most replicated cost-effect pairs (78%) were located in the northeast quadrant and 22% were found in the northwest (Figure 7.7). Once again, this suggests that in most cases, the yoga intervention was both more costly and more effective.

Figure 7.7: Healthcare perspective: cost-effectiveness plane, Scenario 4

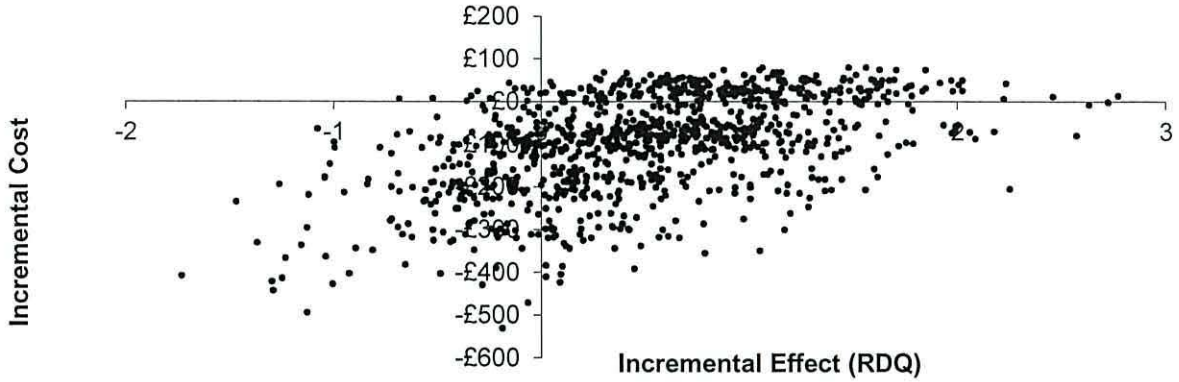


Employer perspective: cost-effectiveness planes

In scenarios 1 and 4 from the employer perspective, the ICERs ranged from £1 to £33 per one point reduction in RDQ. The cost-effectiveness planes for both scenarios showed that most replicated cost-effect pairs were located in the southeast quadrant, 52% in scenario 1 and 50% in scenario 4.

This indicates that from the employer perspective, the yoga intervention was often more effective and less costly than usual care (Table 7.8).

Figure 7.8: Employer perspective: cost-effectiveness plane, Scenario 1



7.5 Discussion

Cost-effectiveness analysis indicated that from the healthcare perspective, the ICERs ranged from £21 to £114 per one point reduction in RDQ. From the employer perspective (scenarios 1 and 4), the ICERs were from £1 to £33 per one point reduction in RDQ. ICERs represent the cost required to achieve a unit of benefit, in this case, a reduction of one point on the RDQ scale. According to Stratford et al. (1998), a reduction in RDQ scores of one to two points can be considered clinically significant for populations with little disability, such as employees in the workplace.

In the cost-effectiveness planes for the healthcare perspective, the majority of bootstrapped cost-effect pairs were located in the northeast quadrant. For the employer perspective, the majority fell in the southeast quadrant. This suggests that from the healthcare perspective, the yoga intervention was both more effective and more costly than usual care, and from the employer perspective, yoga was *dominant*.

The cost-effectiveness acceptability curves indicated when using a threshold of £1,300 per one point reduction in RDQ, the probability of the yoga intervention being cost-effective ranged from 75% to 78% from the healthcare perspective and from to 84% to 85% from the employer perspective.

Although NICE has established a cost-effectiveness threshold for generic measures of health-related quality of life (£20,000 per QALY gained), there are no such thresholds for condition-specific generic outcome measures such as the RDQ. Recently, however, wellbeing valuation methods (chapter 10) identified £1,306 as the annual social value per person for significant improvements in conditions related to back problems. Therefore, £1,300 was selected as a hypothetical cost-effectiveness threshold for a one point reduction in RDQ (back pain).

Without established cost-effectiveness thresholds, the choice between two interventions when neither is dominant can be complex. In this study, however, the ICERs from the healthcare perspective and from the employer perspective (scenarios 1 and 4) were well below the hypothetical threshold of £1,300 per one point reduction in RDQ. This suggests that the yoga programme was a cost-effective intervention compared to usual care for reducing back pain.

Limitations

The lack of an established cost-effectiveness threshold makes it difficult to compare this study with other back pain-related economic evaluations. In addition, the relatively healthy employees in this study were different to most back pain-related study populations where patients are recruited with a history of non-specific low back pain or with chronic low back pain (Aboagye et al., 2015; Tilbrook et al., 2011; Sherman et al., 2011). The population in this study reported a mean baseline RDQ score of only 2.01 points, whereas other back-pain related yoga studies exclude participants with RDQ scores of less than four (Tilbrook et al., 2011).

In addition, the healthcare resource use data in this study was collected from participants at baseline, end-programme and at six-month follow-up. At all three time points, participants were asked to report their healthcare service use for the two preceding months. Relying on study participants to recall how much they used health resources could result in *recall bias* (where participants forget what resources they used). However, since recall bias is likely to be similar between groups, any potential bias is effectively cancelled (Whitehurst et al., 2007).

Finally, the healthcare resource use costs were based on a small number of visits to healthcare professionals for musculoskeletal conditions over the six month study period. The 39 yoga participants who completed six month questionnaires reported only 5 visits, while the 30 usual care participants recorded 18 visits for musculoskeletal conditions. Due to this small number of visits, the difference in healthcare resource use between the two groups could have been due to chance.

7.6 Conclusion

The incremental cost-effectiveness ratios showed that the additional cost needed to achieve a one-point reduction in back pain (RDQ) ranged from £21 to £114 per person from the healthcare perspective and from £1 to £33 from the employer perspective.

With a threshold of £1,300 per one point reduction in RDQ, the cost-effectiveness probability of the yoga programme compared to usual care ranged from 75% to 78% from the healthcare perspective, and from 84% to 85% from the employer perspective. This suggests that yoga can be a cost-effective intervention from both the healthcare and employer perspectives.

However, without an established threshold for a condition-specific outcome measure such as the RDQ, it was difficult to make a definitive judgement on cost-effectiveness, especially in scenarios 1 and 4 when the yoga programme was both more effective and more costly than usual care.

Chapter 8: Cost-utility analysis

8.1 Chapter summary

Cost-utility analysis was conducted for all cost scenarios from the healthcare perspective and for scenarios 1 and 4 from the employer perspective. The EQ5D-5L was used as a global measure for assessing health-related quality of life, which was assessed for both yoga and usual care participants at baseline, end-programme and six-months. The differences in health-related quality of life between the two groups at six months were compared with the total costs to calculate the ICERs for each cost scenario.

During the six-month study, the yoga group reported notable improvements in health-related quality of life when compared with usual care. Cost-utility analysis indicated that the yoga programme was cost-effective, with probability ranging between 87% and 92% from the healthcare perspective and 90% to 93% from the employer perspective.

8.2 Introduction

Cost-utility analysis is a type of cost-effectiveness analysis in which the primary outcome measure is health-related quality of life (HRQoL) expressed as quality-adjusted life years (QALYs). In cost-utility analysis (as in cost-effectiveness analysis), ICERs are calculated by comparing the differences in costs with the differences in outcomes between groups.

Measuring health-related quality of life is highly recommended in complementary and integrative medicine interventions such as yoga, since these activities tend to affect the whole person rather than target only one symptom or disease (Herman, 2012).

Recently, two randomised controlled trials of yoga included a cost-utility analysis: a twelve-week hatha yoga intervention in the UK for patients with chronic low back pain (Chuang et al., 2012) and a six-week MediYoga programme in Sweden for patients with non-specific low back pain (Aboagye et al., 2015).

Both of these studies reported cost-utility analysis from the societal perspective. In addition, the Chuang study included the healthcare perspective and Aboagye addressed the employer perspective.

8.3 Methods

Cost-utility analysis in this study of workplace yoga considered the employer, healthcare and societal perspectives. Total costs for each perspective were presented in chapter 6. Total benefits were assessed for health-related quality of life, measured with the EQ5D-5L at baseline, end-programme and six-month follow-up.

In assessing HRQoL, the EQ5D-3L has been the most commonly-used generic measure (Devlin and Krabbe, 2013). Recently, a five level version (EQ5D-5L) was developed to allow for greater sensitivity in assessing health-related quality of life. This added sensitivity is especially pertinent for relatively healthy populations, such as employees in the workforce (Devlin and Krabbe, 2013).

In this workplace study, the health state of each participant was measured using the EQ5D-5L to assess the following dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression (Table 8.1).

Table 8.1: EQ5D-5L

Outcome Measure	Description	Reliability and Validity
EQ5D-5L	5 item/5 level questionnaire measuring mobility, self-care, usual activities, pain/discomfort and anxiety/depression.	EQ5D-5L is a valid extension of the EQ5D-3L. The five level system improves the measurement properties, enhances discriminatory power and establishes convergent and known-groups validity (Janssen et al., 2012).

Calculating QALYs using multiple linear regression

In order to calculate quality-adjusted-life-years (QALYs), the EQ5D-5L responses for each participant were weighted according to a UK value set, which assigns values ranging from -0.594 to 1.0 and where a year of perfect health is worth 1.0 and a year of less than perfect health is worth less than 1.0 (Phillips, 2005; Devlin and Krabbe, 2013).

After the EQ5D-5L responses were weighted, a mean QALY for each group was calculated from the sum of the individual scores. QALY gains or losses were then calculated using a multiple linear regression approach by comparing the mean QALY values in the yoga group with the mean QALY values in the usual care group (Edwards et al., 2004; Manca et al., 2005).

An ordinary least squares (OLS) multiple linear regression was used to control for baseline differences in EQ5D-5L scores (Manca et al., 2005). The difference in mean QALYs for each group was then compared with the difference in mean cost for each group in order to estimate the ICERs, using the formula:

$$\text{ICER (EQ5D)} = \frac{\text{mean cost yoga group} - \text{mean cost usual care group}}{\text{mean QALY yoga group} - \text{mean QALY usual care group}}$$

Imputation for missing data

In this study, 46% of participants completed EQ5D-5L questionnaires at baseline and six-months. To avoid potentially biased results from complete case analysis, missing values for six-month EQ5D-5L scores were imputed using a multiple imputation method in SPSS Statistics 20.0.

As mentioned in chapter 3 of this thesis, the multiple imputation method is considered statistically valid, dealing with missing data by creating several imputed data sets and then pooling the results (Sterne et al., 2009).

Since it is recommended that the number of imputed datasets should be equal to the percentage of incomplete cases, 54 imputed data sets were created using SPSS Statistics 20.0 (White et al., 2011). Imputed EQ5D-5L mean scores were then compared with complete case mean scores to determine the degree to which complete cases were representative of the pooled imputed data set.

In this study, missing EQ5D-5L values at six months were imputed from baseline and end-programme EQ5D-5L scores.

8.4 Results

In this study, 151 employees were randomised either to an eight-week yoga intervention (n=76) or to usual care (n=75). At baseline, 75 yoga participants and 73 usual care participants had usable cost data. There were no significant differences between the yoga group and usual care group for mean EQ5D-5L scores (p=0.59) indicating that the blinded randomisation was successful. At end-programme (8 weeks), 109 complete cases (72%) had usable cost data.

At six months, there were 69 complete cases (46%) with usable cost data. Using complete case data, yoga participants reported QALY gains of 0.047 using the change-from-baseline method, 0.034 using the area-under-the-curve method and 0.027 using a multiple linear regression method (Manca, et al., 2005).

Using imputed case data, yoga participants reported QALY gains of 0.033 using the change-from-baseline method, 0.017 using the area-under-the-curve method and 0.016 using a multiple linear regression method (Manca, et al., 2005).

After the eight week yoga intervention, the QALY gain for the yoga group compared to usual care using the change-from-baseline method ranged from 0.081 for complete cases to 0.044 for imputed cases.

As expected, the QALY gains for the yoga participants were substantially larger immediately after the programme at eight weeks than at the six-month follow-up (Tables 8.2, 8.3).

Table 8.2: EQ5D-5L mean scores (SE): complete cases

Measure EQ5D-5L (complete)	Yoga n=39	Usual care n=30	Difference in mean scores	Change in mean scores between groups
Baseline	0.836 (.017)	0.815 (.016)	0.021	
End-programme	0.857 (.017)	0.776 (.022)	0.081	0.060 (end-programme – CfB)
6 month (CfB)	0.850 (.018)	0.782 (.023)	0.068	0.047 (6 month –CfB)
6 month (AUC) [95% confidence intervals]	0.426	0.392	0.034	0.034 (6 month – AUC w/o regression) [0.010, 0.056]
Multiple linear regression [95% confidence intervals]	0.450	0.423	0.027	0.027 (6 month – AUC with regression) [0.009, 0.046]

Table 8.3: EQ5D-5L mean scores (SE): imputed cases*

Measure EQ5D-5L (imputed)	Yoga n=75	Usual care (n=73)	Difference in mean scores	Change in mean scores between groups
Baseline	0.839 (.012)	0.838 (.012)	0.001	
End-programme	0.846 (.014)	0.802 (.016)	0.044	0.043 (end-programme - CfB)
6 month (CfB)	0.844 (.018)	0.811 (.020)	0.033	0.032 (six-months - CfB)
6 month (AUC) [95% confidence intervals]	0.422	0.405	0.017	0.017 (6 month – AUC w/o regression) [0.015, 0.019]
Mulitple linear regression [95% confidence intervals]	0.438	0.422	0.016	0.016 (6 month – AUC with regression) [0.014, 0.018]

***pooled mean scores from 54 imputations**

Healthcare perspective: differences in costs and QALYs

From the healthcare perspective, the QALYs gained were compared with the intervention costs and healthcare resource use costs (Table 7.2). The total cost per yoga participant ranged from £39 to £88 depending on the cost scenario, while the total cost per usual care participant was £28 (Table 8.4).

From the healthcare perspective, the yoga programme was more costly than usual care in each scenario (Table 8.4).

Table 8.4: Healthcare perspectives: differences in costs and QALYs

Healthcare Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Costs per yoga participant	£70.85	£53.80	£38.64	£87.59
Costs per usual care participant	£27.87	£27.87	£27.87	£27.87
Difference in costs between groups bootstrapped 95% confidence interval	£42.98 £10 to £64	£25.93 -£4 to £47	£10.77 -£18 to £33	£59.72 £31 to £83
Difference in QALYs between groups (complete cases – AUC) bootstrapped 95% confidence interval	0.034 -.018 to .094	0.034 -.025 to .071	0.034 -.014 to .087	0.034 -.017 to .097
Cost per QALY	£1,264.00	£763.00	£317.00	£1,756.00
Cost-effectiveness probability at £20,000/ QALY	88%	90%	92%	87%

Employer perspective: differences in costs and QALYs

From the employer perspective, the QALYs gained were compared with the intervention costs and production loss costs (Table 7.1). The total cost per yoga participant ranged from £36 to £85 depending on the scenario, while the total cost per usual care participant was £67 (Table 8.5).

From the employer perspective, the yoga programme was more costly than usual care in scenarios 1 and 4, when yoga instructors were paid £91 per session. The yoga programme was less costly than usual care in scenarios 2 and 3, when yoga instructors were paid £64 and £40 per session, respectively (Table 8.5).

Table 8.5: Employer perspectives: differences in costs and QALYs

Employer Perspective	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Costs per yoga participant	£67.98	£50.93	£35.77	£84.72
Costs per usual care participant	£67.27	£67.27	£67.27	£67.27
Difference in costs between groups (mean cost per person) bootstrapped 95% confidence interval	0.71 -£366 to £57	-16.34 Dominant	-31.50 Dominant	17.45 -£303 to £73
Difference in QALYs between groups (complete cases - AUC) bootstrapped 95% confidence interval	0.034 -.017 to .093	0.034 Dominant	0.034 Dominant	0.034 -.016 to .089
Cost per QALY	£21.00	Dominant	Dominant	£513.00
Cost-effectiveness probability at £20,000/ QALY	93%	Dominant	Dominant	90%

Cost-effectiveness acceptability curves

From the healthcare perspective, the ICERs ranged from £317 to £1,756 per QALY. The cost-effectiveness probability ranged from 87% to 92% at a threshold of £20,000 per QALY (Table 8.4, Figure 8.1).

From the employer perspective, the ICERs were between £21 and £513 per QALY for scenarios 1 and 4, respectively, with a cost-effectiveness probability range of 90% to 93% at a threshold of £20,000 per QALY (Table 8.5, Figure 8.2).

From both perspectives, cost-utility analysis indicated a high probability that yoga was cost-effective when compared with usual care.

Figure 8.1: Healthcare perspective: cost-effectiveness acceptability curve

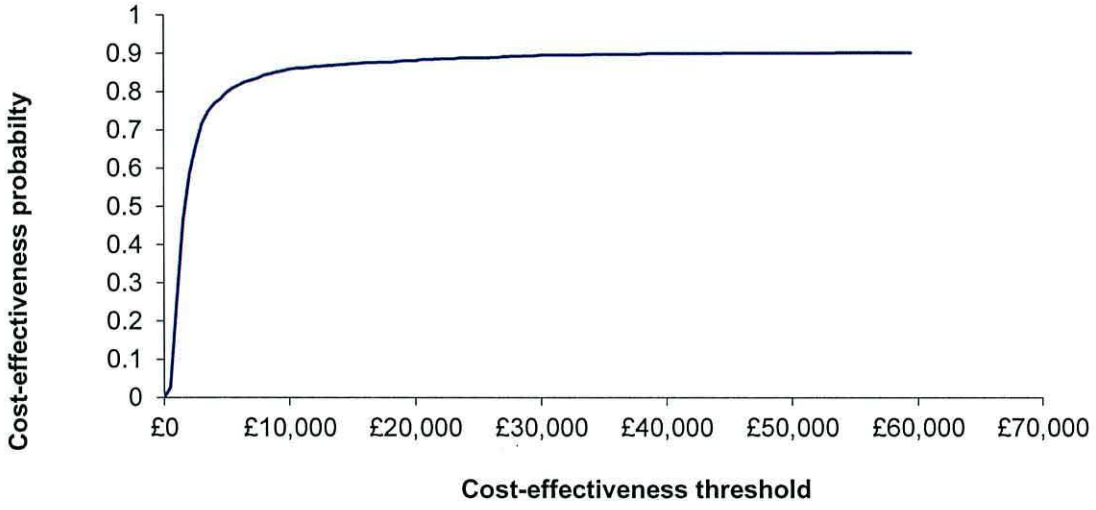
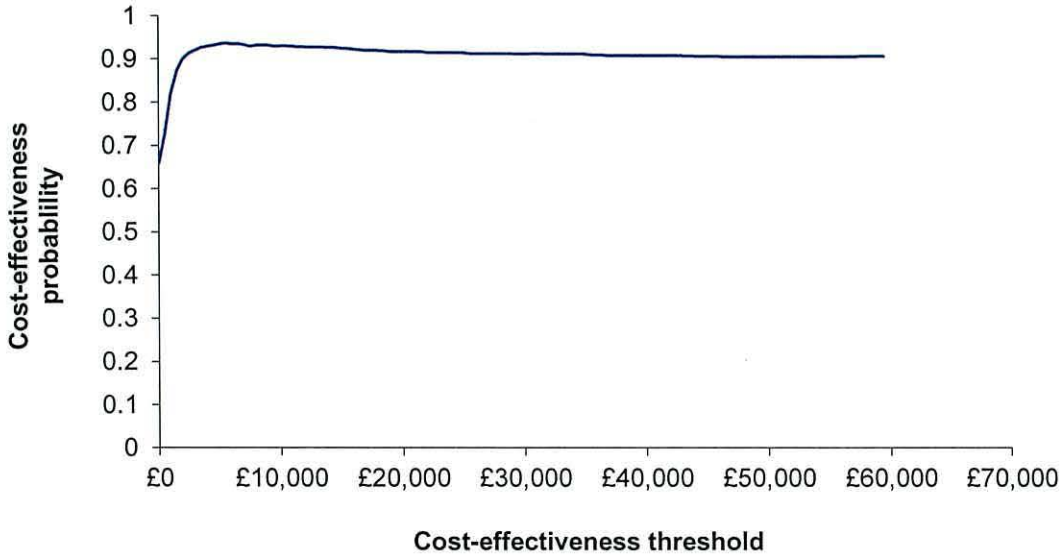


Figure 8.2: Employer perspective: cost-effectiveness acceptability curve

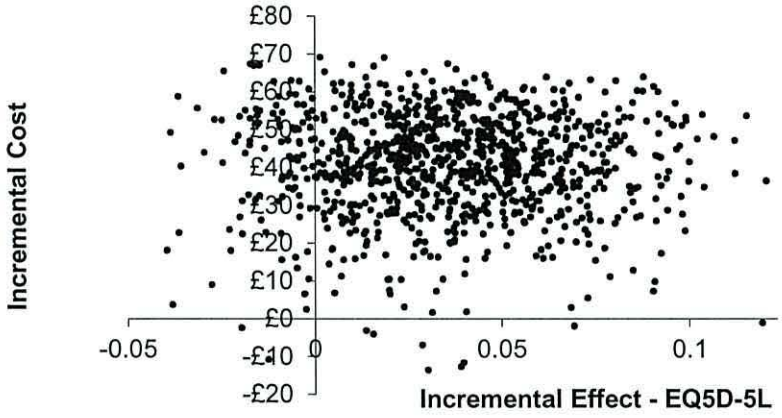


Healthcare perspective: cost-effectiveness planes

In scenario 1, the ICER was £1,264 per QALY. The cost-effectiveness plane showed 89% of replicated cost-effect pairs located in the northeast quadrant, indicating that the yoga intervention was both more costly and more effective for improving HRQoL (Figure 8.3).

A smaller percentage of replicated cost-effect pairs (10%) were located in the northwest quadrant suggesting that in some cases, the yoga intervention was both more costly and less effective than usual care for improving HRQoL (Figure 8.3). The remainder fell in the southeast quadrant where yoga was more effective and less costly.

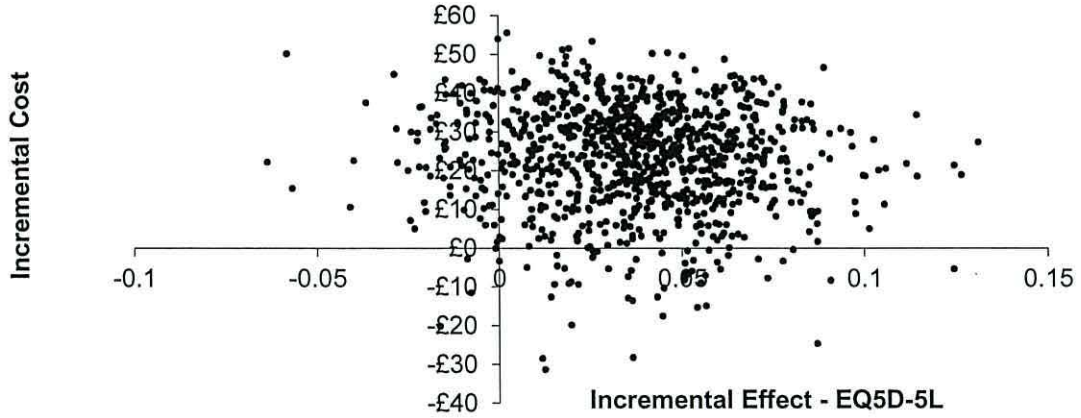
Figure 8.3: Healthcare perspective: cost-effectiveness plane, Scenario 1



In scenario 2, the ICER was £763 per QALY. Most of cost-effect pairs (86%) were located in the northeast quadrant, 9% in the northwest, and 5% in the southeast

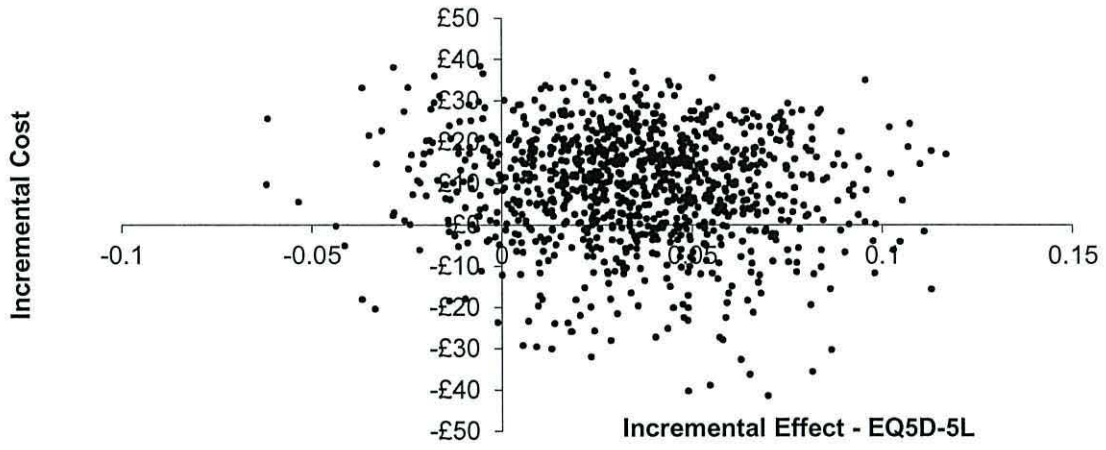
In most cases, the yoga intervention was more costly and more effective, in some cases more costly but less effective, and in a few cases yoga was less costly and more effective than usual care (Figure 8.4).

Figure 8.4: Healthcare perspective: cost-effectiveness plane, Scenario 2



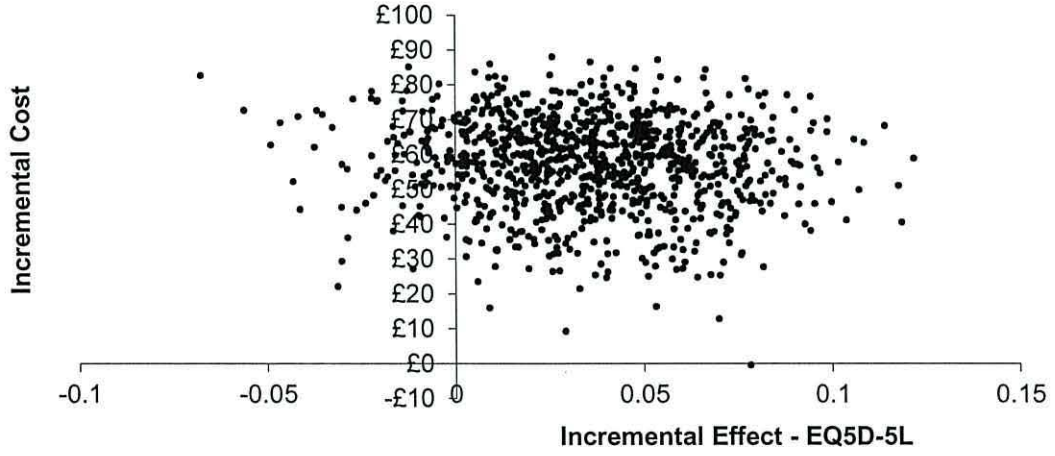
The ICER in scenario 3 was £317 per QALY. Of the four scenarios, this particular scenario had the largest number (20%) of cost-effect pairs in the southeast quadrant, demonstrating that yoga was more effective and less costly. In the other quadrants, 69% fell in the northeast quadrant, 9% in the northwest, and 2% in the southwest (Figure 8.5).

Figure 8.5: Healthcare perspective: cost-effectiveness plane, Scenario 3



In scenario 4, the ICER was £1,756 per QALY. As expected for the maximum cost scenario, 91% of the cost-effect pairs were situated in the northeast quadrant and 9% were found in the northwest (Figure 8.6), indicating that the yoga programme was more expensive than usual care.

Figure 8.6: Healthcare perspective: cost-effectiveness plane, Scenario 4

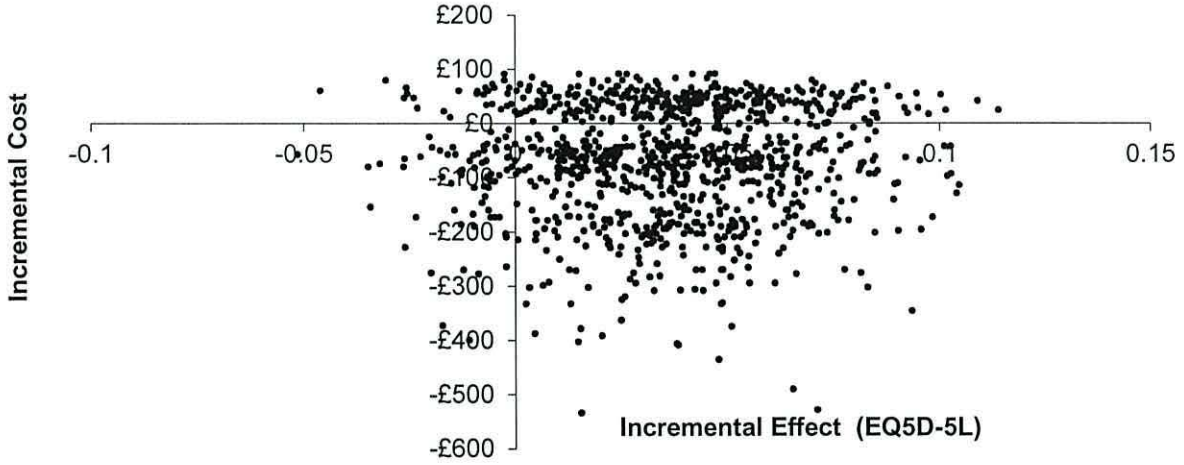


Employer perspective: cost-effectiveness plane

From the employer perspective, the ICER for scenario 1 was £21 per QALY and for scenario 4, £513 per QALY. The cost-effectiveness planes for both scenarios showed that most replicated cost-effect pairs were located in the southeast quadrant, 68% in scenario 1 and 59% in scenario 4.

This indicates that from the employer perspective, the yoga intervention was mostly more effective and less costly than usual care (Table 7.5)

Figure 8.7: Employer perspective: cost-effectiveness plane, Scenario 1



8.5 Discussion

The results of this cost-utility study appear to be consistent with the two previous cost-utility studies of yoga for patients with back pain (Chuang et al., 2012; Aboagye et al., 2015).

Chuang et al. (2012) compared hatha yoga with usual care for patients with chronic low back. Compared with usual care, the yoga programme in this study was likely to be 72% cost-effective from the healthcare perspective and *dominant* from the societal perspective. Patients who engaged in yoga as a treatment for back pain gained 0.037 QALYs more than those offered usual care. Given willingness-to-pay for an additional QALY of £20,000, the ICER in the Chuang evaluation was £13,606 per QALY. In addition, the average patient in the yoga group reported 8.5 fewer sickness absence days than the control group during the twelve month study.

The Aboagye et al. (2015) evaluation reported that from a societal perspective, a six-week MediYoga intervention for patients with non-specific low back pain was *dominant* compared to a usual care. Interestingly, the study did not report healthcare resource use costs, including only intervention costs and production loss costs in the societal perspective.

Patients who were offered MediYoga for back pain in the Aboagye study gained 0.036 QALYs more than those offered usual care. In addition, the average participant in the MediYoga group reported 17.2 fewer sickness absence days due to back pain than the usual care group during the twelve month study.

The cost-utility analysis in this thesis indicated that yoga was 87% to 92% cost-effective compared with usual care from the healthcare perspective. Yoga was also dominant from the societal perspective, given a willingness-to-pay for an additional QALY of £20,000.

Employees who were offered the Dru Yoga programme gained 0.034 QALYs more than those offered usual care. In addition, NHS electronic staff records showed 2 sickness absence days due to musculoskeletal conditions taken by yoga participants compared to 43 by usual care participants.

The results of this cost-utility analysis, combined with the findings of Chuang and Aboagye, indicate that yoga is *dominant* to usual care when production loss costs are considered from the employer and societal perspectives.

Furthermore, the Chuang study and the study reported in this thesis suggest that the cost-effectiveness probability of yoga compared to usual care ranged between 72% and 92% from the healthcare perspective given a threshold of £20,000 per QALY.

Limitations

Although the results of this economic evaluation appear promising, there are limitations. Some costs were not included in the total, such as the opportunity costs for the time participating in yoga classes and the medication costs for all participants.

The rationale for not including opportunity costs for the time participating in yoga classes was that productivity loss costs would have been minimal since yoga classes were held after work (Chuang et al., 2012). The opportunity costs for lost leisure time would also have been negligible since participation was voluntary and those who took part in the yoga classes reported a high satisfaction with the programme.

This suggests that there was no equally attractive or valuable alternative activity, and that participants incurred no significant opportunity costs from lost leisure time (Aboagye et al., 2015). Indeed, most studies of physical activity programmes do not include opportunity costs for lost leisure time, perhaps due to the assumption that exercise is part of leisure time (Wolfenstetter and Wenig, 2011).

Medication costs were also not included in this study, although qualitative data from end-programme questionnaires indicated that some yoga participants reduced medication use for back pain and depression during the eight-week yoga programme. It would be useful for future studies to note changes in medication use for both yoga and usual care participants.

While opportunity costs and medication costs were not considered in this cost-utility analysis, production loss costs were included (from the societal and employer perspectives). Although some economists maintain that including both production loss costs and QALYs is 'double-counting', recent research suggests that the potential income loss from sickness absence does not significantly influence utility scores, and therefore, the impact of double counting is negligible (Davidson, 2009; Shiroiwa et al., 2013).

Another limitation is that missing data can raise questions about the internal validity of a study. Multiple imputation techniques were used in this study to overcome any potential bias due to missing data. Comparing conclusions of complete case analysis with pooled imputed data from a multiple imputation approach may reduce the degree of uncertainty. However, since bootstrapping techniques use only complete case data, cost-utility planes and acceptability curves do not adequately capture this reduced degree of uncertainty (Whitehurst et al., 2007).

8.6 Conclusion

From the employer and societal perspectives, yoga was shown to be dominant to usual care mainly due to the savings in production loss costs from reduced sickness absence days. From the healthcare perspective and with a threshold of £20,000 per QALY, the cost-effectiveness probability of yoga, compared with usual care, ranged between 87% and 92% depending on the cost scenario.

Yoga participants reported not only substantial improvements in the health-related quality of life, but also less healthcare resource use per person for musculoskeletal conditions than usual care participants. Although these results suggest that yoga can provide value for money, future high quality studies with larger sample sizes are recommended to validate these findings.

Chapter 9: Return on investment analysis

9.1 Chapter summary

Using return on investment analysis, benefit-cost ratios were estimated to determine the financial return of the yoga programme for employers. Return on investment analysis compared the difference in production loss costs between the yoga and usual care groups with difference in intervention costs between groups. Intervention costs were presented in four different cost scenarios to reflect a variety of real life settings.

Production loss costs were calculated from NHS electronic staff records which indicated that compared with usual care, yoga participants reported 41 fewer sickness absence days due to musculoskeletal conditions during the six-month study.

The results showed that the intervention costs of the yoga programme were greater than the savings in production loss costs in scenarios 1 and 4, when yoga instructors were paid £91 per session. However, the intervention costs of the yoga programme were less than the savings in production loss costs in scenarios 2 and 3, when yoga instructors were paid £64 and £40 per session, respectively.

The benefit-cost ratios for the four cost scenarios ranged from 0.78 to 2.02 (where 1.0 is the break-even point). However, when a 1.28 multiplier was added to account for the additional costs of lost production from sickness absence, the benefit-cost ratios ranged from 1.00 to 2.59. When employees were willing to make a co-payment of £4.50 per session, the ratios were more favourable, ranging from 1.23 to 3.19. When the 1.28 multiplier and the £4.50 co-payment were included, the benefit-cost ratios were from 1.45 to 3.76.

9.2 Introduction

Return on investment (ROI) is a type of cost-benefit analysis in which intervention costs are compared with total monetised benefits. The total monetised benefits of the yoga programme were the production loss costs calculated from the difference in sickness absence due to musculoskeletal conditions between the yoga and usual care groups during the six month study.

Although there are no published return on investment studies of yoga in the workplace, two recent economic evaluations of yoga for patients with low back pain indicated significant savings in production loss costs related to back pain (Chuang et al., 2012; Aboagye et al., 2015).

Whereas those two studies used self-report methods to calculate work-related sickness absence for patients with low back pain, this case study of yoga in the workplace used electronic staff records to more accurately determine sickness absence for employees within a single organisation. Measuring the effect of yoga on sickness absence within a single organisation can be useful for employers considering yoga as a means to reduce production loss costs due to musculoskeletal conditions.

9.3 Methods

Three ROI metrics were calculated: net benefits, benefit-cost ratio and return on investment (van Dongen et al., 2013a).

$$\text{Net benefits} = \text{benefits} - \text{costs}$$

$$\text{Benefit cost ratio} = \frac{\text{benefits}}{\text{costs}}$$

$$\text{Return on investment} = \frac{(\text{benefits} - \text{costs})}{\text{costs}} * 100$$

Total Costs

Since this ROI analysis was performed from the employer's perspective, only costs relevant to the employer (i.e., instruction, equipment, recruitment, and venue costs) were considered. Although healthcare resource use costs were used in cost-effectiveness and cost-utility analysis, they were not included in this ROI. The total costs to the employer for delivering the eight week yoga programme were estimated using four different scenarios (chapter 5).

Total Benefits

The monetised benefits of the yoga programme were calculated by considering:

- cost savings from reduced sickness absence due to musculoskeletal conditions
- the impact of the additional costs of lost production
- the willingness of participants to make a co-payment for yoga sessions.

The production loss costs from reduced sickness absence was calculated using the human capital approach, where every day of sick leave was a day of productivity lost regardless of whether replacement workers were found (van den Hout, 2010). The difference in the cost of sickness absence due to musculoskeletal conditions between the yoga and usual care groups was measured over the six-month trial period. These costs were then monetised based on the mean cost per day for an NHS employee in 2013, which was £113.84[1]

[1] http://www.nhsemployers.org/

In addition, this mean cost per day can be multiplied by 1.28 to account for the extra costs of lost production associated with absenteeism. These additional costs can include the cost of finding a substitute worker and the cost of lower productivity from a substitute worker (Nicholson et al., 2006). With the 1.28 multiplier, the mean cost per day for an NHS employee in 2013 was £145.72.

Finally, the willingness of employees to make a co-payment for yoga sessions can increase the return on investment to employers. When asked how much they would be willing to pay for ongoing sessions, most participants (86%) were willing to pay £3 or more for the yoga classes, 17% were willing to pay £6 or more and 4% were willing to pay £9 or more (Table 9.1).

The willingness-to-pay question was in the form of a payment scale format that asked participants to reveal how much they would be willing to pay for a weekly yoga class. The payment scale format was the preferred elicitation method because it has been found to produce a higher response rate than open-ended willingness-to-pay questions (Frew et al., 2012). In addition, providing 'tick box' responses can put respondents more at ease while at the same time generating sufficient information for data analysis (Frew, 2010).

In this study, the payment scale format provided yoga participants with a vertically arranged list of values that ranged from £0 to £12 (Table 9.1). A lower end value of £0 and an upper end value of £12 were chosen to reflect reasonable willingness-to-pay values for a weekly 60 minute yoga class in North Wales, where sessions in 2013 typically cost around £6[1].

This amount (£6) became the median value in the payment scale which included two increments of £3 below the median value and two increments above. 'Weekly' was chosen as the most appropriate time frame, as research indicates that once-a-week yoga classes are effective and convenient for participants (Saper et al., 2013).

With the hypothetical willingness-to-pay question used in this study, the payment vehicle for the yoga classes was not compulsory, that is, only those choosing to attend yoga classes would pay. When only users of a good pay, then willingness-to-pay tends to be lower than when the payment vehicle is compulsory for everyone whether they attend classes or not (Ivehammer, 2009). In general, willingness-to-pay is considered an appropriate methodology for estimating the value of physical activity programmes because willingness-to-pay questions allow for the consideration of all potential benefits, (Frew et al., 2014).

[1] [1] www.bwywales.org.uk/classes.htm

Table 9.1: Participants' willingness-to-pay (n=56)

Question:	Likert scale range	Likert scale descriptor	# of responses	% of participants
How much would you be willing-to-pay per 60 minute class?	0 – 5	0 = £0 1 = £0.01 to £2.99	2 6	14%
		2 = £3 to £5.99 3 = £6 to £8.99 4 = £9 to £11.99 5 = £12 or more	38 8 2 0	86%

Although presenteeism costs are sometimes included when calculating monetary benefits, they were not included in this study due to difficulties in measurement and a lack of consensus regarding their inclusion (Ashby and Mahdon, 2010; Braakman-Jansen et al., 2012). Presenteeism refers to the loss of productivity when employees show up to work when unwell and consequently under-perform (Johns, 2010; Ashby and Mahdon, 2010).

Currently, there is no common standard for assessing presenteeism. Different tools lead to different results making it difficult to achieve an accurate estimation (Braakman-Jansen et al., 2012). The loss of productivity from presenteeism could be significantly greater than from absenteeism, especially in the field of healthcare (Ashby and Mahdon, 2010; Aronson and Gustafsson, 2005; Phillips, 2005).

9.4 Results

Net benefit, benefit-cost ratio, and an ROI percentage were calculated for each of the four cost scenarios. Over the six-month trial period, yoga group participants missed 2 calendar days due to musculoskeletal conditions, while the usual care group missed 43 days.

This difference in sickness absence days resulted in production loss costs of £3.00 per person in the yoga group compared with £65.27 per person in the usual care group. The monetised benefit of the yoga programme compared to usual care was £62.27 per person (Chapter 6, Tables 6.3, 6.4 and 6.5).

To calculate benefit-cost ratios, monetised benefits were divided by intervention costs for each of the four cost scenarios (chapter 5). Benefit-cost ratios ranged from 0.78 to 2.02 (Table 9.2).

Table 9.2: Net benefit, benefit-cost ratio and ROI percentage

Cost scenarios	Total benefits (production loss cost) £	Total costs (intervention) £	Net benefit (per person) £	ROI	Benefit-cost ratio
Scenario 1 instruction costs at £91 per session	62.27	62.98	-0.71	-1%	0.99
Scenario 2 instruction costs at £64 per session	62.27	45.98	16.29	35%	1.35
Scenario 3 instruction costs at £40 per session	62.27	30.77	31.50	102%	2.02
Scenario 4 instruction costs at £91 per session, venue costs and retail prices	62.27	79.72	-17.45	-22%	0.78

Additional cost of lost production

The human capital approach offers a reliable approach to calculating the costs of lost production (Drummond et al., 2005). As noted above, a true consideration of these costs includes the extra cost of lost production associated with absenteeism.

To account for these additional costs, Nicholson et al. (2006) maintain that a median multiplier of 1.28 times the average daily wage rate provides a more accurate estimate. When the 1.28 multiplier was considered, the benefit-cost ratios ranged between 1.00 and 2.59 (Table 9.3).

Table 9.3: Additional cost of lost production (using multiplier of 1.28)

Cost scenarios	Total benefits (production loss cost)* £	Total costs (intervention) £	Net benefit (per person) £	ROI	Benefit-cost ratio
Scenario 1	79.71	62.98	16.73	27%	1.27
Scenario 2	79.71	45.98	33.73	73%	1.73
Scenario 3	79.71	30.77	48.94	159%	2.59
Scenario 4	79.71	79.72	-0.01	0%	1.00

*** Using multiplier of 1.28**

Willingness to make a co-payment

In the end-programme questionnaire, yoga participants indicated a willingness to make a co-payment of £3 to £6 per yoga class. If yoga participants were willing to pay £4.50 per class, this would add another £36 per person in benefits from the employer perspective for an eight-week programme.

When this co-payment was included in the calculation, the benefit-cost ratios ranged between 1.23 and 3.19 (Table 9.4).

Table 9.4: Willingness to make a co-payment (£4.50 per session)

Cost scenarios	Benefits (PLC)* £	Benefits (WTP)** £	Total benefits £	Total costs (intervention) £	Net benefit (per person) £	ROI	Benefit-cost ratio
Scenario 1	62.27	36.00	98.27	62.98	35.29	56%	1.56
Scenario 2	62.27	36.00	98.27	45.98	52.29	114%	2.14
Scenario 3	62.27	36.00	98.27	30.77	67.50	219%	3.19
Scenario 4	62.27	36.00	98.27	79.72	18.55	23%	1.23

*** Production loss cost**
**** Willingness-to-pay**

When both a willingness to make a co-payment and the 1.28 multiplier were considered, the benefit-cost ratios ranged between 1.45 and 3.76 (Table 9.5)

Table 9.5: Willingness-to-pay and additional costs of lost production

Cost scenarios	Benefits (PLC x 1.28)* £	Benefits (WTP)** £	Total benefits £	Total costs (intervention) £	Net benefit (per person) £	ROI	Benefit-cost ratio
Scenario 1	79.71	36.00	115.71	62.98	52.73	84%	1.84
Scenario 2	79.71	36.00	115.71	45.98	69.73	152%	2.52
Scenario 3	79.71	36.00	115.71	30.77	84.94	276%	3.76
Scenario 4	79.71	36.00	115.71	79.72	35.99	45%	1.45

*** Production loss cost**
**** Willingness-to-pay**

9.5 Discussion

The results indicated that an eight week yoga programme provided cost savings from the employer perspective in cost scenarios 2 and 3 when yoga instructors were paid £64 and £40 per session, respectively. In these scenarios, the benefit cost ratios ranged from 1.35 to 2.02.

When a median multiplier of 1.28 was incorporated to account for additional production loss costs related to sickness absence, then the benefit-cost ratios for scenarios 2 and 3 ranged

from 1.73 to 2.59 (Table 9.3). When yoga participants were willing to make a co-payment of £4.50 per class, the cost-benefit ratios in scenarios 2 and 3 ranged from 2.14 to 3.19 (Table 9.4).

These results indicate that when instructors were compensated at rates consistent with national averages (£40 and £64 per session), yoga provided cost savings by reducing sickness absence days due to musculoskeletal conditions.

When yoga instructors were paid at rates above national averages, cost savings for employers were less certain. Scenarios 1 and 4 indicated that the yoga programme did not provide cost savings when instructors were paid £91 per session, unless a 1.28 multiplier and/or an employee co-payment of £4.50 were considered (Table 9.2).

Randomised controlled study design

Most workplace health promotion programmes are not evaluated with a randomised controlled study design. Randomised controlled trials are considered the gold standard for investigating effectiveness untainted by bias (Kunz et al., 2007; Van Dongen et al., 2013a; Kraaijeveld et al., 2013). Benefit-cost ratios from randomised controlled trials tend to result in much smaller estimates of effect than non-randomised studies.

The benefit-cost ratios in this workplace study of yoga ranged from 0.78 to 3.76. These are lower than many other workplace health promotion programmes which report ratios ranging from 2.3 to 10.1 (Goetzel and Ozminkowski, 2008; Price Waterhouse Coopers, 2008), and as high as 15.4, 24.6, and 84.9 for musculoskeletal conditions (DeRango et al., 2003; Lahiri et al., 2005).

In a recent systematic review, Van Dongen et al. (2013a) identified 17 studies of workplace health promotion aimed at improving physical activity and/or nutrition. Of these, 13 were non-randomised studies, four were randomised controlled trials. Results from the 13 non-randomised studies indicated that physical activity/nutrition programmes at work produced a positive return on investment, while the four randomised controlled trials reported a negative financial return.

The discrepancy between the results of randomised and non-randomised studies may be due to *selection bias* arising when participants are not randomly allocated. Without randomisation, outcomes between intervention and control groups may be biased due to significant differences in group characteristics or because of confounders, such as the intervention group having a higher motivation to change (Linden, 2011; van Dongen et al., 2013a).

In addition to using a randomised controlled study design, another strength of this study was that sickness absence data for each participant was collected from NHS electronic staff records (ESR) supplied by the employer. ESR is reported to be a more accurate method than self-report in measuring sickness absence costs (Edwards, 2008). Although both Chuang et al. (2012) and Aboagye et al. (2015) used patient self-report to measure sickness absence, this workplace study used ESR, which avoids the possibility of recall bias that may limit the findings of economic evaluations (van Dongen et al., 2013a).

It is recommended that future ROI studies use a randomised controlled design and obtain sickness absence data directly from the employer. Since there is currently no common standard for measuring presenteeism, further research is essential for developing such a standard (van Dongen et al., 2013a).

Limitations

Although benefit-cost ratios in this study appear promising for yoga, the findings need to be interpreted with caution due to the small sample size. During the eight-week yoga programme and six-month follow-up, only six participants missed working days due to musculoskeletal conditions (Table 6.3, 6.4). Five of these participants were in the usual care group, and only one was in the yoga group. Of these five usual care participants, one missed 29 days, which accounted for 67% of the total sickness absence days due to musculoskeletal conditions.

Although it could be argued that participation in the yoga programme may have prevented these 29 days of sickness absence, such an outlier may have distorted the magnitude of benefit that yoga can offer. High-quality investigations of yoga in workplace settings, with robust sample sizes, are needed to verify these results.

Nevertheless, the sickness absence benefits reported in this yoga study are consistent with the results of the Chuang and Aboagye yoga studies which also reported substantial savings from reduced absenteeism due to back pain (Chapter 8). These three studies suggest that yoga can be cost saving for employers seeking to manage sickness absence due to musculoskeletal conditions.

9.6 Conclusion

The yoga intervention generated a positive return on investment from the employer perspective when yoga instructors were compensated in line with national averages at £64 and £40 per session (scenarios 2 and 3). There was no return on investment when yoga instructors were paid at £91 per session (scenarios 1 and 4), unless a co-payment programme was considered.

However, when employees were willing to make a co-payment of £4.50 per session, the benefit-cost ratios for all scenarios (including those where the instructor was paid £91 per session) were between 1.23 and 3.19. When willingness to make a £4.50 co-payment and the real costs of lost production (multiplier of 1.28) were taken into account, the return on investment was even higher, ranging from 1.45 to 3.76.

These results suggest that yoga can generate a profitable return on investment for employers, especially when instructors are paid at standard rates and employees are willing to make a co-payment.

Chapter 10: Social return on investment

10.1 Chapter summary

This was the first SROI analysis of a workplace yoga programme. Two methodologies, a Cabinet Office approach and wellbeing valuation, were used to estimate the total monetary value of relevant health outcomes for three key stakeholders. SROI ratios were calculated by dividing the value of stakeholder outcomes by the intervention costs.

Four cost scenarios provided a range of intervention costs to reflect real-life settings (chapter 5). Using the Cabinet Office methodology, the SROI ratios ranged between 2.76 and 6.88, and from wellbeing valuation the ratios were 2.61 to 6.50.

These results suggest that an eight-week yoga programme can generate a positive social return on investment, indicating that yoga in the workplace was valuable for the three main stakeholders.

10.2 Introduction

Social return on investment is a relatively new method of economic evaluation with few published academic papers on its advantages and limitations (Fujiwara, 2015, Krlev, 2013).

Although SROI has become increasingly popular in the third sector (not-for-profit organisations), it is seldom used in a policy-making context by government departments or international organisations (Fujiwara, 2015). Nevertheless, social return on investment is a quickly growing approach to economic evaluation, providing an alternative or supplement to currently accepted methods such as cost-benefit analysis (Fujiwara, 2015).

Social return on investment adopts a societal perspective. Compared to return on investment analysis (chapter 9), SROI takes a broader view of monetised outcomes by assessing the overall social impact of an intervention as experienced by the main stakeholders (Fujiwara, 2014a). In this SROI, the key stakeholders were the NHS employees who participated in the yoga programme, the NHS as a health service provider and the NHS as an employer.

In recent years, the demand for SROI among third sector organisations has increased in response to the need to generate maximum value for money. Although value for money is frequently misunderstood to mean *least cost*, it more accurately refers to the value generated from a given investment (Arvidson et al., 2014).

While estimating value for money can be difficult, there is a clear and long-standing policy within the UK government of assigning monetary values to intangible benefits, which can facilitate a more informed approach to decision-making (Arvidson et al., 2014).

In this SROI of yoga in the workplace, the social return on investment was investigated using two different methodologies: the Cabinet Office approach and wellbeing valuation. Although social return on investment analysis has been applied in a number of different settings, this may be the first study to apply SROI to yoga in the workplace.

10.3 Cabinet Office approach

The Cabinet Office approach is based on identifying and valuing what matters most to the key beneficiaries of a programme (Nicholls et al., 2012). This approach allows intangible benefits to be monetised through the use of financial proxies, which are inferred values from the prices of similar market-traded goods and services (Nicholls et al., 2012).

In this approach, stakeholders are not directly asked how much they would be willing to pay for an outcome (stated preference). Instead, financial proxies are used to estimate how much the benefit is worth to the stakeholder (revealed preference).

Within the Cabinet Office methodology, there are two types of SROI: forecast and evaluative (Nicholls et al., 2012). A forecast SROI is used in the planning stages of an intervention to estimate the value of health outcomes (Nicholls et al., 2012). An evaluative SROI is conducted retrospectively using the actual outcome data (Nicholls et al., 2012). This case study of yoga in the workplace is an evaluative SROI based on valid and reliable outcome measures assessed at baseline, end-programme and six months.

The Cabinet Office approach consists of several stages (Nicholls et al., 2012):

- identifying stakeholders and establishing the scope of analysis
- evidencing outcomes
- choosing financial proxies and valuing outcomes
- calculating the SROI.

Stage 1: Identifying stakeholders and establishing scope

In this SROI, the key stakeholders experienced benefit in the following ways:

- *NHS employees*: from reduced back pain due to the yoga programme
- *NHS as the health service provider*: from less healthcare resource use
- *NHS as the employer*: from fewer sickness absence days.

The scope of SROI analysis included measuring the monetary value of yoga for reducing:

- back pain (for NHS employees)
- healthcare resource use related to musculoskeletal conditions (for the NHS as a health service provider)
- sickness absence days due to musculoskeletal conditions (for the NHS as an employer).

Table 10.1 Key stakeholders and rationale for inclusion

Stakeholder	Role	Rationale for Inclusion
NHS	as yoga participants	Direct beneficiaries of the yoga programme.
NHS	as an employer	Indirect beneficiary of the yoga programme from fewer sickness absence days due to musculoskeletal conditions.
NHS	as a health service provider	Indirect beneficiary of the yoga programme from reduced healthcare resource use for musculoskeletal conditions.

Stage 2: Evidencing outcomes

In stage 2, evidence is provided to substantiate the main outcomes for each of the three stakeholders (Table 10.2).

Table 10.2: Evidencing outcomes for key stakeholders

Stakeholder	Role	Evidencing outcomes	Outcome measurement tools
NHS	as yoga participants	• Reduced back pain • Enhanced health-related quality of life • Improved psychological wellbeing	• RDQ • EQ5D-5L • WHO-5
NHS	as an employer	• Less sickness absence days due to musculoskeletal conditions	• NHS electronic staff records (ESR)
NHS	as a health service provider	• Less healthcare resource use for musculoskeletal conditions	• Healthcare resource use questionnaires

Evidencing outcomes for NHS employees

For NHS employees participating in the yoga programme, the primary outcome was reduced back pain. At six months, the yoga group reported less back pain, improved psychological wellbeing, and more health-related quality of life than the usual care group (Table 10.3).

Table 10.3 Evidencing outcomes: baseline and six-month mean scores

	Yoga Group			Usual Care Group			Between Groups
Outcomes	**Baseline**	**6 months**	**Mean change**	**Baseline**	**6 months**	**Mean change**	**Mean difference 6 months**
Back pain (RDQ)	1.97	1.28	-0.69	2.07	1.90	-0.17	-0.52
Psychological wellbeing (WHO-5)	13.47	16.55	3.08	14.03	15.43	1.35	1.73
HRQoL (EQ5D-5L)	0.706	0.741	0.035	0.656	0.644	-0.12	0.047

Once the outcomes were identified, the next step was to compare the number of participants reporting positive change with those reporting negative change (Table 10.4).

For back pain and psychological wellbeing, the number of participants in the yoga group reporting positive change was considerably higher than for usual care. There was no clear difference, however, between the two groups in the numbers reporting negative change for back pain and psychological wellbeing (Table 10.4).

For health-related quality of life, the number of participants reporting both positive and negative change was greater for the yoga group (Table 10.4).

For all three outcomes, yoga participants reported more positive than negative change in comparison with usual care (Table 10.4).

Table 10.4 Evidencing outcomes: number of participants reporting significant change

Back Pain (RDQ)	**No change**	**Improved**	**Worsened**	**Net Benefit**
Yoga (n=39)	14 (36%)	17 (44%)	8 (20%)	9
Usual care (n=30)	13 (43%)	9 (30%)	8 (27%)	1
Psychological wellbeing	**No change**	**Improved**	**Worsened**	**Net Benefit**
Yoga (n=38)	14 (36%)	20 (53%)	4 (10%)	16
Usual Care (n=30)	18 (60%)	10 (33%)	2 (7%)	8
HRQoL	**No change**	**Improved**	**Worsened**	**Net Benefit**
Yoga (n=39)	7 (18%)	18 (46%)	14 (36%)	4
Usual Care (n=30)	8 (27%)	12 (40%)	10 (33%)	2

Evidencing outcomes for the NHS as a health service provider

Reduced healthcare resource use was relevant and significant to the NHS as a healthcare service provider. During the six-month study period, usual care participants visited healthcare professionals for musculoskeletal conditions more than twice as often as yoga participants. Yoga participants reported £5.87 per person in healthcare resource use for musculoskeletal conditions compared to £25.87 for usual care participants. This resulted in a cost saving of £20 per person that may be attributed to the yoga programme (chapter 6).

Evidencing outcomes for the NHS as an employer

Reduced sickness absence was relevant and significant to the NHS as an employer (Boorman, 2009). As reported in chapter 6, NHS electronic staff records showed a difference of 41 sickness absence days attributed to musculoskeletal conditions between the two groups at six months.

The production loss costs for yoga participants were £3.00 per participant compared with £65.27 per participant in the usual care group. This resulted in a cost saving of £62.27 per person that may be attributed to the yoga programme.

Stage 3: Choosing financial proxies and valuing outcomes

In this next stage, monetary values were assigned to the main outcomes in order to assess the social impact of the yoga programme for the key stakeholders (Nicholls et al., 2012). Equivalent market price proxies were identified for (Nicholls et al., 2102; Fujiwara, 2014a):

- reduced back pain
- improved psychological wellbeing
- increased health-related quality of life.

Reduced back pain

In the UK, physiotherapy is a common treatment for back pain. Research shows that reductions in back pain can be achieved by regular sessions with a physiotherapist (Adamczyk et al., 2009). Since a session with an NHS physiotherapist cost £44 in 2013 (Department of Health, 2013), eight sessions over a six month period would cost £352. Using this figure as a financial proxy, the total social benefit for 9 yoga participants reporting less back pain was £3,168 (Table 10.5).

Improved psychological wellbeing

There is a strong association between back pain and stress/depression (Trivedi, 2004). Psychosocial factors are considered important for reducing back pain (Sherman et al., 2011; Cohen et al., 2008). In the UK, the NHS recommends psychological counselling and cognitive behavioural therapy for managing stress and depression (Clark, 2011).

A session with an NHS counsellor cost £51 per session in 2013 (Department of Health, 2013). Eight sessions over a six month period would cost £408. Using this amount as a proxy, the combined social benefit for 16 yoga participants reporting significantly greater psychological wellbeing was £6,528.

Increased health-related quality of life

Health-related quality of life as measured with the EQ5D-5L includes five dimensions of health: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. Of these five, pain/discomfort does not need a financial proxy apart from the physiotherapy sessions mentioned above. Similarly, anxiety/depression is dealt with by the financial proxy for eight sessions with a NHS counsellor.

The first three dimensions of the EQ5D-5L are mobility, self-care, and usual activities which refer to general physical health. These could be addressed by regular sessions with a personal trainer at an average cost of £30 per session in the UK.[1] Eight sessions would cost £240 per person.

The total social benefit was calculated at £960 for 4 yoga participants who experienced an increased health-related quality of life at six months.

Table 10.5: Total social value for yoga participants at six months (using financial proxies)

Outcome	Yoga participants (net benefit)	Financial proxy	Value of equivalent market service £	Total social value £	Total social value per participant £
Less back pain, n=39	9	8 sessions with a physiotherapist	44.00	3,168.00	81.23
Improved psychological wellbeing, n=38	16	8 sessions with a counsellor	51.00	6,528.00	171.79
Increased HRQoL, n=39	4	8 sessions with a personal trainer	30.00	960.00	24.62
					£277.64

[1] https://nationalcareersservice.direct.gov.uk/

Calculating deadweight

Deadweight refers to outcomes that would have happened anyway. In randomised controlled trials, deadweight is measured by the outcomes of the control group. At six months, deadweight was calculated at £137 per person from usual care participants reporting reductions in back pain, improvements in psychological wellbeing and increases in health-related quality of life (Table 10.6). When this amount (£137) is divided by the average social value for yoga participants (£278), the deadweight percentage was found to be 62%.

Table 10.6: Total social value for usual care participants (deadweight) at six months

Outcome	Usual care participants (net benefit)	Financial proxy	Value of financial proxy	Total social value	Total deadweight per participant
Less back pain (n=30)	1	8 sessions with a physiotherapist	£44.00	£352.00	£11.73
Improved psychological wellbeing (n=30)	8	8 sessions with a counsellor	£51.00	£3,264.00	£108.80
Increased HRQoL (n=30)	2	8 sessions with a personal trainer	£30.00	£480.00	£16.00
					£136.53

Total social value for key stakeholders

The total social value for each key stakeholder was calculated as follows:

- *NHS employees*: Subtract the total social value per person for the usual care participants (£137) from the total social value per person for the yoga participants (£278) to calculate a total social value of £141 per participant.
- *NHS as a health service provider*: Subtract the healthcare resource use (for musculoskeletal conditions) of usual care participants from the resource use of yoga participants during the six-month study to give a total social value of £20 per person.
- *NHS as an employer*: Because of 41 fewer sickness absence days due to musculoskeletal conditions during the six month study, the social value to the NHS as an employer was determined to be £62 per participant.

Table 10.7: Total social value for all stakeholders

Stakeholders	Social value per person £	Total social value (n=76) £
NHS employees	141.11	10,724.36
NHS as healthcare provider	20.00	1,520.00
NHS as employer	62.27	4,732.52
Total social value	**£223.38**	**£16,976.88**

Stage 4: Calculating the SROI

The final stage using the Cabinet Office approach was to calculate the social return on investment ratios by comparing the total social value for 76 yoga participants with the total intervention costs. Using the four cost scenarios, the SROI ratios ranged from £2.73 to £6.82 for every £1 invested. This indicates that an eight week yoga programme generated a positive social return on investment in all four cost scenarios, suggesting that yoga in the workplace provided excellent value for money.

Table 10.8 SROI ratios for the Cabinet Office approach

Methodology	Cost scenarios	Total costs £	Total social value £	SROI ratio £
Cabinet Office approach	1	4,939.00	16,976.88	**1 : 3.44**
	2	3,643.00	16,976.88	**1 : 4.66**
	3	2,491.00	16,976.88	**1 : 6.82**
	4	6,211.00	16,976.88	**1 : 2.73**

10.4 Wellbeing valuation approach

Developed by economist Daniel Fujiwara and the Housing Association Charitable Trust (HACT), wellbeing valuation provides an alternative to the revealed preference approach in the Cabinet Office methodology. Wellbeing valuation sidesteps the need to find suitable proxy values, thus reducing subjectivity and increasing consistency (Carpenter, 2015).

The wellbeing valuation approach incorporates tools such as a Social Value Bank to assign financial values to the main outcomes of an intervention. Using multiple linear regression and an instrumental variable method, these outcome values are calculated from large national UK datasets which include the British Household Panel Survey (BHPS) (Fujiwara,

2014a).

The majority of outcome values in the Social Value Bank are derived from the BHPS which has been completed by the same 10,000 individuals every year since 1991. Wellbeing valuation uses self-reported wellbeing data from these individuals to calculate the value of factors (such as good overall health, relief from depression, improvements in back problems) that help to create a particular level of wellbeing (Trotter et al., 2014).

The Social Value Bank is reported to be extremely robust due to the vastness of the datasets and the statistical methods with which the values have been derived (Fujiwara, 2014a). Outcome values from the Social Value Bank include good overall health valued at £20,141 per person per year, relief from depression/anxiety at £36,766 per person per year and improvement in back problems at £1,306 per person per year.

Applying the Social Value Bank

In this case study of yoga in the workplace, the most relevant outcome in the Social Value Bank was *problems with arms, legs, hands, feet, and back* valued at £1306 per person per year. Since this study lasted for six months (0.5 years), the outcome value was £653 per person for reduced back pain.

Of the 39 yoga participants who completed six-month questionnaires, 17 reported a reduction in back pain, 14 indicated no change and 8 registered more back pain, resulting in a net benefit of 9. Using the wellbeing valuation approach, the number benefitting was multiplied by the outcome value from the Social Value Bank (£653) to calculate the total social value (£5,877) for reduced back pain. In this instance, the social value was £151 per person (Table 10.9).

In wellbeing valuation, deadweight is calculated using a mean percentage provided by the Social Value Bank. For heath interventions, this percentage is 27% (Fujiwara, 2013). When applied to this analysis, the deadweight per person was £41 per person, and the total social value after deadweight was £110 per person (Table 10.9).

Table 10.9: Total social value for reduced back pain with deadweight at 27%

Group	Participants with less back pain (net benefit)	Outcome value* (Social Value Bank)	Total social value	Total social value per participant
Yoga (n=39)	9	£653.00	£5,877.00	150.69
Deadweight at 27%				**£110.01**

***for relief from problems associated with back, arms, legs, hands and feet**

Although a 27% deadweight estimate for health interventions is recommended in wellbeing valuation, the randomised controlled design used in this case study made it possible to estimate the actual deadweight percentage. This was achieved by calculating the social value per person for the usual care group.

At six months, 9 participants in the usual care group reported less back pain and 8 indicated more back pain, a net benefit of 1 participant. Using wellbeing valuation, the total social value for usual care participants was £653, or £22 per person (Table 10.10).

When this amount (£22 per person) was divided by the total social value for yoga participants (i.e., £151 per person), the deadweight percentage was found to be 14%. This is significantly lower than the deadweight percentage of 27% recommended in the Social Value Bank.

The total social value of the yoga programme for all participants (£129 per person) was calculated by subtracting the total social value for the usual care participants (£22 per person) from the total social value for the yoga participants (£151 per person) (Table 10.10).

Table 10.10: Total social value for reduced back pain with deadweight using actual data

Group	Participants with less back pain (net benefit)	Outcome value* (Social Value Bank) £	Total social value £	Total social value per participant
Yoga (n=39)	9	653.00	5,877.00	150.69
Usual care (n=30)	1	653.00	653.00	21.77
Difference between groups				**£128.92**
Deadweight percentage using actual usual care group data				**14%**

Total social value for all stakeholders:

The total social value for all stakeholders was calculated at £213 per person by adding the total social value for the NHS yoga participants (£129 per person), for the NHS as an employer (£62 per person) and for the NHS as health service provider (£20 per person) (Table 10.11).

Table 10.11: Total social value for all stakeholders

Stakeholders	Social value per person £	Total social value (n=76) £
NHS employees	128.92	9,797.92
NHS as employer	62.27	4,732.52
NHS as healthcare provider	20.00	1,520.00
Total social value	**211.19**	**16,050.44**

Calculating the SROI ratio

As with the Cabinet Office approach, the SROI ratio was calculated by comparing the total social value for all stakeholders with the total intervention costs. Using the four cost scenarios, the SROI ratios ranged from £2.58 to £6.44 for every £1 invested (Table 10.12).

Table 10.12 SROI ratios using wellbeing valuation

Methodology	Cost scenarios	Total costs £	Total social value £	SROI ratio £
Wellbeing valuation approach	1	4,939.00	16,050.44	**1 : 3.25**
	2	3,643.00	16,050.44	**1 : 4.41**
	3	2,491.00	16,050.44	**1 : 6.44**
	4	6,211.00	16,050.44	**1 : 2.58**

10.5 Discussion

Applying both the Cabinet Office and wellbeing valuation approaches, the SROI analysis in this study showed that the yoga programme generated a profitable social return on investment for each of the four cost scenarios. Both methodologies resulted in very similar ratios. Using the Cabinet Office approach, the SROI ratios ranged from 2.73 to 6.82 depending on the cost scenario, whereas the ratios from the wellbeing valuation varied from 2.58 to 6.44.

The SROI ratios presented in this chapter are considerably larger than the ROI ratios generated in chapter 9, which ranged from 0.78 to 3.76. Although both ROI and SROI are based on cost-benefit analysis and the monetisation of outcomes, they differ in this case study according to the economic perspective taken.

The return on investment analysis (chapter 9) was performed from the employer perspective, whereas the SROI analysis in this chapter was conducted from a societal perspective which incorporated monetised outcomes for all three key stakeholders.

For one stakeholder, NHS yoga participants, the monetised outcomes were determined by selecting appropriate financial proxies to account for reductions in back pain (Cabinet Office approach) or by using a suitable social value for reduced back pain from the Social Value Bank (wellbeing valuation).

In this SROI, the strength of the Cabinet Office approach was in its step-by-step methodology (Tables 10.8 and 10.12).:

1. three key stakeholders were identified
2. the scope of analysis was determined (musculoskeletal-related outcomes)
3. outcome measures were selected (RDQ, EQ5D-5L, WHO-5)
4. relevant and significant benefits were assessed
5. financial proxies were chosen
6. deadweight was estimated,
7. SROI ratios were calculated

The main limitation of this approach, however, was in the lack of standardisation when selecting financial proxies. Although there is a Global Value Exchange from which appropriate financial proxies can be chosen, there are few guidelines for selecting financial proxies other than to advise transparency and to avoid over-claiming (Nicholls et al., 2012).

In this study, the financial proxies (e.g., physiotherapist for back pain, counsellor for psychological wellbeing and personal trainer for health-related quality of life) were selected based on a subjective opinion about their validity. This subjectivity, however, can generate biased estimates of value (Fujiwara, 2015).

To prevent bias, further development of standards for SROI reporting is recommended as well as identifying exemplary SROI studies in various fields as models for good practice (Krlev et al., 2013). Without standards for choosing financial proxies, it can be difficult for decision-makers to compare SROI ratios between competing interventions and programmes (Arvidson et al., 2013).

The strength of wellbeing valuation, on the other hand, is that it provides a standard methodology without the necessity for financial proxies. SROI ratios are generated from robust outcome values provided in the Social Value Bank.

In this SROI, reductions in back pain were measured at £1,306 per person per year, an amount derived from statistical analysis of four large datasets including the British Household Panel Survey (Fujiwara, 2013).

Although the Social Value Bank provided a standardised monetary value for a reduction in back pain, the average deadweight estimate for health programmes of 27% was considerably higher than the 14% deadweight calculation derived from the actual data of usual care participants.

Without a control group to measure that which would have happened anyway, it is difficult to accurately assess deadweight for a specific intervention using wellbeing valuation. As a result, social impact can be easily over- or under-estimated (Carpenter, 2015).

To ensure greater accuracy in social return on investment analysis, the SROI Network, a leading social value enterprise in the UK, recommends conducting the broader and more coherent wellbeing valuation approach alongside the more detailed and programme-specific Cabinet Office approach (Carpenter, 2015).

Whereas the Cabinet Office approach is limited by the financial proxies used in calculating SROI ratios, wellbeing valuation is currently constrained by a relatively small number of outcome values (n=53) in the Social Value Bank.

Nevertheless, the strength of wellbeing valuation lies in the consistent methodology of the Social Value Bank which facilitates the comparison of SROI ratios between competing programmes. The Cabinet Office approach, on the other hand, can provide more in-depth and accurate insight into the social impact created by specific programmes (Leach, 2014).

Taken together, these methodologies for calculating SROI make it possible to place a monetary value on intangible social outcomes and to give value to what is significant and important to people, such as good physical and mental health.

Strengths and limitations

The main strengths of this social return on investment analysis were the use of valid and reliable outcome measures, a randomised controlled design and two SROI methodologies,. These three factors enabled a more accurate estimation of outcomes, deadweight and SROI ratios.

There were also limitations. First, although this SROI analysis took a societal perspective in terms of benefits to key stakeholders, it compared this societal benefit with a much narrower perspective of costs (e.g., intervention costs to the employer).

The SROI ratio showed the social return on the costs to the *employer*, rather than the social return on the costs to *society* (Fujiwara, 2015). Therefore, the SROI ratio may not have generated an accurate societal perspective.

Second, the total social impact of the yoga programme was calculated by multiplying the number of people benefitting from yoga by the social value of that intervention (calculated with financial proxies or with wellbeing valuation).

Although this calculation may have captured the *direction* of benefit (i.e., number of people with positive or negative outcomes) it did not adequately account for the *magnitude* of benefit or loss (Table 10.4). For example, although 17 of 39 yoga participants reported less back pain after six months, the magnitude of improvement was not considered in determining the total social value.

Third, data collection and outcome measurement was limited to only three key stakeholders. Focus group interviews (chapter 4) indicated that additional beneficiaries might include yoga participants' close family members and work colleagues.

For example, work colleagues may have experienced fewer increases in workload when employees who practised yoga took less sickness absence days due to musculoskeletal conditions. In addition, focus group interviews revealed that, for several yoga participants, close family members benefitted by participating in home practice sessions.

Finally, outcomes were limited to a handful of valid and reliable questionnaires including those measuring back pain, psychological wellbeing, and health-related quality of life. Future studies could consider measuring the impact of a yoga programme on work performance. A 2013 study by Strijk et al. reported that high yoga attendance within a workplace physical activity programme showed positive effects on productivity.

10.6 Conclusion

The social return on investment analysis in this chapter showed that approximately £2.5 to £6.8 of social value was created for every £1 invested in the yoga programme. The SROI ratios were very similar using two methodologies, thus strengthening the evidence that in comparison with usual care, the yoga programme generated a valuable social return on investment for the key stakeholders.

Chapter 11: Discussion, implications and conclusion

11.1 Chapter summary

An analysis of the research questions and main findings of this thesis are presented in this final chapter. It also compares

- the main findings of this thesis with other studies
- the use of welfarist and extra-welfarist methods in the same economic perspective
- preference-based valuation with wellbeing valuation.

In addition, the implications for employers are presented, as well the strengths, limitations, suggestions for future research and the novel contributions of this thesis.

Finally, using yoga in the workplace as a case study, conclusions are drawn about the value and generalisability of a multiple method approach to economic evaluation in public health.

11.2 Research questions and main findings

To date, there are no known published studies investigating the cost-effectiveness and financial return of yoga for managing musculoskeletal conditions among employees. To fill this gap, this thesis was designed to take a broad approach to economic evaluation using yoga in the workplace as a case study. In doing this, several research questions were presented, which are listed below with a summary of the main findings.

Thesis Chapter 1

Research Question 1: *What are the costs of back pain to employers in the UK and how effective is yoga in addressing these costs?*

Main Findings: Musculoskeletal conditions and back pain contribute to more than 30 million sickness absence days per year in the UK at a direct cost to employers of £5.6 billion. To reduce back pain, NICE recommends structured group exercise programmes of at least eight sessions over a twelve week period.

Although yoga is one form of group exercise with a strong evidence base for effectively reducing chronic low back pain among patient populations, there is no published evidence of its cost-effectiveness in managing back pain among employee populations.

Thesis Chapter 2

Research Question 2: *Given there are no published cost-effectiveness studies of yoga in workplace settings, what is the existing literature on the effectiveness of yoga in the workplace?*

Main Findings: This is the first systematic review, based on PRISMA guidelines, of randomised trials that investigated the effectiveness of yoga in workplace settings. Eight randomised trials, conducted between 1998 and 2014, met the inclusion criteria.

Although these eight studies reported generally favourable results for the effectiveness of yoga in occupational settings, the overall evidence was limited due to a lack of high quality studies. The evidence from these studies suggested that the effectiveness of yoga in the workplace was:

- *high* for managing musculoskeletal conditions
- *moderate* for reducing perceived stress
- *limited* for increasing sleep quality
- *conflicting* for improving heart rate variability.

Among these eight studies, there was considerable variation in styles of yoga implemented, length of programme offered and frequency of sessions delivered. These differences in study design made it difficult to draw more definitive conclusions about the effectiveness of yoga in workplace settings.

Thesis Chapter 3

Research Question 3: *Using evidence from a pragmatic randomised controlled trial conducted for this thesis, how effective is yoga for managing back pain in the workplace?*

Main Findings: To assess the effectiveness of yoga for managing back pain in the workplace, a pragmatic randomised controlled trial was conducted (n=151). Offered at three hospital sites, the yoga programme consisted of eight 60 minute yoga classes, a DVD and an illustrated booklet.

Compare with usual care, yoga participants at eight weeks reported statistically significant reductions in back pain and physical exhaustion and statistically significant improvements in psychological wellbeing, rejuvenation, and tranquillity. Yoga participants also reported feeling more resilient and positively engaged, although the gains for these factors were not statistically significant compared to the usual care group.

At the six months, yoga participants reported less back pain and greater psychological wellbeing than the usual care group, but the differences between the two groups for these outcomes were no longer statistically significant.

Two back pain scales were used in this trial. The RDQ assessed physical symptoms, and the Keele STarT measured both the physical and psychosocial impact of back pain. The results at eight weeks were significant for both Keele STarT ($p<0.001$) and RDQ ($p=0.035$), suggesting that the Dru Yoga programme effectively addressed both the physical and psychosocial indicators of back pain.

Thesis Chapter 4

Research Question 4: *What is the employee experience of a yoga programme in the workplace?*

Main Findings: This was the first qualitative study of yoga in a workplace setting. Focus groups were used to understand the experience of employees participating in the programme. Thematic analysis indicated that yoga participants experienced both improved physical and mental health.

Most participants enjoyed the yoga programme. They reported reduced pain levels, more flexibility, better posture, improved sleep and feeling more relaxed. Participants were positive about the intervention. Most indicated that they would recommend the programme to others.

Two participants reported muscle spasms from home practice. One withdrew after the first week, while the second continued to practise at home using the DVD, reporting longer-term benefits from continued yoga practice at home.

Thesis Chapter 5

Research Question 5: *What are the direct costs to the employer when implementing a workplace yoga programme?*

Main Findings: The costing analysis (chapter 5) was conducted from the employer perspective, considering only the direct costs to the employer for implementing an eight week workplace yoga programme. Four different cost scenarios were created to represent different real-life settings.

With research costs excluded, scenario 1 considered the actual costs of implementing the yoga intervention as part of a randomised controlled trial. Yoga teachers were paid £91 per

session, equipment was purchased at wholesale prices and venues were provided at no charge in NHS hospitals. All costs were presented in 2013 British Sterling prices.

Scenarios 2 and 3 differed from scenario 1 in that yoga instructors were paid £64 and £40 per session, respectively. Scenario 4 was the maximum cost scenario when yoga instructors were paid £91 per session, equipment was purchased at retail prices and venue costs were £15 per session which included overheads.

The costing analysis showed that the intervention costs of the eight-week yoga programme for 76 yoga participants ranged from £33 to £82 per person depending on the scenario.

Thesis Chapter 6

Research Question 6: *What are the costs and disaggregated consequences of yoga in a workplace setting?*

Main Findings: This was the first cost-consequence analysis of yoga in a workplace setting. Three economic perspectives were established: employer, healthcare and societal.

From the employer perspective, the yoga programme was less costly than usual care in scenarios 2 and 3, when yoga instructors were paid £64 and £40 per session, respectively. Yoga was more expensive in scenarios 1 and 4 when instructors were paid £91 per session.

From the healthcare perspective, the yoga programme was more expensive than usual care in all four scenarios due to higher intervention costs involved in delivering the programme.

From the societal perspective, the yoga programme was less costly than usual care in all four scenarios due to lower production loss costs from fewer sickness absence days attributed to musculoskeletal conditions.

The costs from these three perspectives were then listed alongside the outcomes of the yoga intervention in a cost-consequence balance sheet. The outcomes (reported in chapter 3) were back pain, psychological wellbeing, resilience, rejuvenation, tranquillity, physical exhaustion and positive engagement.

At six months, there were no statistically significant differences in outcomes between groups. However, yoga participants reported less back pain than usual care participants which may have been the result of continued home practice.

In situations where yoga was more effective and more costly than usual care, the cost-effectiveness of yoga depended on whether the benefits gained were large enough to justify the additional costs.

This comparison between benefits and costs was investigated using cost-effectiveness analysis (chapter 7), cost-utility analysis (chapter 8), return on investment analysis (chapter 9) and social return on investment analysis (chapter 10).

Thesis Chapter 7

Research Question 7: *What is the range of incremental cost-effectiveness ratios of yoga compared with usual care for reducing back pain in the workplace?*

Main Findings: Using reduced back pain (RDQ) as the primary outcome measure, this was the first cost-effectiveness analysis of yoga in a workplace setting.

At the six-month follow-up, yoga group participants reported a greater mean reduction in back pain (0.525 RDQ) than usual care participants.

From the healthcare perspective (all scenarios) and from the employer perspective (scenarios 1 and 4), the yoga programme at six months was more effective and more costly than usual care. Cost-effectiveness analysis was performed to determine if the greater mean reduction in back pain (0.525 RDQ) was enough to justify the additional costs of the yoga programme.

From the healthcare perspective, results showed ICERs ranging from £21 to £114 per one point reduction in RDQ. The cost-effectiveness probability of the yoga programme in comparison to usual care ranged from 75% to 78% with a threshold of £1,300 per one point reduction in RDQ.

From the employer perspective, the ICERs ranged from £1 to £33 per one point reduction in RDQ with the probability of cost-effectiveness ranging from 84% to 85% using a threshold of £1,300. This hypothetical threshold was derived from the Social Value Bank, where a decrease in back pain is valued at £1,306 per person per year (chapter 10).

These results indicate that in comparison with usual care, yoga was a cost-effective intervention for reducing back pain from both the employer and healthcare perspectives.

Thesis Chapter 8

Research Question 8: *What is the range of incremental cost-effectiveness ratios of yoga compared with usual care for improving health-related quality of life in the workplace?*

Main Findings: Using the EQ5D-5L to measure health-related quality of life, this was the first cost-utility analysis of yoga in the workplace. At six months, the yoga group reported greater improvements in HRQoL than the usual care group. The mean HRQoL gain for a yoga

participant compared to usual care was 0.047 using complete case data, and 0.034 using a multiple imputation method.

Since the yoga programme was both more effective and more costly than usual care from the healthcare perspective (all scenarios) and from the employer perspective (scenarios 1 and 4), cost-utility analysis was performed to determine if the greater improvement in HRQoL was enough to justify the additional costs of the yoga programme.

From the societal perspective, yoga was more effective and less costly than usual care due to the savings in production loss costs from yoga participants who reported fewer sickness absence days for musculoskeletal conditions.

From the employer perspective, yoga was more effective and less costly than usual care in cost scenarios 2 and 3 when yoga instructors were paid £64 and £40 per session, respectively. Although yoga was more costly than usual care in scenarios 1 and 4 (when yoga instructors were paid £91 per session), the ICERs ranged from £21 to £513 per QALY, well below the NICE threshold of £20,000 per QALY. When compared with usual care, the probability that yoga was cost-effective in these scenarios ranged from 90 to 93%.

From the healthcare perspective, yoga was more effective and more costly than usual care in all scenarios. The ICERs ranged from £317 to £1,756 per QALY using a threshold of £20,000 per QALY. The probability of yoga being cost-effective compared to usual care ranged from 87% to 92%.

These results indicate that from societal, employer and healthcare perspectives, yoga in the workplace was a cost-effective intervention for improving health-related quality of life.

Thesis Chapter 9

Research Question 9: *What is the return on investment for employers when implementing a yoga-based programme for managing musculoskeletal conditions in the workplace?*

Main Findings**:** This was the first known return on investment analysis of yoga in the workplace for managing musculoskeletal conditions.

Employer benefits were monetised by valuing the difference between the yoga and usual care groups in sickness absence days due to musculoskeletal conditions. During the study, yoga participants reported a combined total of 41 fewer sickness days due to musculoskeletal conditions, which resulted in savings to the employer of £62 per participant during the six months.

These monetised benefits were compared with the intervention costs from four scenarios to determine the range of benefit-cost ratios. The results indicated that the yoga programme produced a profitable return on investment in two of the four cost scenarios.

Although not cost saving in scenarios 1 and 4 when instructors were paid £91 per session, yoga generated a positive financial return when instructors were compensated at £64 and £40 per session (scenarios 2 and 3). The benefit-cost ratios for all scenarios ranged from 0.78 to 2.02.

When a 1.28 multiplier was included to reflect the actual costs of sickness absence, the yoga programme provided benefit-cost ratios ranging from 1.00 (break-even point) to 2.59.

When employees were willing to make a co-payment of £4.50 per session, the benefit-cost ratios were even more favourable, ranging from 1.23 to 3.19 for all scenarios.

When both the co-payment and the 1.28 multiplier were considered, the benefit-cost ratios were from 1.45 to 3.76, indicating that the yoga programme generated a highly beneficial return on investment to the NHS as an employer.

Thesis Chapter 10

Research Question 10: *What is the social return on investment of yoga for managing musculoskeletal conditions at work?*

Main Findings: This was the first known SROI analysis of a workplace yoga programme.

Monetised benefits were calculated for the three main stakeholders: NHS employees, the NHS as a health service provider and the NHS as an employer. Both revealed preference valuation (Cabinet Office approach) and wellbeing valuation were used to monetise the benefits for NHS employees who participated in yoga.

Using both methodologies, the number of yoga participants with less back pain at six months was multiplied by either a financial proxy value (Cabinet Office approach) or by a value from the Social Value Bank (wellbeing valuation). After deadweight was subtracted, monetised benefits were then compared with intervention costs to generate a range of SROI ratios.

SROI ratios ranged from 2.73 to 6.82 using the Cabinet Office approach and from 2.58 to 6.44 using wellbeing valuation. For every £1 invested in the yoga programme, approximately £2.50 to £6.80 of social value was created, indicating that the yoga programme provided a substantial social return on investment.

Thesis Chapter 11

Research Question 11: *Using yoga in the workplace as a case study, what is the value and generalisability to the key stakeholders of a multiple method approach to economic evaluation?*

Main Findings: This was the first study of yoga in the workplace (or in any setting) to incorporate a broad economic evaluation using five different methods.

From the employer perspective, return on investment analysis showed that yoga could generate positive benefit-cost ratios, especially when yoga instructors were compensated at standard rates (£40 to £64 per session). When employees were willing to make a co-payment of £4.50 per session and when a 1.28 multiplier was applied to account for the actual costs of sickness absence, the benefit-cost ratios became even more favourable.

From the healthcare perspective, cost-effectiveness analysis and cost-utility analysis indicated that in comparison with usual care, yoga could be a cost-effective workplace intervention for reducing back pain and for improving health-related quality of life. The cost-effectiveness probability of yoga, compared to usual care, was 75% to 78% with a threshold of £1,300 per one point reduction in RDQ and 87% to 92% with a threshold of £20,000 per QALY gained.

At six months, yoga participants reported not only less back pain and more health-related quality of life than usual care participants, but they also reported more than 50% fewer visits to healthcare professionals for musculoskeletal-related conditions.

From the societal perspective, social return on investment analysis indicated that yoga provided a beneficial social impact. For every £1 invested, £2.50 to £6.80 in social value was created.

By applying different methods of economic evaluation and including different economic perspectives, a broad approach provided key stakeholders with a wide range of evidence from which to base decisions regarding the allocation of scarce resources (Table 11.1).

11.3 Comparing results with other studies

Effectiveness of yoga

The results presented in this thesis are generally consistent with previous trials indicating the effectiveness of yoga for managing musculoskeletal conditions in the workplace (chapter 2). The effectiveness results (chapter 3) indicated that in comparison with usual care, yoga participants at end-programme reported statistically significant results in five domains:

- back pain (RDQ, p=0.035, Keele STarT, p<0.001)
- psychological wellbeing (WHO, p=0.014)
- physical exhaustion (EFI-PHY, p<0.001)
- rejuvenation (EFI-RV, p<0.001)
- tranquillity (EFT-TQ, p=0.001)

Overall, the eight-week yoga programme was a positive and safe experience for most NHS employees, with only 2 participants (3%) reporting adverse events (chapter 4).

Cost-effectiveness of yoga

The cost-utility results (chapter 8) in this thesis were also consistent with two previous economic evaluations of yoga for patients with low back pain (Chuang et al, 2012; Aboagye et al., 2015).

From the societal perspective, all three of these cost-utility analyses revealed that yoga was *dominant* to usual care, indicating that yoga was more effective and less costly when production loss costs from fewer sickness absence days were considered.

From the healthcare perspective, the cost-utility analysis in this thesis generated a range of ICERs ranging from £317 to £1,756 per QALY with a cost-effectiveness probability of 87% to 92% using a £20,000 per QALY threshold.

These results compared favourably with the Chuang study which reported an ICER of £13,606 per QALY and a cost-effectiveness probability of 72% with a £20,000 per QALY threshold. Taken together, these studies indicate that yoga can be cost-effective in comparison with usual care for improving health-related quality of life.

11.4 Comparing methods within each perspective

Using multiple methods, this broad approach to economic evaluation provided key stakeholders with a wide range of analyses presented from three different perspectives: employer, healthcare and societal.

Employer perspective

For the NHS as an employer, the results from the return on investment analysis were consistent with the findings from cost-effectiveness analysis and cost-utility analysis.

The return on investment analysis (chapter 9) indicated that the yoga programme could generate substantial cost savings. For example, when yoga instructors were paid £64 per session (scenario 2):

- the benefit-cost ratio was 1.35, representing a return on investment of 35%
- with the inclusion of the 1.28 multiplier, the benefit-cost ratio increased to 1.73
- with a co-payment of £4.50 per session, the benefit-cost ratio rose further to 2.14
- with both the co-payment and the 1.28 multiplier, the benefit-cost ratio was 2.52.

From the employer perspective, cost-effectiveness analysis and cost-utility analysis confirmed these findings by showing that yoga was *dominant* to usual care when instructors were compensated at £64 per session. The cost-effectiveness planes for scenario 2 showed most bootstrapped cost-effect pairs located in the southeast quadrant, indicating that yoga was both more effective and less costly than usual care (Figures 7.8 and 8.7).

Healthcare perspective

Healthcare resource use costs were calculated from the number of visits to healthcare professionals. During the six month study, usual care participants visited healthcare professionals for musculoskeletal conditions more than twice as often as yoga participants. Yoga participants reported a mean 0.13 visits per person compared to 0.30 visits per person for usual care participants (Table 6.6).

This difference in healthcare resource use between groups resulted in a £20 per person difference in healthcare resource use costs at 2013 prices. These costs were £5.87 per participant in the yoga group during the six-month trial period, compared to £25.87 per person in the usual care group (Table 6.6).

However, despite lower healthcare resource use costs for yoga participants, yoga was still more costly than usual care due to the higher intervention costs of the yoga programme. Because yoga was more effective than usual care for reducing back pain and for improving health-related quality of life, cost-effectiveness analysis and cost-utility analysis were performed from the healthcare perspective to determine if these improvements were enough to justify the additional costs of the yoga programme.

Cost-effectiveness analysis from the healthcare perspective revealed ICERs ranging from £21 to £114 per one point reduction in RDQ. With a threshold of £1,300 (per one point reduction in RDQ), the probability that yoga was cost-effective compared to usual care ranged from 75% to 78%.

Cost-utility analysis produced ICERs ranging from £317 to £1,756 per QALY. With a threshold of £20,000 per QALY, the probability that yoga was cost-effective compared to usual care ranged from 87% to 92%.

These results indicate that compared with usual care, yoga was cost-effective for reducing back pain and for improving health-related quality of life

From a societal perspective, both extra-welfarist (cost-utility analysis) and welfarist (social return on investment analysis) approaches found that yoga provided excellent value for money.

Cost-utility analysis from the societal perspective showed that the yoga intervention was *dominant* to usual care. Yoga was both more effective for improving health-related quality of life and less costly due to savings in production loss costs from fewer sickness absence days attributed to musculoskeletal conditions. From the societal perspective, the total costs of yoga ranged from £40 to £89 per person, while the total costs of usual care were £93 per person in each cost scenario.

Social return on investment was analysed from a societal perspective by monetising the benefits of reduced back pain for all three key stakeholders: the employer, the healthcare provider and the employees who participated in the yoga programme. Using the Cabinet Office approach and wellbeing valuation, SROI ratios ranged between 2.6 and 6.8, indicating that the yoga programme generated a valuable social impact from the societal perspective when compared with usual care.

11.5 Comparing preference-based and wellbeing valuation

Although the SROI ratios were very similar for the two methods of valuation, wellbeing valuation represents a significant departure from the more traditional preference-based valuation used in cost-utility analysis and cost-benefit analysis during the last forty years (Fujiwara, 2014a).

Preference-based valuation in cost-utility analysis

In cost-utility analysis, the weighting of QALYs from EQ5D responses was developed from stated preference research methods. To determine these weightings, members of the general public were asked how many life years they would be willing to trade-off to attain better health.

In the UK, the main studies to develop the EQ5D-3L value sets were carried out in the early 1990s. For the EQ5D-5L, valuation studies have been conducted since 2005. In many countries, stated preference methods are now underway to derive value sets for the EQ5D-5L (Devlin and Krabbe, 2013).

Although NICE recommends a preference-based approach to health valuation (i.e., cost-utility analysis), others argue that the way in which preference-based values are elicited from the general population in the form of hypothetical questions is subject to biases that rarely reflect real life experience (Fujiwara, 2014b).

Hypothetical questions using time trade-off and standard gamble approaches, for example, are designed to elicit rational responses from individuals about how particular health states may impact them in the future. In practice, preference-based hypothetical approaches can bring up irrational fears about particular health states, rather than a measured assessment of what life would actually be like with those particular health conditions (Fujiwara, 2014a).

Consequently, preference-based methods for valuing QALYs may not reflect actual experience, resulting in inaccurate or unreliable information being used to inform decision-making (Fujiwara, 2014a; Attema et al., 2013).

Preference-based valuation in cost-benefit analysis

In cost-benefit analysis, willingness-to-pay methods can be used to estimate the intangible benefits of public health interventions (McIntosh et al, 2010; Frew et al., 2014).

Some health economists, however, view willingness-to-pay methods with scepticism (Cookson, 2003). They maintain that willingness-to-pay methods can be biased due to the wording and presentation of questions, and by the income level of respondents. In addition, they maintain that the hypothetical nature of willingness-to-pay questions does not reflect real life experience (Fujiwara, 2014a).

Finally, they argue that stated preference approaches may be under-sensitive to the true impact of health interventions, since they are likely to capture the willingness-to-pay for the activity, rather than the real value of outcomes (Cookson, 2003; Fujiwara, 2014a).

In this case study of workplace yoga, for example, participants were asked how much they would be willing to pay for the activity of yoga. Most participants indicated that they would be willing to pay between £3 and £5.99 per session.

Although this represented the value that NHS employees placed on the *activity* of yoga, it did not necessarily represent the value of the *outcomes* that they experienced (i.e., reduced back pain, improved psychological wellbeing and increased health-related quality of life).

Using a stated preference approach where employees indicated a willingness-to-pay £4.50 per session for eight weeks, the social value for the yoga programme was calculated at £36 per person or £2,736 for 76 participants (Table 9.5).

By contrast, wellbeing valuation estimates the value of reduced back pain at £1,306 per person per year, an amount listed in the Social Value Bank. Using this value, the social value for the yoga programme was calculated at £110 per person or £8,360 in total (Table 10.9), an amount three times greater than the amount elicited from the willingness-to pay-question.

Wellbeing valuation as an alternative to preference-based valuation

Rather than using preference-based approaches in cost-benefit analysis or in cost-utility analysis, wellbeing valuation draws on vast survey results from datasets such as the British Household Panel Survey (BHPS). It then calculates the extent to which a specific health outcome (e.g., reduced back pain) affects wellbeing, and how much additional income is needed to create this improvement in wellbeing

As an example, the social value published in the Social Value Bank for a significant reduction in back pain is £1,306 per person per year. To determine this value, BHPS survey data was analysed (controlling for other factors) to identify the degree to which a reduction in back pain improved wellbeing. Wellbeing valuation was then used to compare wellbeing data with BHPS income data to determine the value of that reduction (Fujiwara, 2014).

According to Fujiwara (2014), the three main advantages of wellbeing valuation include:

- assessing the full impact of a health condition on individual welfare rather than using a limited number of domains (EQ5D-5L)
- measuring the impact of a health condition according to peoples' actual experience, rather than how people predict their preferences from a set of hypothetical health conditions
- monetising health outcomes so they can be used in cost-benefit analysis, return on investment, or social return on investment analysis.

Despite these advantages and the recent surge of interest in wellbeing valuation, there is a lack of consensus about which measures to use in defining and estimating wellbeing (Powdthavee and van den Berg, 2011). Different measures can result in different valuations.

When life satisfaction or cognitive wellbeing measures are used, the monetary values are frequently less than with more affective or domain-specific wellbeing measures. Health economists favouring wellbeing valuation need to consider these differences in order for wellbeing valuation to become a valid and reliable alternative to preference-based valuation (Powdthavee and van den Berg, 2011).

11.6 Implications for yoga in the workplace

Return on investment analysis indicated that for the NHS as an employer, the yoga programme was cost saving in all scenarios when yoga instructors were paid £64 per session. At this rate of pay and with an employee co-payment of £4.50 per class, the return on investment for the employer was £2.14 for every £1 invested.

Social return on investment also considered the monetised benefits to NHS employees from reduced back pain. Using revealed preference valuation and wellbeing valuation (chapter 10), the social return on investment when yoga instructors were paid £64 per class ranged from £4.41 to £4.66 for every £1 invested.

These positive outcomes for employers and employees suggest that in comparison with usual care, yoga can provide excellent value for money.

Recommendations for employers

Given these results, employers may want to consider the following ways in which yoga can be offered in occupational settings to manage musculoskeletal conditions:

- ***Provide a twelve week yoga programme for employees.*** Focus group interviews with yoga participants and NHS managers revealed that for several participants, the eight-week yoga programme was too short and a twelve-week series of classes was preferred. In addition, two high quality trials (Sherman et al., 2011; Tilbrook et al., 2011) indicated that twelve week yoga programmes resulted in significant reductions in RDQ scores for patients with chronic low back pain. In Sweden, a twelve-session yoga programme for patients with non-specific low back pain also showed significant reductions for those with high adherence to the programme (Aboagye et al., 2015).

- ***Deliver yoga sessions at a variety of times - before work, at lunchtime, after work.*** Focus group interviews from this study indicated that some participants, especially those with childcare commitments, would have preferred lunchtime classes. Offering a variety of class times - before, during and after work - could meet the needs of more employees.

- ***Create co-payment schemes - employees pay between £3 and £6 per yoga session.*** While co-payment schemes can enhance cost saving for employers, careful consideration is required to avoid creating barriers to employee participation. Employers may decide to cover the main costs of a worksite yoga programme with employees paying a nominal amount per class.

- ***Offer flex-time to employees enabling yoga to be offered during working hours.*** Flex-time policies allow employees to shift their work schedules, such as coming in earlier or later or taking a lunch break at different times or for various durations. This provides an opportunity for employees to participate in yoga classes during the working day, while maintaining their expected number of work hours.

- ***Partner with local fitness facilities.*** Some worksites may not have the space for onsite yoga classes. In such cases, employers may be able to partner with local fitness facilities or leisure centres to enable employees to attend classes at subsidised rates.

- ***Consider monthly booster sessions to facilitate longer lasting outcomes.*** Research indicates that booster sessions (monthly or bimonthly) in mindfulness and cognitive behaviour therapy have been effective in achieving sustainable results (Labbe, 2011; Gearing et al., 2013). Future studies could explore whether the short-term benefits of yoga could be sustained if monthly booster sessions were provided upon completion of a twelve-week programme.

- ***Use yoga as part of a rehabilitation programme to facilitate return to work.*** Research shows that yoga can help with rehabilitation and return to work in professional athletes who have sustained injuries (Brukner et al., 2013). More research is needed to explore the effectiveness and cost-effectiveness of yoga in helping employees with musculoskeletal conditions return to work.

- ***Integrate yoga into worksite manual handling training.*** Yoga techniques for stretching and strengthening muscle groups as well as for developing core stability are increasingly being integrated into manual handling training for healthcare workers.[1] In this case study of yoga in the workplace, telephone interviews with NHS managers after the eight-week programme indicated keen interest for incorporating yoga in manual handling training.

- ***Offer online yoga resources for employees who wish to practise at home.*** Online yoga classes could be used to supplement weekly classes in the workplace. Employers could obtain a corporate subscription to online yoga resources and make these available to employees at home or at work. In addition, online yoga at the desk can include simple stretching, breathing and relaxation exercises.

[1] www.integratedhealth.com

Finally, for yoga to be successfully implemented in the workplace, ongoing management support is crucial (Chu et al., 2000). At Aetna Insurance, one of the 100 largest US companies by revenue, a company-wide yoga programme was championed by the CEO, who credited yoga with his recovery from a near fatal skiing accident (Gelles, 2015). More than 13,000 Aetna employees have participated in the workplace yoga programme with the following results (Gelles, 2015):

- 28% reduction in stress
- 20% improvement in sleep quality
- 19% reduction in pain
- 62 minute gain per week in productivity (US $3,000 per person per year in cost saving).

In addition to management support, key factors for implementing a successful workplace yoga programme include (Chu et al, 2000):

- carrying out a health and wellbeing needs assessment for employees
- planning and implementing a yoga programme in response to the needs assessment
- evaluating the effectiveness of the programme
- integrating yoga into the organisational culture.

Recommendations for health economists

Although there are hundreds of randomised trials investigating the effectiveness of workplace health interventions, only a few of these studies take the extra step of considering the cost-effectiveness and financial return of these programmes (van Dongen et al., 2014). Randomised controlled trials provide an important opportunity for researchers to undertake economic evaluation and assess the resource implications of new interventions (Medical Research Council, 2008).

In the UK, many organisations in the public and private sectors are facing the challenge of tightening budgets and scarce resources for occupational health. Increasingly, decision-makers seek evidence showing that workplace health interventions are not only effective but also efficient in terms of resource use (van Dongen et al., 2014). Economic evaluations provide information on the relative efficiency of two or more alternative interventions by measuring, valuing, and comparing the costs and effects of competing alternatives (Phillips, 2005).

Choosing the most appropriate type of economic evaluation for workplace health interventions can be a challenge due to the variety of important stakeholders: the employees, the employer, the healthcare providers (i.e., NHS) and public policy makers (van Dongen et al., 2014).

Generally, employers prefer cost-benefit analysis or return on investment analysis because they provide insight into the financial return from an intervention. Public policy makers and healthcare providers, on the other hand, tend to favour cost-effectiveness analysis and cost-utility analysis because they are more likely to factor in health benefits for employees and reduced resource use for healthcare providers.

Therefore, it is recommended to conduct several different types of economic evaluation within the same study in order to inform a variety of stakeholders (Tompa et al., 2010). Additional recommendations for economic evaluation in the workplace include the following (van Dongen et al., 2014):

1. **Use randomised controlled trials with sufficiently powered sample sizes:** Pragmatic randomised controlled trials are considered the best vehicle for economic evaluations because they are conducted under real life conditions. Economic evaluation, however, usually requires larger sample sizes than are needed for most randomised controlled trials (Briggs, 2000). Because RCTs are often underpowered for economic outcomes, results should be reported with both estimation (confidence intervals) and hypothesis testing (p-values) (Davies and Crombie, 2009).
2. **Apply various perspectives:** Different stakeholders are interested in different perspectives. The employer is concerned with the employer perspective; the NHS is interested in the healthcare perspective; and public policy makers want to know the societal perspective. The perspective chosen should be clearly identified in the reporting of economic evaluations.
3. **Identify, measure and value relevant costs:** In economic evaluation, all costs are valued in monetary terms. Relevant cost categories depend on the perspective taken and could include intervention costs, healthcare resource use costs, productivity loss costs, opportunity costs and overheads.
4. **Identify, measure and value relevant outcomes:** In cost-effectiveness analysis, outcomes are measured in natural units (i.e., sickness absence days saved, amount of back pain reduced, etc.). In cost-utility analysis, outcomes are measured in quality-adjusted life years (QALYs). In cost-benefit analysis from the employer perspective, outcomes are measured in monetary terms based on absenteeism and presenteeism.

5. **Develop an effective strategy for minimising withdrawals and missing data:** Drop-outs and missing data can reduce the power a study and lead to biased estimates of cost-effectiveness. Financial incentives and regular communication with study participants can help improve the percentage of complete cases (Bower et al., 2014).
6. **Use multiple imputation to impute missing values**: When more than 5% of data is missing, multiple imputation is recommended to fill in missing values. To deal with the uncertainty about missing values, several imputed datasets can be created. It is recommended that the number of imputed datasets is equal to the percentage of incomplete cases (White et al., 2011).
7. **Calculate incremental costs effectiveness ratios (ICERs):** In cost-effectiveness analysis and cost-utility analysis, the preferred method for comparing costs and outcomes is to calculate the ICERs. This is done by dividing the mean difference in costs between two interventions by the mean difference in effect. In cost-utility analysis, multiple linear regression techniques are recommended to account for baseline differences in EQ5D scores (Manca et al., 2005).
8. **Use cost-effectiveness planes and cost-effectiveness acceptability curves:** Because ICERs can be difficult to interpret, they are often graphically illustrated on cost-effectiveness planes and cost-effectiveness acceptability curves. Non-parametric bootstrapping is used to quantify the uncertainty around ICERs.
9. **Conduct cost-benefit analysis from the employer perspective:** Using cost-benefit analysis, the preferred method for comparing costs and outcomes is to calculate the benefit-cost ratio. This is done by dividing the benefits gained in monetary terms by the costs invested. Interventions can be considered cost saving if the benefit cost ratio is greater than one.
10. **Perform sensitivity analysis to address uncertainty surrounding costs:** In economic evaluation, sensitivity analysis is important for assessing how the results would change if different assumptions were made about the value of unit prices. Therefore, it is appropriate to provide a range of unit prices that reflect a variety of possible real life scenarios. A rationale should be provided for choosing the range of prices used in sensitivity analysis.

11.8 Main strengths of thesis

In addition to using two different valuation methods for estimating social return on investment, this thesis had a number of strengths which included using a randomised controlled design, applying a mixed methods epistemological approach, assessing yoga for

both preventing and treating back pain and measuring both physical and psychological dimensions of back pain.

- ***Randomised controlled study design***: The study design increased the validity of the results for both effectiveness and cost-effectiveness. In measuring the effectiveness of the yoga programme, this randomised controlled trial included six different instructors at three locations, which compared favourably with most trials of yoga which include only one yoga instructor at one location.

  In assessing financial return, the randomised controlled design removed selection bias, which is a limitation in most return on investment studies. The benefit-cost ratios reported in this thesis ranged from 0.78 to 3.76 (chapter 9). These ratios were somewhat less than the 2.3 to 10.1 range reported in a recent systematic review of workplace wellness programmes, all of which were non-randomised studies and subject to selection bias (Price Waterhouse Coopers, 2008).

- ***Mixed methods epistemological approach:*** The qualitative evaluation (chapter 4) supported the quantitative findings (chapter 3) in that participants experienced not only reduced back pain, but also improved sleep quality, and feeling more relaxed and body-aware. Using focus groups and follow-up interviews enabled a broader perspective of the benefits (and constraints) related to delivering yoga in the workplace.

  Qualitative evaluation also made it possible to discover two adverse events related to withdrawals. Although one withdrawal expressed disappointment with the programme, the other continued to use the DVD at home under the guidance of a physiotherapist. At the six-month follow-up, this participant reported longer-term success in managing back pain and in reducing prescribed medication for stress and anxiety.

  The mixed method approach used in this thesis was appropriate for a complex intervention such as yoga in the workplace, where reported effects may have been caused by different components of the yoga programme, such as the classes, instructors, DVDs, illustrated booklets, location of venues and management support.

- ***Preventive approach with relatively healthy employees*:** This study differs from previous non-workplace trials in taking a preventive-oriented approach by including participants both with and without back pain.

Among those participants without back pain at baseline, usual care participants reported more back pain at end-programme (mean RDQ score = 1.19) than yoga participants (mean RDQ score =0.55). This difference in back pain scores at end-programme indicates that the yoga programme was successful in preventing back pain for those with no back pain at baseline.

- ***Two different outcome measures for back pain***: Most previous studies of yoga for back pain have used the Roland Morris Disability Questionnaire, the gold standard for measuring this condition. Although the RDQ was the primary outcome measure in this study, the Keele STarT back screening tool was also used. Where the RDQ primarily assessed the physical impact of back pain, the Keele STarT measured both the physical and psychological impact (i.e., fear, worry, loss of hope and displeasure associated with back pain).

  At end-programme, the difference in back pain between groups in this workplace study was larger ($p<0.001$) using the Keele STarT back screening tool. Smaller differences between groups were reported with the RDQ ($p=0.035$). The statistically significant outcome for the RDQ indicates that the Dru Yoga programme was effective for reducing the physical impact of back pain, while the more significant outcome for the Keele STarT suggests that the programme also successfully addressed the psychological factors associated with back pain.

11.9 Main limitations of thesis

This thesis was based on a randomised controlled trial for 151 NHS staff, using six yoga instructors at three hospital sites. It was an ambitious study design with a limited research budget of £10,000. Given these funding constraints, financial incentives were not offered to study participants for completing questionnaires contributing to:

- ***Lower than expected number of complete cases***: After the eight week yoga programme, 72% of participants (n=109) completed end-programme questionnaires. Although this was slightly below the recommended 80% completion rate for high quality studies, 109 complete cases was more than the 87 needed for this study to be sufficiently powered (chapter 3).

  At six months, however, only 46% of the original 151 participants (n=69) completed follow-up questionnaires which indicated that the six month results were underpowered, which increases the likelihood that the results were due to chance.

Although funding constraints may have contributed to a lower than expected number of complete cases, the 28% drop-out rate at eight weeks and 54% drop-out rate at six months could also be attributed to additional factors such as (Bower et al., 2014):

1. *Burden of health questionnaire*: The health questionnaires at baseline, end-programme and six months were each 14 to 16 pages containing seven outcome measures plus health service use during the past two months. Although the health questionnaire could be completed in less than 15 minutes, the number of sections may have been overly taxing for participants (Appendix 9).
2. *Lack of regular communication with participants (especially usual care group)*: A nominated staff person at the BCUHB Office of Occupational Health and Wellbeing was the official designated contact person between the principal investigator and NHS participants. When the principal investigator wanted to contact participants (i.e., send reminders and updates), communication occurred through the BCUHB nominated person. When the nominated person was engaged with other BCUHB responsibilities, there was less opportunity for the principal investigator to contact trial participants.
3. *Underutilising social media:* A trial website, blog, Facebook page or Twitter account (with prior ethical approval) may have provided increased opportunity for the principal investigator to communicate with participants, thus improving involvement and retention in the study.

- ***Small sample size:*** Due to the factors described above, the small sample size at six months made the economic evaluation underpowered. Typically, economic evaluation requires much greater sample sizes than for clinical effectiveness evaluation (Briggs, 2000). Production loss costs were based on sickness absence days taken by only six participants, five in the usual care group and one in the yoga group. In addition, the number of visits to healthcare professionals for musculoskeletal conditions at six months was based on only 18 visits from usual care participants (n=30) and 5 visits from yoga participants (n=39).

Taken together, the lower-than-expected number of complete cases and the small sample size limit the robustness of study results. In addition, funding constraints also meant that the author of this thesis was the main trial coordinator, data entry person, focus group interviewer and outcome assessor. In order to carry out these different roles, the author became un-blinded after randomisation, which introduced the risk of observer bias.

11.9 Future research

Despite the limitations of this study, the effectiveness and cost-effectiveness results are promising. However, high quality studies of workplace yoga are needed to confirm these findings. To generate more high quality studies, the following recommendations are suggested:

1. larger sample sizes for assessing cost-effectiveness and financial return
2. financial incentives and regular communication to minimise participant withdrawals
3. blinding of outcome assessors
4. longer yoga programme (12 weeks minimum) with at least one year follow-up period
5. reporting on reasons for withdrawals and adverse events
6. inclusion of presenteeism costs and measures of work productivity
7. assessing willingness-to-pay both before and after the yoga intervention
8. measuring wellbeing with pre- and post-questionnaires aligned with the BHPS
9. using a multiple method approach to economic evaluation as suggested by NICE.

When using a multiple method approach to economic evaluation in the workplace, the inclusion of cost-benefit analysis from the employer perspective is essential. The benefit-cost ratio forms the business case and provides the financial information necessary to decide whether to implement a workplace health intervention (van Dongen et al., 2013b).

In addition, proposed health interventions in the workplace should be in-line with the priorities of occupational health decision-makers. It is unrealistic to expect the decision-making process to be designed around research priorities (van Dongen et al., 2013b).

Finally, although cost-benefit analysis from the employer perspective is essential, health outcomes for employees are frequently excluded because they are more difficult to monetise (van Dongen et al., 2013b). Therefore, cost-effectiveness analysis and cost-utility analysis are helpful because they compare the incremental costs of an intervention with the incremental health benefits gained by employees.

In addition, social return on investment may provide a promising alternative in the future. Although its methods are still being developed and refined, SROI attempts to monetise the intangible health benefits to key stakeholders using both preference-based and wellbeing valuation.

11.10 Novel Contributions

This study was the first economic evaluation using multiple methods of yoga in the workplace. Despite NICE recommendations for multiple methods of economic evaluation, rarely are welfarist and extra-welfarist methods used side by side in the same study.

Although cost-utility analysis was used in previous economic evaluations of yoga for patients with back pain, this current study appears to be the first yoga trial to use return on investment and social return on investment methodologies. In addition, this is one of the first randomised controlled trials of public health interventions to use both revealed preference valuation and wellbeing valuation to calculate the social return on investment.

A multiple method approach to economic evaluation of public health interventions provides key stakeholders, working individually or jointly, with additional evidence upon which to base decisions regarding the allocation of scarce resources. Welfarist and extra-welfarist methods are not mutually exclusive. As there are limitations to each of these methods, relying on a single method may result in less than optimal decision-making.

In this study of yoga in the workplace, five methods of economic evaluation using four cost scenarios from three different perspectives made it possible to assess cost-effectiveness and return on investment. For employers, yoga appeared to be a cost-effective intervention for managing back pain and musculoskeletal conditions, especially when instructors were paid at typical rates.

High quality trials with larger sample sizes are needed to confirm the promising results reported in this thesis. Employers will be keen to introduce yoga programmes for their employees when cost-effectiveness and financial return are sufficiently demonstrated.

11.11 Conclusion

Using multiple methods of economic evaluation, evidence from this thesis suggests yoga to be an economically viable intervention for key stakeholders, generating substantial social value for employees, cost-effectiveness for healthcare providers and a favourable return on investment for employers

Table 11.1: Main findings of thesis

Thesis chapter	Key finding(s)
Chapter 1	• Group exercise programmes for 8 to 12 weeks are recommended to help prevent and alleviate non-specific low back pain. • Research indicates that yoga is one form of group exercise that can significantly reduce musculoskeletal conditions and back pain.
Chapter 2	• Due to a lack of high quality studies investigating yoga in occupational settings, there is promising but limited evidence for the effectiveness of yoga in the workplace.
Chapter 3	• An eight week randomised controlled trial showed that yoga, in comparison with usual care, generated statistically significant reductions in back pain and physical exhaustion, and statistically significant improvements in psychological wellbeing.
Chapter 4	• Thematic analysis revealed that yoga participants experienced reduced pain, improved posture, more flexibility, better sleep quality and increased body awareness.
Chapter 5	• Four cost scenarios were created. Scenario 1 reflected the actual costs of this study. Scenarios 2, 3 and 4 provided a variety of costs to facilitate sensitivity analysis.
Chapter 6	• Cost-consequence analysis showed that yoga was less costly than usual care from the societal perspective and more costly from the healthcare perspective. • The yoga programme was more effective than usual care for reducing back pain and improving psychological wellbeing.
Chapter 7	• Cost-effectiveness analysis indicated that the yoga programme was more effective than usual care for reducing back pain. • Compared to usual care, yoga was dominant from the employer and societal perspectives and 75% cost-effective from the healthcare perspective using a threshold of £1,300 per one RDQ point reduction in back pain.
Chapter 8	• Cost-utility analysis suggested that the yoga programme was more effective than usual care for improving health-related quality of life. • Compared to usual care, yoga was dominant from the societal perspective and 89% cost-effective from the healthcare perspective (QALY threshold = £20,000).
Chapter 9	• The benefit-cost ratios ranged from 0.78 to 2.02 for the eight-week yoga programme. • When a 1.28 multiplier and a co-payment of £4.50 per session were added, the benefit-cost ratios ranged from 1.45 to 3.76, indicating a positive return on investment for employers.
Chapter 10	• SROI ratios for all four cost scenarios, ranged from 2.73 to 6.82 using the Cabinet Office approach and from 2.58 to 6.44 using wellbeing valuation, indicating that yoga compared to usual care generated a positive social impact.
Chapter 11	• The results from these five methods of economic evaluation suggest that from the healthcare perspective, yoga can be cost-effective when compared with usual care. • From the employer perspective, yoga can generate a favourable financial return. • From the societal perspective, yoga can provide a substantial social impact. • A multiple method approach to economic evaluation can provide key stakeholders with additional evidence from which to base decisions regarding the allocation of scarce resources.

Appendices

Appendix 1: PRISMA Guidelines

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	Thesis, p.40
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	Thesis, p.194 (Appendix 2)
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	Thesis, p.40
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	Thesis, p.41
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	No protocol
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	Thesis, p.41
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	Thesis, p.41
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Thesis, p.41
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	Thesis, p.41
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	Thesis, p.42 and p.195 (Appendix 3)
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	Thesis, p.41-42
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	Thesis, p.42-43, Table 2.2
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	Thesis, p.51 (Table 2.7, difference in means)
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	Thesis, p.53

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	Thesis, p.42-43
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	Thesis, p.52- 53 (not pre-specified)
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	Thesis, p.44 and p.58 (flow diagram)
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Thesis, pp.47-49, and Table 2.7 on p.51
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Thesis, p.42- 43, and Table 2.6 on p.47
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Thesis, pp.47-49, and Table 2.7 on p.51
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	Thesis, p. 52-53
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	Table 2.6 on p.47
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	Thesis, p.52-53
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	Thesis, pp.54-56
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	Thesis, p.57
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	Thesis, p.57-58
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Thesis, p.11 (Acknowledgements)

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit: **www.prisma-statement.org**.

Appendix 2: Systematic Review Abstract

Title: The effectiveness of yoga for improving health in the workplace: A systematic review

Objective:

The aim of this systematic review was to summarise and assess the evidence on the effectiveness of yoga for improving health-related outcomes in the workplace.

Background:

Sickness absence costs UK organisations almost £29 billion per year (CIPD, 2013). Employees in the UK miss an average of 9.1 working days per year, compared with 4.9 days in the United States and 2.2 days in the Asia Pacific region (Price Waterhouse Coopers, 2013). The World Health Organisation has identified the workplace as a priority setting for health promotion and physical activity. Identifying effective workplace interventions that can improve health and reduce sickness absence is a major priority in the UK.

Methods:

Four electronic databases – CINAHL, Medline, Pubmed and Science Direct – were searched for randomised studies until 11 September 2014. Additional trials were searched by reviewing reference lists of included studies. Working together, two researchers found eight randomised trials which met the inclusion criteria. Selected studies used yoga as the primary or comparison intervention, and employees as the study population. Data extraction, quality assessment and risk of bias were conducted independently by two researchers.

Results:

The results suggested that yoga's effectiveness in the workplace was strong for musculoskeletal conditions, moderate for perceived stress, limited for sleep quality and conflicting for heart rate variability. Overall, the evidence was promising for yoga, yet limited due to a lack of high quality studies.

Conclusions:

Small sample sizes and wide heterogeneity of data made it difficult to draw more definitive conclusions. The length of the yoga programmes in the eight studies ranged from 6 to 12 weeks; the frequency of workplace yoga varied from one to five classes per week and several different styles of yoga were offered. Future studies of yoga in the workplace should be sufficiently funded to enable larger samples, higher quality and a lower risk of bias.

Appendix 3: Data Extraction & Critical Analysis Form (DECA)

Citation: Hartfiel, N., Havenhand, J., Khalsa, SB., Clarke, G. and Krayer, A. (2011). The effectiveness of yoga for the improvement of well-being and resilience to stress in the workplace. *Scandinavian Journal of Work, Environment, and Health*, 37(1):70-76.

Date extraction categories	Results
1. type of study	Randomised controlled trial
2. location of study	North Wales, UK
3. length of study	Six weeks (Table 2.7)
4. inclusion criteria	Employees of Bangor University
5. number of participants	48 (Table 2.7)
6. mean age of participants	Mean age = 39.3 (Table 2.7)
7. gender of participants	90% female
8. method of randomisation	Online randomisation tool (randomiser.org) (Tables 2.4, 2.5 and 2.6)
9. allocation concealment	Not reported (Tables 2.5 and 2.6)
10. type of yoga intervention	Dru Yoga (Table 2.7)
11. type of comparison group	Wait-list control (Table 2.7)
12. frequency of intervention	Once per week for six weeks (Table 2.7)
13. blinding of participants	No (Tables 2.4, 2.5 and 2.6)
14. blinding of instructors	No (Tables 2.4, 2.5 and 2.6)
15. blinding of assessors	Not reported (Tables 2.4, 2.5 and 2.6)
16. differences in baseline characteristics	No significant differences between groups
17. completion rate and drop-outs	83% completion rate (Table 2.7)
18. adverse events	Not reported (Table 2.7)
19. valid/reliable outcome measures	Inventory of Positive Psychological Attitudes (Table 2.7)
20. methods of statistical analysis	Two-way ANOVA
21. mean differences reported	Yes (Table 2.7)
22. standard deviations reported	Yes (Table 2.7)
23. confidence intervals reported	No
24. outcome measures reported (p-values)	Yes (Table 2.7)

Appendix 4: CONSORT 2010 Checklist

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	Thesis, p.59
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	Thesis, p.200 (Appendix 5)
Introduction			
Background	2a	Scientific background and explanation of rationale	Thesis, page 59 -60
and objectives	2b	Specific objectives or hypotheses	Thesis, page 60
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	Thesis, page 60-65
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	Not applicable
Participants	4a	Eligibility criteria for participants	Thesis, page 61
	4b	Settings and locations where the data were collected	Thesis, page 63
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	Thesis, page 62
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	Thesis, page 63-64
	6b	Any changes to trial outcomes after the trial commenced, with reasons	Not applicable
Sample size	7a	How sample size was determined	Thesis, page 61-62
	7b	When applicable, explanation of any interim analyses and stopping guidelines	Not applicable

Section/Topic	Item No	Checklist item	Reported on page No
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	Thesis, page 61
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	Thesis, page 61
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	Thesis, page 61
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	Thesis, page 61
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	Thesis, page 76 (Limitations)
	11b	If relevant, description of the similarity of interventions	Thesis, page 62
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	Thesis, page 64-65
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	Thesis, page 65 (Missing Data)
Results			
Participant flow diagram	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	Thesis, page 78 (Flow Diagram)
	13b	For each group, losses and exclusions after randomisation, together with reasons	Thesis, page 78 (Flow Diagram)
Recruitment	14a	Dates defining the periods of recruitment and follow-up	Thesis, page 63
	14b	Why the trial ended or was stopped	Not applicable
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Thesis, page 66 (Table 3.3)
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	Thesis, p.73 (Table 3.8)

Section/Topic	Item No	Checklist item	Reported on page No
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	Thesis, p.73 (Table 3.8)
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	Not applicable
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	Thesis, p.70 (Table 3.5, Adherence)
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	Thesis, page 69 (adverse events)
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	Thesis, page 66
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	Thesis, page 66
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	Thesis, page 66
Other information			
Registration	23	Registration number and name of trial registry	Thesis, page 59
Protocol	24	Where the full trial protocol can be accessed, if available	Thesis, page 63 and p.232 (References)
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	Thesis, page 11 (Acknowledgements)

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Appendix 5: Effectiveness Evaluation Abstract

Title: The effectiveness of yoga for managing back pain in the workplace – Results of a pragmatic randomised controlled trial.

Objective: The aim of this paper was to investigate the effectiveness of yoga for reducing back pain among a cohort of NHS employees.

Background: In 2013, back pain and musculoskeletal conditions resulted in more than 30 million sickness absence days (Office of National Statistics, 2014), costing British employers approximately £5.6 billion (CBI, 2013; CSP, 2013). Recent research indicates that yoga can be an effective intervention for reducing back pain and musculoskeletal conditions.

Methods: One hundred and fifty-one NHS employees were randomised to either an eight-week yoga programme or to usual care. Participants in the yoga group attended one 60 minute class per week, after work at one of three hospital sites. A registered Dru Yoga instructor led the sessions, which consisted of warm-up movements, flowing energy block release sequences, back care postures for spinal mobility and relaxation. The primary outcome was back pain measured with the Roland Morris Disability Questionnaire (RDQ) and the Keele STarT Back Screening Tool. Secondary outcomes measures assessed psychological wellbeing (WHO-5), mood (EFI) and resilience (RS-14).

Results: After eight weeks, the yoga participants (compared with the usual care group) reported significant reductions in reduced back pain ($p=0.35$ for RDQ and $p<0.001$ for Keele) and physical exhaustion ($p=0.001$), as well as significant improvements in psychological wellbeing ($p=0.014$), tranquillity ($p<0.001$) and rejuvenation ($p<0.001$). The yoga group also reported feeling more positively engaged ($p=0.096$) and more resilient ($p=0.198$) than the usual care group after eight weeks.

Conclusions: Although the yoga group reported significant health improvements after eight weeks, the differences between groups was not significant at the six month follow-up, suggesting that ongoing classes or booster sessions may be needed to sustain the benefits experienced by participants at eight weeks.

Appendix 6: Recruitment Announcement - *Health Matters* (2/13)

COMING SOON - Invitation to free Yoga based classes for staff to reduce back pain & improve wellbeing

We would like to inform you about an excellent opportunity coming up in April/May 2013 to improve your overall health and wellbeing. You are warmly invited to participate in a research study at BCUHB in collaboration with Bangor University. This study will be comparing an eight week yoga-based programme with a care educational programme for reducing back pain and improving wellbeing at work.

We will be offering yoga-based classes at Ysbyty Gwynedd, Glan Clwyd and Wrexham Maelor Hospital beginning Tuesday 9 April 2013.
Participation in this study is open to all BCUHB staff.

YOGA-BASED EXERCISE PROGRAMME

The yoga-based exercise programme will be based on Dru Yoga, which is recognised as a safe and therapeutic style of yoga which incorporates gentle movement, breathing exercises, and relaxation methods using visualisation and affirmation.

The programme will be suitable for participants of all ages and levels of ability.

STUDY RISKS

There are no obvious risks involved with participation in this study. The instructors for the yoga-based sessions will be qualified and fully trained Dru Yoga teachers. Before yoga classes are offered, the instructors will a Health Questionnaires to ensure that participants are not at risk.
For safety reasons, participants who have experienced recent surgery, who are pregnant, who have spinal disc problems or who have certain pre-existing medical or psychological conditions may be excluded from participation in this study.

TO PARTICIPATE

You will need to read a participation information, sign a consent form and fill in a health questionnaire.

After completing your Health Questionnaire, you will then be randomly allocated to either a control group of the eight-week yoga-based group.

Further details and participant forms to be released soon

6

Appendix 7: Recruitment e-mail – all staff (2/13)

18 February 2013

Subject: FREE yoga classes for BCUHB staff – reduce back pain and improve wellbeing!

To all BCUHB staff,

We would like to let you know about an excellent opportunity in April/May 2013 to improve your overall health and wellbeing.

You are invited to participate in a research study at BCUHB in collaboration with Bangor University. This study will be comparing an eight week yoga programme with an educational programme for reducing back pain and improving wellbeing at work.

We will be offering Dru Yoga sessions at Ysbyty Gwynedd (YG), Glan Clwyd (GC) and Wrexham Maelor (WM) beginning Monday 8 April 2013 and concluding Thursday 30 May 2013.

The sessions will be held from 5.30 – 6.30 pm on Tuesdays and Thursdays at YG and GC, and on Mondays and Thursdays at WM. Participation in these sessions is open to all BCUHB staff.

Please read the attached Participant Information Sheet for more details.

If you decide to participate in this study, then please sign and return the attached Consent Form, via internal mail, by Monday 11 March, to:

CARE, Occupational Health and Wellbeing
Glan Clwyd Hospital
Bodelwyddan, Rhyl, LL18 5UJ

After we receive your Consent Form, we will send you a Health Questionnaire which takes only 10 minutes to complete. You will then be randomly allocated to either the eight-week yoga programme or the educational programme.

Please note that if you are selected for the educational programme, you will receive a free yoga DVD and a free six month subscription to online yoga classes after the study is completed. Thus, everyone who joins this study will have the opportunity to experience the yoga programme.

If you have further questions about this study, please feel free to contact Ned Hartfiel at Bangor University on 01248 388 606 or ned.hartfiel@bangor.ac.uk.

We look forward to hearing from you by Monday 11 March!

Best wishes,

Ned Hartfiel
Centre for Health Economics
Bangor University

Sarah Wynne-Jones
Head of Occupational Health and Wellbeing
Betsi Cadwaladr University Health

Appendix 8: Recruitment e-mail for focus groups (5/13)

Dear Yoga Participants,

Thank you again for your on-going participation in our yoga study!

Here are a few announcements:

1) **THIS WEEK (28 – 31 May): Yoga Class and Questionnaire**

Be sure to come to one of the yoga classes this week. This week is a chance to consolidate what we've learned over the 8 weeks, and we'll be completing the end-of-programme questionnaire during the last 15 minutes of the class. Your responses and feedback are really important!

2) **NEXT WEEK (3 – 6 June): Yoga Class, Group Interview and Refreshments!**

You are also invited to take part in the **group interview session** during the week of Monday 3 June – Thursday 6 June.

The group interview session will include a **30 minute yoga class** followed by a **30 minute group interview (and refreshments!)**

The **group interview sessions** will be held from 5.30 – 6.30 pm on the following dates:

- **Wrexham Maelor**: Mon 3 June & Thurs 6 June, Clinical Training Unit
- **Abergele Hospital**: Tues 4 June, Wed 5 June, & Thurs 6 June, Manual Handling Room
- **Ysbyty Gwynedd**: Tues 4 June & Thurs 6 June, Manual Handling Room

Everyone attending the group interview session will receive **a FREE four month voucher for online yoga classes** (more than 75 classes from which to choose – £40 value!).

We hope you can attend the yoga classes during these final two weeks.

It doesn't matter how many yoga classes you've already attended – do come!

Let me know if you have any questions.

Best wishes,

Ned Hartfiel
ned.hartfiel@bangor.ac.uk
01248 388 606

Appendix 9: End programme Health Questionnaire

Health Questionnaire for Yoga Study- Yoga Group

Please complete and return this Health Questionnaire by FRIDAY 21 JUNE, 2013

Thank you for answering ALL the questions in this questionnaire!

You can complete and return this Health Questionnaire in two ways:

1. Complete online and return via e-mail to: **BCUCARE@wales.nhs.uk**

2. Complete and return a paper copy of this Health Questionnaire (via BCUHB internal mail) to:

Occupational Health and Wellbeing CARE Service
Glan Clwyd Hospital, Bodelwyddan, Rhyl LL18 5UJ.

SECTION 1

First Name	
Last Name	
Phone Number	
E-Mail	
Work Address	
Age	

Weight **in Stones** **Pounds** **Or in Kilograms**

SECTION 2

For the questions below, please tick the box that best indicates how you feel about the yoga programme

1. How much did you benefit from the yoga classes in general?

	0	1	2	3	4	5	6	7	8	9	10
0=Not at all 10=Very much so	○	○	○	○	○	○	○	○	○	○	○

2. How much did you benefit from the yoga DVD?

	0	1	2	3	4	5	6	7	8	9	10
0=Not at all 10=Very much so	○	○	○	○	○	○	○	○	○	○	○

3. How much did you benefit from the illustrated yoga booklet?

	0	1	2	3	4	5	6	7	8	9	10
0=Not at all 10=Very much so	○	○	○	○	○	○	○	○	○	○	○
	○	○	○	○	○	○	○	○	○	○	○

4. Would you recommend this yoga programme to future participants?

definitely	probably	possibly	unlikely	definitely not
○	○	○	○	○

5. To what extent do you intend to continue practicing this yoga programme?

daily	several times a week	once a week	once a month	never
○	○	○	○	○

6. Although this was a free yoga programme (part of a research study), would you be willing to pay for this programme (i.e. classes, yoga mat, cushion, dvd, booklet) ? If so, how much would you be willing to pay per 60 minute class?

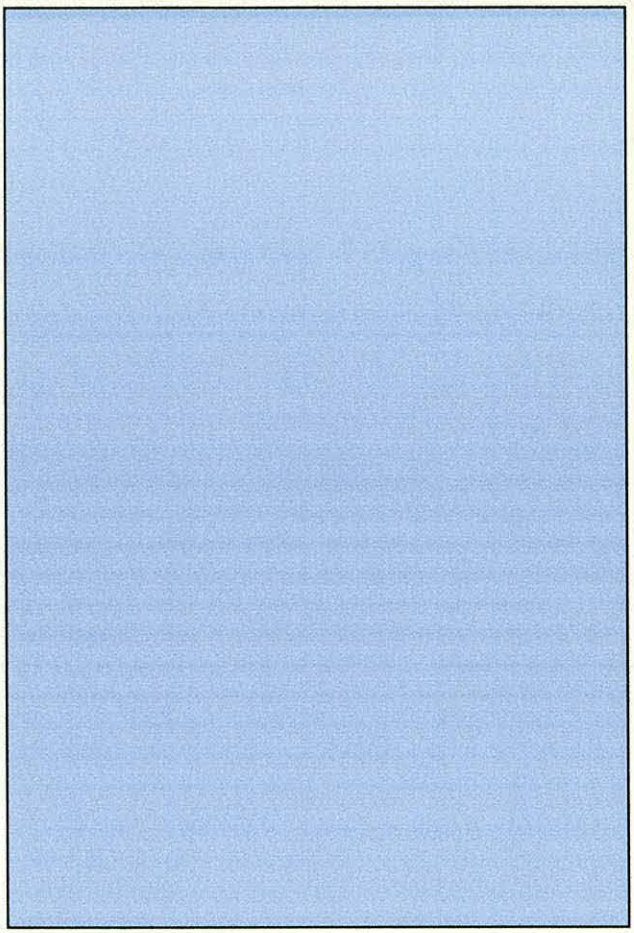
£12 or more	£9 - £11.99	£6 - £8.99	£3 - £5.99	£0.01- £2.99	not at all
○	○	○	○	○	○

7) Approximately how many miles from your workplace did you have to travel each week to attend the yoga classes?

0- 2 miles	2- 4 miles	4- 6 miles	6- 8 miles	8- 10 miles	more than 10 miles
○	○	○	○	○	○

8) Did you have to pay any extra costs for caring for a family member due to your participation in the yoga classes? If so, how much per week?

9. We would be grateful for your comments about your experience of the yoga programme.

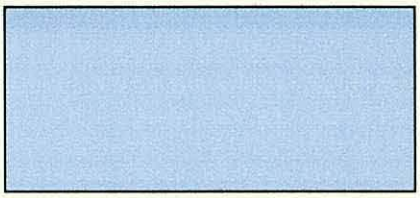


SECTION 3

IN THE LAST 8 WEEKS, on how many occasions have you :

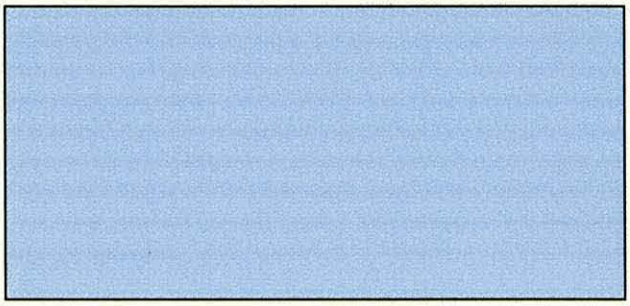
	Number of times	Reasons for visits
1) Consulted the GP (If >0 give reasons for visits)		
2) Visited the Practice Nurse (If >0 give reasons for visits)		
3) Visited Hospital Outpatient Department. (If >0 give reasons for visits)		
4) Visited a Hospital A&E Department (If >0 give reasons for visit)		
5) Been a Hospital Inpatient for a day only (no overnights) (If >0 give reasons for visits)		
6) Been a Hospital Inpatient for one night or longer (If >0 give reasons for visits and number of overnights)		

7) Consulted or visited other health care professionals
(If >0 give reasons for visits)



8) In the last 2 months, how many days from work have you missed due to back pain?

9) Have you had any changes in medication during the last 2 months
(If yes, please state reason)



SECTION 4

Under each heading, please TICK the ONE box that best describes your health TODAY

MOBILITY	◯ I have no problems in walking about ◯ I have slight problems in walking about ◯ I have moderate problems in walking about ◯ I have severe problems in walking about ◯ I am unable to walk about
SELF-CARE	◯ I have no problems washing or dressing myself ◯ I have slight problems washing or dressing myself ◯ I have moderate problems washing or dressing myself ◯ I have severe problems washing or dressing myself ◯ I am unable to wash or dress myself
USUAL ACTIVITIES (e.g. work, study, housework, family or leisure activities)	◯ I have no problems doing my usual activities ◯ I have slight problems doing my usual activities ◯ I have moderate problems doing my usual activities ◯ I have severe problems doing my usual activities ◯ I am unable to do my usual activities
PAIN / DISCOMFORT	◯ I have no pain or discomfort ◯ I have slight pain or discomfort ◯ I have moderate pain or discomfort ◯ I have severe pain or discomfort ◯ I have extreme pain or discomfort

ANXIETY / DEPRESSION

- ◯ I am not anxious or depressed
- ◯ I am slightly anxious or depressed
- ◯ I am moderately anxious or depressed
- ◯ I am severely anxious or depressed
- ◯ I am extremely anxious or depressed

We would like to know how good or bad your health is TODAY.

This scale is numbered from 0 to 100.

• 100 means the best health you can imagine.

• 0 means the worst health you can imagine.

Tick on the scale to indicate how your health is TODAY.

- ◯ 100 Best Health
- ◯ 95
- ◯ 90
- ◯ 85
- ◯ 80
- ◯ 75
- ◯ 70
- ◯ 65
- ◯ 60
- ◯ 55
- ◯ 50
- ◯ 45
- ◯ 40
- ◯ 35
- ◯ 30
- ◯ 25
- ◯ 20
- ◯ 15
- ◯ 10
- ◯ 5
- ◯ 0 Worst Health

SECTION 5

When you read a sentence that describes you today, please TICK the box next to it. If the sentence does not describe you, then leave the space blank. Only mark the sentence if it describes you TODAY.

1	☐ I stay at home most of the time because of my back.
2	☐ I change position frequently to try and get my back comfortable.
3	☐ I walk more slowly than usual because of my back.
4	☐ Because of my back I am not doing any of the jobs that I usually do around the house.
5	☐ Because of my back, I use a handrail to get upstairs.
6	☐ Because of my back, I lie down to rest more often.
7	☐ Because of my back, I have to hold on to something to get out of an easy chair.
8	☐ Because of my back, I try to get other people to do things for me.
9	☐ I get dressed more slowly than usual because of my back.
10	☐ I only stand for short periods of time because of my back.
11	☐ Because of my back, I try not to bend or kneel down.
12	☐ I find it difficult to get out of a chair because of my back.
13	☐ My back is painful almost all the time.
14	☐ I find it difficult to turn over in bed because of my back.
15	☐ My appetite is not very good because of my back pain.
16	☐ I have trouble putting on my socks (or stockings) because of the pain in my back.
17	☐ I only walk short distances because of my back.

18	☐ I sleep less well because of my back.
19	☐ Because of my back pain, I get dressed with help from someone else.
20	☐ I sit down for most of the day because of my back.
21	☐ I avoid heavy jobs around the house because of my back.
22	☐ Because of my back pain, I am more irritable and bad tempered with people than usual.
23	☐ Because of my back, I go upstairs more slowly than usual.
24	☐ I stay in bed most of the time because of my back.

SECTION 6

Thinking about the LAST 2 WEEKS, TICK your response to the following questions:

	Disagree	Agree
1. My back pain has spread down my leg(s) at some time in the last 2 weeks	○	○
2. I have had pain in the shoulder or neck at some time in the last 2 weeks	○	○
3. I have only walked short distances because of my back pain	○	○
4. In the last 2 weeks, I have dressed more slowly than usual because of back pain	○	○
5. It's not really safe for a person with a condition like mine to be physically active	○	○
6. Worrying thoughts have been going through my mind a lot of the time	○	○
7. I feel that my back pain is terrible and it's never going to get any better	○	○
8. In general I have not enjoyed all the things I used to enjoy	○	○

9. Overall, how bothersome has your back pain been in the LAST 2 WEEKS?

Not at all	Slightly	Moderately	Very much	Extremely
○	○	○	○	○

SECTION 7

Please use the following scale to indicate the extent to which each word below describes how you feel at this moment in time. Record your responses by ticking the appropriate box next to each word.

HOW DO YOU FEEL AT THIS MOMENT?

	Do not feel	Feel Slightly	Feel moderately	Feel Strongly	Feel Very Strongly
1. Refreshed	○	○	○	○	○
2. Calm	○	○	○	○	○
3. Fatigued	○	○	○	○	○
4. Enthusiastic	○	○	○	○	○
5. Relaxed	○	○	○	○	○
6. Energetic	○	○	○	○	○
7. Happy	○	○	○	○	○
8. Tired	○	○	○	○	○
9. Revived	○	○	○	○	○
10. Peaceful	○	○	○	○	○
11. Worn-out	○	○	○	○	○
12. Upbeat	○	○	○	○	○

SECTION 8

Please indicate for each of the five statements which is closest to how you have been feeling over the LAST 2 WEEKS. Notice that higher numbers mean better well-being.

OVER THE LAST 2 WEEKS.....

	All of the time (5)	Most of the time (4)	More than half of the time (3)	Less than half of the time (2)	Some of the time (1)	At no time (0)
1. I have felt cheerful and in good spirits	○	○	○	○	○	○
2. I have felt calm and relaxed	○	○	○	○	○	○
3. I have felt active and vigorous	○	○	○	○	○	○
4. I woke up feeling fresh and rested	○	○	○	○	○	○
5. My daily life has been filled with things that interest	○	○	○	○	○	○

SECTION 9

Please indicate which statements best describe your OVERALL QUALITY OF LIFE AT THE MOMENT by placing a tick in ONE box for each of the five groups below.

1. Feeling settled and secure

- ◯ I am able to feel settled and secure in all areas of my life
- ◯ I am able to feel settled and secure in many areas of my life
- ◯ I am able to feel settled and secure in a few areas of my life
- ◯ I am unable to feel settled and secure in any areas of my life

2. Love, friendship and support

- ◯ I can have a lot of love, friendship and support
- ◯ I can have quite a lot of love, friendship and support
- ◯ I can have a little love, friendship and support
- ◯ I cannot have any love, friendship and support

3. Being independent

- ◯ I am able to be completely independent
- ◯ I am able to be independent in many things
- ◯ I am able to be independent in a few things
- ◯ I am unable to be at all independent

4. Achievement and progress

- ◯ I can achieve and progress in all aspects of my life
- ◯ I can achieve and progress in many aspects of my life
- ◯ I can achieve and progress in a few aspects of my life
- ◯ I cannot achieve and progress in any aspects of my life

5. Enjoyment and pleasure

- ◯ I can have a lot of enjoyment and pleasure
- ◯ I can have quite a lot of enjoyment and pleasure
- ◯ I can have a little enjoyment and pleasure
- ◯ I cannot have any enjoyment and pleasure

SECTION 10

To the right of each statement, you will find seven numbers, ranging from "1" (Strongly Disagree) on the left to "7" (Strongly Agree) on the right.

Click the number which best indicates your feelings about that statement.
For example, if you strongly disagree with a statement, click "1".
If you are neutral, click "4", and if you strongly agree, click "7", etc.

Strongly Disagree_____Strongly Agree

	1	2	3	4	5	6	7
1. I usually manage one way or another.	○	○	○	○	○	○	○
2. I feel proud that I have accomplished things in life.	○	○	○	○	○	○	○
3. I usually take things in stride.	○	○	○	○	○	○	○
4. I am friends with myself.	○	○	○	○	○	○	○
5. I feel that I can handle many things at a time.	○	○	○	○	○	○	○
6. I am determined.	○	○	○	○	○	○	○
7. I can get through difficult times because I've experienced difficulty before.	○	○	○	○	○	○	○
8. I have self-discipline.	○	○	○	○	○	○	○
9. I keep interested in things.	○	○	○	○	○	○	○
10. I can usually find something to laugh about.	○	○	○	○	○	○	○
11. My belief in myself gets me through hard times.	○	○	○	○	○	○	○
12. In an emergency, I'm someone people can generally rely on.	○	○	○	○	○	○	○
13. My life has meaning.	○	○	○	○	○	○	○
14. When I'm in a difficult situation, I can usually find my way out of it.	○	○	○	○	○	○	○

Thank you for returning this Health Questionnaire by FRIDAY 21 JUNE, 2013

You can return this Health Questionnaire in two ways:

1. Complete online and return via e-mail to: BCUCARE@wales.nhs.uk

2. Complete and return a paper copy of this Health Questionnaire (via BCUHB internal mail) to:

Occupational Health and Wellbeing CARE Service
Glan Clwyd Hospital
Bodelwyddan, Rhyl
LL18 5UJ

Appendix 10:

Production loss costs for additional categories

In addition to fewer sickness absence days attributed to musculoskeletal conditions, yoga participants reported less production loss costs for coughs, colds, flu and respiratory illness, ear/nose/throat conditions and gastrointestinal problems. The yoga group, however, reported more sickness absence days than the usual care group for migraine headaches, stress, anxiety and depression. Without measuring these specific health conditions at baseline and end-programme, it is difficult to determine whether the reductions in sickness absence were due to the yoga programme.

Because research indicates that yoga can be effective for reducing respiratory problems (Woodyard, 2011) and improving gastrointestinal conditions such as irritable bowel syndrome (Kuttner et al., 2006), future trials of yoga in the workplace could assess these conditions and evaluate the effectiveness of yoga for preventing sickness absence due to these conditions.

Table A 1: Production loss costs for additional categories

Group yoga (n=56) usual care (n=53)	Participants reporting sickness absence	Number of episodes	Sickness absence days	Cost to NHS (£113.84/day) £	Cost per person £	Absence Reason
Yoga Usual Care	1 5	1 5	2 43	£227.68 £4,895.12	£4.06 £92.36	Musculoskeletal conditions, back pain
Yoga Usual Care	3 5	3 5	6 13	£683.04 £1,479.92	£12.20 £27.92	Cold, cough, flu, respiratory problems
Yoga Usual Care	1 8	1 10	3 64	£341.52 £7,285.76	£6.10 £137.47	Gastrointestinal problems
Yoga Usual Care	3 1	3 1	6 13	£683.04 £1,479.92	£12.20 £27.92	Ear, nose and throat
Yoga Usual Care	1 1	2 1	11 1	£1,252.24 £113.84	£22.36 £2.15	Headache/migraine
Yoga Usual Care	2 1	2 1	74 5	£8,424.16 £569.20	£150.43 £10.74	Anxiety, stress, depression,
Total Yoga	**10**	**12**	**102**	**£11,611.68**	**£207.35**	
Total Usual Care	**21**	**23**	**139**	**£15,823.76**	**£298.56**	

Appendix 11:

Healthcare resource use costs for additional health conditions

Primary healthcare resource use for all conditions included visits to a GP, practice nurse, osteopath, counsellor, physiotherapist, occupational health nurse or a massage therapist.

The total for the yoga group was £38.38 per person compared with £74.13 per person in the usual care group. This indicates that usual care group participants spent nearly twice as much per person on primary care than yoga group participants.

Table A2: Healthcare resource use – primary care at six months

Healthcare Professional	Cost per visit	# of visits between baseline and 8 weeks	Costs between baseline and 8 weeks	# of visits 8 weeks to 6-month follow-up	Costs between 8 weeks and 6-month follow-up	Total costs during six month study	Total cost per person
GP	£53[1]	11	£583	11	£583	£1,166	£29.90
Practice Nurse	£38[1]	2	£76	1	£38	£114	£2.92
Physio-therapist	£44[2]	0	£0	3	£132	£132	£3.38
Osteopath	£43[3]	0	£0	0	£0	£0	£0.00
Counsellor	£51[2]	1	£51	0	£0	£51	£1.31
Occupational Health	£34[1]	0	£0	1	£34	£34	£0.87
Massage Therapist.	£38[4]	0	£0	0	£0	£0	£0.00
Yoga Total (n=39)		**14**	**£710**	**16**	**£787**	**£1,497**	**£38.38**
GP	£53[1]	11	£583	14	£795	£1,378	£45.93
Practice Nurse	£38[1]	1	£38	3	£114	£152	£5.07
Physio-therapist	£44[2]	1	£44	2	£88	£132	£4.40
Osteopath	£43[3]	7	£301	4	£172	£473	£15.76
Counsellor	£51[2]	0	£0	1	£51	£51	£1.70
Occupational Health	£34[1]	0	£0	0	£0	£0	£0.00
Massage Therapist	£38[4]	0	£0	1	£38	£38	£1.27
Usual Care Total (n=30)		**20**	**£966**	**25**	**£1,258**	**£2,224**	**£74.13**

1 Curtis, L. (2013). Unit costs of health and social care. University of Kent: Personal Social Services Unit.

2 Department of Health. (2013). Reference costs 2012-13.

3 http://www.osteopathy.org.uk/visiting-an-osteopath/what-to-expect/

4 https://nationalcareersservice.direct.gov.uk/advice/planning/jobprofiles/Pages/massagetherapist.aspx

Appendix 12: Cost per sickness absence day saved

In cost-effectiveness analysis, the total costs of an intervention are compared with a single primary health outcome. In this study, the number of sickness absence days saved could also be used as a primary outcome measure.

The ICERs below show the additional cost needed to achieve a reduction in one day of sickness absence due to musculoskeletal conditions. ICERs ranged between £21 (scenario 3) and £114 (scenario 4). The mean cost of a sickness absence day in the NHS ranges between £114 (using the conventional method) and £146 (using a 1.28 median multiplier). This suggests that the yoga programme, compared to usual care, can be cost-effective for reducing sickness absence days due to musculoskeletal conditions.

Table A3.1: Sickness absence per person per group

Group	Sickness absence days	Sickness absence days per person
Yoga (n=76)	2	0.026
Usual care (n=75)	43	0.573
Difference between groups	41	0.547

Table A3.2: Intervention costs per person

Scenario	Yoga	Usual care	Difference
Scenario 1	£64.98	£2.00	£62.98
Scenario 2	£47.93	£2.00	£45.93
Scenario 3	£32.77	£2.00	£30.77
Scenario 4	£81.72	£2.00	£79.72

Table A3.3: Costs and outcomes: estimating ICERs

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Difference in costs between groups (mean intervention costs per person)	£62.98	£45.93	£30.77	£79.72
Difference in effect between groups (mean sickness absence days saved per person)	0.547	0.547	0.547	0.547
ICER	£115	£84	£56	£146

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