THE EFFECT OF A THREE-YEAR WORKPLACE HEALTH PROGRAMME ON EMPLOYEE QRISK2 RELATIVE RISK SCORES: A UK-BASED CASE STUDY

by

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ABSTRACT

INTRODUCTION: Workplace health programmes (WHPs) have shown to be effective at reducing employees' cardiovascular risk, and this study aims to address the lack of UK-based WHP literature, by investigating the effects of a three-year WHP on employee's cardiovascular health.

METHODS: Utilising a within-subject case study, data were collected retrospectively on 3 occasions over 3 years, during which time employees had access to WHP interventions. The primary outcome was QRISK2 relative cardiovascular risk. Secondary outcomes included body mass index (BMI), body fat percentage, waist:height ratio, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC), high-density lipoprotein (HDL) and TC-HDL ratio.

RESULTS: 33 employees met inclusion criteria (27 male, 6 female). Males showed a significant change in QRISK2 relative risk scores (1.62 at T1, 1.36 at T2 and 1.41 at T3) (p=0.023). No change in QRISK relative risk was observed for females (p=0.585). BMI significantly increased in males (p=0.01), while waist:height ratio significantly increased in females (p=0.012). DBP significantly improved for males between the first and second measurements (p=0.020), but this didn't continue at the third measurement. No significant changes were seen for body fat percentage, SBP or blood lipids.

CONCLUSIONS: This study supports the use of WHPs to address cardiovascular risk for male employees in UK workplaces. Further research should investigate a larger sample, and the potential benefit of 12-month intervals between health checks, integrating individuals' readiness to change.

DEDICATION

I would like to dedicate this report to Richard, Jane, Jonathan and Alexandra, who have kept me going for the duration of this study. It hasn't been easy at times, but I owe each and every one of them for their ongoing and unconditional support, which has inspired and motivated me to see this research through.

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Abbreviations Used

BMI	Body Mass Index
CVD	Cardiovascular Disease
DBP	Diastolic Blood Pressure
HDL	High-density Lipoprotein
LDL	Low-density Lipoprotein
NICE	National Institute of Health and Clinical Excellence
NHS	National Health Service
SBP	Systolic Blood Pressure
TC	Total Cholesterol
WC	Waist Circumference
WHP	Workplace Health Programme
WPAI-GH	Work Productivity and Activity Impairment Questionnaire (General Health)

INTRODUCTION

Chronic Disease and the Workplace

It is estimated that by 2024, approximately 50% of the UK population will be aged over 50 years (HM Treasury, 2007), and with an aging population comes an aging workforce. Medical improvements have allowed for longer lifespans, resulting in the age of retirement increasing, which paired with a shift away from traditional family values as a consequence of cultural changes, means individuals are now continuing to work later in life (PricewaterhouseCoopers, 2008). Consequently the workforce is at increased risk of developing chronic disease, and a growing concern is how employers will prioritise the health of their employees to result in both more productive, and increasingly engaged members of staff. The present study investigates the current state of workplace health programmes (WHPs) in the UK, and will use a company case study over a 3-year period, to evaluate whether providing employees with easier access to health interventions, is able to improve the health profile of a company's employees. Based on current literature, and for the purpose of this report, a WHP is defined as a service offered by an employer to their employees, with the intention of improving the work environment and encouraging a better health profile of employees (Guazzi et al., 2014, Goetzel and Ozmlnkowski, 2008). Another important concept is that of wellbeing and wellness, which are often used interchangeably, however describe subtly different things. For the purpose of this report, wellbeing describes a holistic approach incorporating health, financial emotional and social characteristics, whereas wellness focuses more on a deliberate effort to address the health aspect of wellbeing.

Despite medical advances, chronic disease risk and its associated costs are set to rise (Hall et al., 2012), and employers will be under increased pressure to maintain the health of their workforce, not only as there is growing social corporate responsibility to do so, but it is also in their interest for staff to work to their full capabilities. One of the leading drivers of employee absence, is non-work related illness and injury (Confederation of British Industry, 2013), yet employers are still financially impacted as a consequence of these cases. Particularly in the USA, where much of the WHP literature originates, one of the main incentives is the healthcare system (Soler et al., 2010). This is due to employers covering the costs of health insurance premiums for their staff, so organisations can directly influence savings regarding the rising costs of hospital treatment and other health-related costs (Morrison and MacKinnon, 2008, PricewaterhouseCoopers, 2010, Aneni et al., 2014). Literature has concluded that healthier employees are also more productive in the workplace (Guazzi et al., 2014, Pelletier et al., 2004), which can directly create a business case for improving staff health. This supports that rather than simply reducing health risks, companies should be doing more to actively improve the health of their employees, to maximise productivity and improve work performance.

A 2011 report by Dame Carol Black estimated that sickness was responsible for around 140 million lost working days in the UK annually, which equates to an average of 4.9 days for each employee (Black, 2011). Figures to illustrate the direct annual cost of absence to the UK economy are in the region of £14 billion (Confederation of British Industry, 2013). In particular long-term absence (over 4 weeks), makes up around 30% of all absence (Confederation of British Industry, 2013), and may be responsible for greater cost to the economy than short-term absence as there are additional financial implications, including costs to recruit and train new employees, as well as the individuals utilising the National Health Service (NHS), possibly claiming statutory sick pay, and paying reduced income tax.

Absence presents just one component of productivity, and it is important to include presenteeism in these estimations. Presenteeism is defined as an employee being physically present, however having reduced work performance due to poor health. Presenteeism is considerably harder to quantify than absenteeism, but reports have estimated that the cost of presenteeism may be in the magnitude of seven times greater than absenteeism (PricewaterhouseCoopers, 2008).

Several studies have drawn links between health risk factors and workplace absenteeism and presenteeism (Schultz and Edington, 2007, Cancelliere et al., 2011). Pelletier and colleagues (2004) looked at 500 employees who had health checks recording several cardiovascular risk factors, as well as measuring absenteeism and presenteeism using questions from the Work Productivity and Activity Impairment Questionnaire (General Health) (WPAI-GH). This self-assessment tool measures time away from work, as well as reduced work and daily life performance as a consequence of health. At baseline, significantly greater productivity losses were observed from employees exhibiting poor diet, unhealthy body mass index (BMI), physical inactivity, high blood pressure and diabetes. There was also an additive effect with employees who exhibited more risk factors at T1 showing greater productivity improvements at T2. The study went on to quantify the impact of risk factors on WPAI-GH scores, and estimated a 9% improvement in presenteeism, and a 2% improvement in absenteeism for each risk factor that is brought to within healthy levels. A similar study (Boles et al., 2004) found health risk factors were again correlated with employee absenteeism and presenteeism, quantified by WPAI-GH scores, and the cumulative effect of multiple risk factors was evident, with employees with no risk factors averaging about 1.8% presenteeism, compared to 25.9% presenteeism for employees displaying eight risk factors. The average employee in this study was reported to experience 1.8% absenteeism and 6.6% presenteeism as a result of health reasons, which corresponds to 41 minutes of absence, and 2 hours 29 minutes of presenteeism, per employee, per week.

The implications of poor health in the workplace are widespread, and with the cost of ill-health felt by both employers and employees alike, the workplace is a logical location to host wellness interventions, taking the front line of medicine outside of hospitals. There is some supporting existing literature investigating WHPs, with the vast majority of workplace health literature originating from North America, with some research from Asia and Australia, and a small amount from Europe. Notably there is a lack of information originating from UK workplaces, and with such large heterogeneity within ethnic differences, national healthcare services and available resources, it is crucial that the WHP research catches up with the growing demand from UK businesses. One reason for the lack of UK-based literature may be the NHS, which is a publicly funded healthcare system, so employers are less likely to support WHPs as they may not see as much of a financial benefit as organisations in America where employers absorb some of the healthcare costs of an employee illness. Much of the UK-based information available from the emerging field of workplace health comes from commissioned reports, which are not subject to peer-review and consequently limits the external validity of the conclusions. While some UK companies have begun to introduce workplace health programmes in their organisations, these are largely cosmetic and currently reported in grey literature, with no minimum programme standards thus producing mixed programme results. This results in poor-quality wellness programmes, and a lack of shared knowledge if results and findings are not published, or often not even evaluated. The present study aims to contribute to the lack of WHP literature originating from the UK, by analysing the effects of a three-year WHP on a UK-based company's cardiovascular health. Primarily looking at the effect on employee cardiovascular relative risk, quantified using the QRISK2 algorithm, expecting to see a reduction over the course of the WHP. We also expect to see improvements in each of the secondary outcomes of BMI, body fat percentage, waist-height ratio, systolic blood pressure (SBP), diastolic blood pressure (DBP), total cholesterol (TC), high-density lipoprotein (HDL) and TC-HDL ratio.

Workplace Health Programmes vs. Public Health and Occupational Health

Public health and occupational health are two methods used to tackle the costs associated with ill health. Public health can be defined as "helping people to stay healthy, and protecting them from threats to their health". It works alongside medicine to help reduce risk factors associated with poor health, often before they start to develop, utilising a primordial preventive approach which is highly effective in disseminating information to the public, however as the information is largely generic, it may not be capable of reaching those who require it most, with those at the highest risk potentially requiring more specific information.

Occupational health is more specialised than public health, and typically practices reducing the effects of disability, or helping those with health issues improve their independence. In a workplace setting, occupational health specialists may conduct health and safety checks, and provide information about preventing injury in the workplace. Specifically occupational health therapists may work alongside human resources to track absenteeism in the workplace, and aid the return to work of individuals.

These two approaches share a focus on reducing health risk, whereas WHPs take this further by additionally actively promoting positive health changes through practical interventions, and tailoring information on an organisational and individual level. WHPs are about creating positivity, rather than just reducing negativity, and should achieve this through both health, and non-health-related measures (Fonarow et al., 2015) such as job satisfaction, morale and motivation (Schulte and Vainio, 2010, Rajaratnam et al., 2014). These humanistic outcomes, although not directly health-related, can improve work output and can help attract the best new employees (Arena et al., 2013, Carnethon et al., 2009, Boorman, 2009). Employee engagement has been reported as the main motivation for UK companies implementing WHPs (Hall et al., 2012), with employees now looking for employers who go above and beyond what is expected, and WHPs are one way to accomplish this.

A significant advantage of using the workplace as a location for health programmes is that they can provide a concentrated group of people, with a common culture. An interesting concept is that workplaces are to adults, what schools are to children, illustrating the power of a workplace to educate and steer behaviours (Goetzel and Ozmlnkowski, 2008). In 2014, 63.5% of the UK's population was aged between 16 and 64 (Office for National Statistics, 2015), and employees are often at an age where many risk factors are receptive to interventions (Task Force on Community Preventive Services, 2010, Soler et al., 2010). Adapting workplace policies and the physical environment can aid development of a wellness culture among staff, reinforcing positive decisions and encouraging participation (Cahalin et al., 2015, Fonarow et al., 2015). Integrating interventions such as standing desks, into the work place can remove barriers to behavioural changes (Rajaratnam et al., 2014), such as location and schedule (Person et al., 2010), and have been shown to significantly increase energy expenditure (Buckley et al., 2014).

It is important to recognise the benefits of workplace health are not just limited to on-site, with many employers expanding employee benefits to include health services for the immediate family of employees (Goetzel and Ozmlnkowski, 2008, Carnethon et al., 2009, Hall et al., 2012). Some interventions may be held off-site, and not be directly related to the workplace, such as organising a company fun run, or subsidising employee's gym memberships, however the benefits of these interventions are widespread, and may also contribute to the development of a culture of wellness.

Utilising resources available to employers may alleviate pressure on national health services, particularly in the UK, where the NHS is publicly funded. With employees spending as much as 60% of their waking hours at work (Black, 2008), WHPs offer a unique opportunity to longitudinally engage a substantial portion of the population (Arena et al., 2013, Cahalin et al., 2015). The annual cost to the economy of sickness absence and illness-associated worklessness, exceeds £100 billion, which eclipses the annual NHS budget (Black, 2008). A research-based WHP that offers comprehensive services to address a range of health issues, can direct the nation's health in a positive direction (Carnethon et al., 2009).

Although both public health campaigns, and occupational health services have many advantages, WHPs can build on these by removing some of the barriers to participation, and offering more direct engagement. Delegating some of the responsibility of health from the government to employers, will allow for interventions to be tailored to the appropriate population, rather than generic information for the country as a whole. Despite the currently lack of literature, there is a place for WHPs in UK businesses, and this study aims to look at the effectiveness of WHPs in the UK, and contribute to the shortfall of UK-based research.

Cardiovascular Disease (CVD)

Many CVDs develop decades before a cardiac event requires clinical attention (Lloyd-Jones et al., 2010). The key to prevention lies in tracking associated risk factors, identifying high-risk individuals, and having resources in place to prevent conditions from reaching clinical levels. Western medicine typically treats chronic disease once it has already developed, and consequently it is a hugely sophisticated and expensive system (Rice, 2010). Within a workplace setting, CVD has a negative influence on workplace productivity (Babu et al., 2014).

While many WHP interventions in the literature include measures of cardiovascular risk factors, relatively few include a quantifiable measure of cardiovascular risk, which is important as it can monitor whether participants are changing their risk, despite maybe staying within the same risk category bracket. They should be used in conjunction with medical diagnosis to accurately quantify the risk of developing a disease, rather than simply labelling someone as ‘high-risk’. There appears to be no existing research utilising QRISK2 scores as the measure of cardiovascular risk during health interventions, although there has been research which measured QRISK2 prevalence in a workplace setting (Gray et al., 2014).

From an economic point of view, estimating the number of people at different risk levels can be used to inform decisions about how to distribute financial investments most appropriately amongst a population, as the imbalance between chronic disease and treatment is becoming increasingly unsustainable.

Around one in three deaths globally is due to CVD (Arena, 2014), and in the UK around 28% of deaths could be attributed to CVD, marginally second to deaths by cancer (29%) (Townsend et al., 2014). CVD also accounts for around 42,000 premature deaths annually in the UK (Bhatnagar et al., 2015), with as many as 10% of male, and 6.2% of female hospital admissions due to CVD (Townsend et al., 2014). Consequently, the total NHS spend on all CVD, totalled £6.897 billion annually (Townsend et al., 2014, Bhatnagar et al., 2015), however some research has estimated spending to be as high as £17.4 billion, which would account for 21% of the total NHS expenditure (Luengo-Fernandez et al., 2006). Integrating the significant effect of productivity losses from those who are ill or unable to work due to CVD (Arena et al., 2013), the total cost to the UK has been estimated to be as high as £29.1 billion annually (Luengo-Fernandez et al., 2006).

Treating individuals at sub-clinical levels is preferable, and can help to reduce the number going on to require hospital interventions. For this to be possible, there must be regular contact with a group of people in order to obtain quantifiable information regarding risk factors, which as outlined previously, lends the workplace as an ideal location. 'Usual-care' has shown to be ineffective at improving risk factors, even in those who have been diagnosed with coronary disease, whereas those who participate in a multifactorial risk reduction programme which addresses several risk factors associated with cardiovascular risk have been more successful at improving their health (Haskell et al., 1994). Screening programmes are one of the most utilised tools within preventative medicine (Colkesen et al., 2011). They are also relatively low-cost (Goetzel and Ozmlnkowski, 2008, Soler et al., 2010), and provide a snapshot of health, which alongside further analysis over a number of years, can be used to analyse WHP effectiveness, and track changes in company health profile (Cahalin et al., 2015). They can quantify risk factor prevalence across a population, whether that is a country or an organisation, which can help direct WHP priorities, and can provide a platform to also provide an education element through explaining results and individual goal setting. Associated risk factors to be measured should include body composition, dietary habits, alcohol consumption, smoking status, as well as psychosocial factors looking at readiness to change (Goetzel and Ozmlnkowski, 2008).

Risk Factor Prevalence

Body Composition and Obesity

In England in 2012, 67% of men and 57% of women were classed as being overweight (BMI=25-29.9kg/m²) or obese (BMI>30kg/m²) (Townsend et al., 2014), with mean BMI for males and females being 27.8kg/m² and 27.4kg.m² respectively in the literature (Flint et al., 2014), whereas figures elsewhere provided values of 25.7kg/m² for males, and 25.0kg/m² for females (Wells et al., 2008). In 2012, the percentage of the adult population with a BMI of 30 or greater was 24.8% (Townsend et al., 2014), which is supported by 2014 research into 790 UK employees, reporting an overweight prevalence of 42% and obesity in 28% within the sample (Gray et al.,

2014) presenting significant risk to health, and in turn increasing the chances of other risk factors developing.

BMI doesn't distinguish between body fat and lean weight, and whilst it gives a good picture of one's body composition, combining the results with a body fat percentage score provides additional benefit. Research including the UK population's body fat statistics is sparse, which is likely to be due to BMI being a quicker and more cost-effective measure of body composition for the general population. A 2014 study on a UK cohort reported mean body fat percentage values of 22.9% for males, and 35.5% for females (Flint et al., 2014). When matched for ethnicity and age, females have consistently shown higher body fat percentages (Gallagher et al., 2000).

A disadvantage of BMI and basic body fat percentage tests is that there is no measure of fat distribution, whereas evidence suggests visceral fat, represented by central obesity, poses a greater risk to CVD (Ashwell and Gibson, 2016). For this reason, an additional measure of body composition such as waist circumference (WC) is frequently used. WC correlates closely with visceral fat (Klein et al., 2007), and is a relatively quick and inexpensive measure compared with body scans. Guidelines suggest that low values for WC are below 94cm for males, and 80cm for females, high WC values are 94-102cm for males and 80-88cm for females, and above these values places individuals in the 'very high' category (Ashwell and Gibson, 2016). Research into body shapes in the UK, found the mean male WC was 94.9cm, and female WC was 87.4cm (Wells et al., 2008). WC is commonly reported as a ratio of an individual's height in the literature as this represents a more comparable measure between participants. Research into a large UK population cohort (Ashwell and Gibson, 2014) found that 70% of individuals had a waist-height ratio greater than 0.5, which is widely regarded as high-risk.

Blood Pressure

High blood pressure increases atherosclerosis risk by increasing stress on blood vessels and the heart, and worldwide hypertension is estimated to be responsible for around 12.8% of all annual deaths (British Heart Foundation, 2016). In England, hypertension was reported in 31% of men and 27% of women in 2013 (Townsend et al., 2014). There is slight variation in reported blood pressures from UK populations, with recorded mean SBP as 115.2 mmHg and DBP as 72.1 mmHg in a study on university administrators (Alkhatib, 2013). Reports suggest that in certain age groups, CVD risk can double for every 20/10 mmHg increment that blood pressure increases (British Heart Foundation, 2016). It is also estimated that around half of adults with high blood pressure are not receiving any treatment to help them bring values down to a healthy level (Heart UK, 2010).

Blood Lipids

Guidelines suggest that TC levels should be 5 mmol/L or below, however in England over half of adults have values exceeding this level, with average TC levels of 5.1 mmol/L in men and 5.2 mmol/L in women (Townsend et al., 2014). For individuals with TC levels above the recommended value, a reduction of just 10% can half one’s risk of CVD within five years (British Heart Foundation, 2016). HDL can help to reduce the risk of atherosclerosis as it removes low-density lipoprotein (LDL) from the blood stream, and NHS guidelines suggest HDL levels should be greater than 1 mmol/L. Also commonly reported is the TC-HDL ratio, which should be ideally below 4, and represents the amount of TC in relation to HDL. Research looking at a local health board, and steel workers in Wales reported baseline TC to be 4.92 mmol/L, HDL to be 1.29 mmol/L and a TC-HDL ratio of 3.6 (Gray et al., 2014a). Similar baseline levels were reported in a study among UK university administrative staff (Alkhatib, 2013).

Lifestyle Risk Factors

Several lifestyle factors (smoking, alcohol, diet and exercise) are responsible for increasing the chances of the above risk factors from developing. Interventions addressing these areas form the foundations of a WHP aimed at addressing the previously mentioned associated physiological risk factors.

Estimates suggest that smoking is the cause of around 10% of CVD (British Heart Foundation, 2016, Heart UK, 2010), through increased susceptibility of developing atherosclerosis and CVDs in general. Trends suggest smoking rate is declining in the UK, however 2011 estimates still show that in England, 20% of men and 18% of women are current smokers (Townsend et al., 2014).

The UK government currently recommends either at least 150 minutes of moderate aerobic activity, 75 minutes of vigorous aerobic activity, or a mixture of both each week. In addition to this aerobic exercise, it is also recommended to do strength training on two or more days a week using major muscle groups (NHS Choices, 2015). In England, 67% of men and 55% of women met these guidelines, with similar levels in Scotland (67% and 58%), and slightly lower figures in Ireland (59% and 49%) (Townsend et al., 2014). The latest data for Wales was measured using old guidelines so is not applicable, however in all UK countries, the proportion of adults meeting these guidelines decreases with age (Townsend, Williams et al. 2014).

During the course of this study, alcohol consumption guidelines from the UK government changed, and were reduced from no more than 21 units a week for males, and 14 for females, to no more than 14 units for anyone, regardless of gender (Department of Health, 2016). It is also newly recommended to distribute consumption over at least 3 days. High blood alcohol levels can raise blood pressure, as well as assisting in weight gain and thus makes endothelial damage more likely. 37% of men and 28% of women in Britain are regularly exceeding the suggested limits of alcohol consumption (Townsend et al., 2014).

There are uncontrollable risk factors such as age, gender, ethnicity and family history, which can place individuals at pre-disposed increased risk of developing CVD. Importantly however, even individuals at increased risk due to these factors, can benefit from optimising their other, controllable, risk factors.

Many of the risk factors associated with CVD are linked, but importantly, it is not a linear risk increase for each additional risk factor, but rather an exponential increase in CVD risk for individuals exhibiting multiple risk factors. Studies in the workplace have shown that about three-quarters of a workforce exhibit between 2 and 5 cardiac risk factors (Pelletier et al., 2004, Boles et al., 2004). Research looking at the relationships between risk factors have found links in males between physical inactivity and poor diet, as well as alcohol consumption and BMI (Laaksonen et al., 2002). The relationships were largely similar for males and females, with the exception of how BMI influences risk factors. Smoking was also linked to most health behaviours measured, which included alcohol use, physical activity, s mention behaviour and BMI. Around 92% of smokers exhibit at least one other risk factor (Prochaska et al., 2008). If an employee with multiple risk factors is able to improve a single risk factor, it may increase the motivation and likelihood of that individual going on to improve multiple risk factors (Prochaska et al., 2008) which supports the use of a multifaceted wellbeing programme to target multiple risk factors simultaneously.

Current Study

Study aims and hypothesis

The present study aimed to be the first published, peer-reviewed research to address the effectiveness of a health screening initiative in a UK organisation. While many studies look at cardiovascular risk factors, relatively few actually quantify cardiovascular risk, and to the best of our knowledge, this is the first study to use the QRISK2 algorithm to track 10-year cardiovascular risk in the workplace. With much of the current research lasting less than 12 months, the present study will also provide a relatively long-term outlook for the benefits to seen from health programmes. This study focuses on how a WHP, including a health check and individual counselling, can improve the health profile of a UK-based company over a 3-year period, primarily focused on CVD risk as quantified by QRISK2 relative risk, but also investigating changes in associated CVD risk factors. At present, few studies have tracked cardiovascular risk in response to WHPs (Makrides et al., 2008, Glasgow et al., 1995, Glasgow et al., 1997, Radler et al., 2015, Racette et al., 2009, Levesque et al., 2015, Freak-Poli et al., 2011) and no study has tracked change in QRISK2 scores in a workplace population as a measure of cardiovascular risk. The QRISK2 was designed for the UK population, and so the general lack of UK-based WHP research in general is likely the reason why QRISK2 is yet to be used to track changes in the workplace environment. The current study provides a relatively comprehensive evaluation of health check data, and illustrates what statistical analysis can be conducted on this information obtained and how it can be used to support the implementation of wellness programmes.

This study outlines the process of a health screening programme in a UK-based company, and looks at how the cardiovascular risk of company employees has changed, since the initial screening. It then outlines the future direction of WHPs in the UK, based on research. Specifically the current study investigates the effectiveness of a UK-based WHP, at evoking change in the QRISK2 relative risk score and the associated risk factors of employees. To address this, data from individuals who attended health checks in 2012, 2013, and 2015 were analysed with the primary aim to test the hypotheses that:

1. The QRISK2 relative risk score of employees is lower at the third health check than it was at first health check, and
2. All secondary measures (body composition, blood lipids, blood pressure and lifestyle factors) would improve between the first and third health checks.

EXISTING PREDICTION TOOLS AND INTERVENTIONS

With CVD being one of the largest causes of mortality in the UK and worldwide (Bhatnagar et al., 2015), CVD risk score tools have been developed to maximise the chances of early intervention (Liew et al., 2013). Two commonly used cardiac prediction tools are the Framingham equation and the ASSIGN score.

The Framingham equation was developed on a population from a small town in the USA, and using a cohort of 5573 people, each person underwent a physical analysis and lifestyle interviews, which were recorded, quantified and analysed (Collins and Altman, 2010). Participants continue to return for retesting every two years, and predicted risk is compared to observed risk. Based on this, an equation to calculate cardiac risk was derived. The risk factors required for the Framingham equation are summarised in Table 1. There are however, several weaknesses of the Framingham equation, including the population for the original derivation were all from one relatively small town (Collins and Altman, 2010), and were almost exclusively white, meaning that the equation may need to be recalibrated if used for a more ethnically diverse group (Hippisley-Cox et al., 2007). In the years during the equation derivation, the incidence of CVD in the USA was at some of its highest levels of all time (Hippisley-Cox et al., 2007) which may also influence its validity.

Glasgow et al. (1995) found little change in Framingham score within a control or an intervention group over an 18 month WHP. The same group published research two years later however, which found that amongst the intervention group, there was a smaller increase in Framingham scores compared to the control group, although this was not significant (Glasgow et al., 1997). It was concluded that continuous, low-cost and low intensity interventions were trending towards improvements in CVD risk in the workplace. Similar results were also reported in relatively short interventions, with a more intense intervention utilising online education materials and weekly nutrition education, supported by regular contact with a registered dietician (Radler et al., 2015). A Framingham score of 10% of above is considered high-risk, and the study found 10-year Framingham risk decreased from 7.66% at baseline, to 6.95% following a 12-week follow-up.

Makrides et al. (2008) also found significant improvements in Framingham risk scores during a 12-week WHP, with improvements of the Framingham score in the intervention group significantly greater than the control group at the 3-month and 6-month follow-ups. The intervention used was fairly intensive, and included individual exercise plans, supervised exercise classes, risk factor education, a smoking cessation programme and telephone contact. The importance of an intervention in addition to health checks has been reported (Racette et al., 2009), where health checks alone did not influence the number of low-risk employees, where a worksite receiving both health checks and an intervention significantly increased the number of low-risk employees, as assessed by Framingham equation. At baseline the prevalence of employees with high-risk Framingham (>10%) at each worksite, were 13% and 12% respectively. Levesque et al. (2015) observed significant improvements in the Framingham score over a 3-month period, with mean risk decreasing from 5.5% at baseline, to 4.5% post-intervention. These findings were observed despite their intervention having little structure, simply issuing prizes to groups of employees who made the biggest improvements in their health over a 3-month period.

Research in Australia used an alternative CVD risk model known as the Absolute CVD risk assessment tool, to investigate 10-year cardiac risk (Freak-Poli et al., 2011). This risk scores takes age, sex, TC, SBP, medication, smoking status, diabetes status, and HDL into account, however interventions focused on increasing physical activity, largely using pedometer-based interventions did not evoke a significant change in CVD risk over the 9-month intervention.

The ASSIGN (**AS**sessing CVD risk using **S**cottish **I**ntercollegiate **G**uidelines **N**etwork) equation was developed in the 1980s and 1990s based on a group of Scottish individuals (Collins and Altman, 2010). The incidence of cardiac events was higher in the Scottish population than the English population so it was felt that a separate equation would be appropriate (Hippisley-Cox et al., 2007). The risk factors used to calculate the ASSIGN cardiac risk score are also presented in Table 1.

QRISK

In 2007, there was growing concern that the limitations of the Framingham equation reduced its accuracy when used on UK populations (Hippisley-Cox et al., 2007), resulting in misidentification of individuals at high-risk, which may cause treatment to be prescribed unnecessarily to some patients and vice versa, so work began developing a UK-specific algorithm called the QRISK (as it is based on health data from the QRESEARCH database). The QRESEARCH database contains health records for over 24 million patients, and was used to obtain longitudinal medical history for a large cohort to derive the algorithm (Hippisley-Cox et al., 2007). The exclusion criteria for the study included any previous diagnosis of CVD or diabetes, patients with interrupted periods of medical history within the QRESEARCH database, or patients aged below 35 or above 74 years of age (Hippisley-Cox et al., 2007). The risk factors investigated for the prediction algorithm are presented in Table 2, with the benefit being they are routinely collected and monitored during medical history, which allowed for the initial cohort to include 636,753 male, and 646,421 female patients. The study then tracked these patients to observe CVD (myocardial infarction, coronary heart disease (CHD), stroke and transient ischaemic attack (TIA)) development over the following years, and could retrospectively investigate which risk factors contributed to this, consequently allowing calculation of an algorithm to quantify 10-year risk. Once the algorithm was developed, Hippisley-Cox et al. (2007) conducted a validation study on a separate group of patients from the QRESEARCH database. The study calculated QRISK scores for 305,140 men and 309,413 women, and then looked at the observed risk of these patients over 10

Framingham Equation	**ASSIGN Score**
Age	Age
Diabetes status	Sex
Smoking status	Scottish postcode
Treated and untreated systolic blood pressure	Family history of Coronary Heart Disease/Stro
Total cholesterol	Diabetes status
HDL cholesterol	Rheumatoid arthritis
Body Mass Index	Number of cigarettes smoked daily
Lipids	Systolic blood pressure
	Total cholesterol
	HDL cholesterol

Table 1. The risk factors required to calculate the Framingham, and the ASSIGN cardiovascular risk scores, which were two of the cardiovascular risk scores in place prior to the development of QRISK.

years. The study also compared the performance of QRISK against the Framingham and ASSIGN cardiac prediction tools. Participant characteristics were similar to that of the national health survey, suggesting that the QRESEARCH data set was representative of the general population. Using the recommended threshold of a 20% QRISK score to define 'high-risk' patients, the QRISK predicted 8.5% of the cohort as high-risk, compared to the Framingham and ASSIGN which predicted 12.8% and 14.0% respectively. Comparing the 10-year estimated risk against the observed risk score, the QRISK over-predicted by 0.4%, which is relatively negligible, compared to the 35% over-prediction by the Framingham equation, and the 36% over-prediction by the ASSIGN score. There were 53,668 patients who would be reclassified from high to low-risk or vice versa depending on whether the QRISK or Framingham equations were used. Despite the QRISK algorithm outperforming the other two prediction tools in this study, one criticism was the validation used a similar cohort to that used in the algorithm derivation, which could lead to a 'home advantage'. For this reason, an external validation was conducted by Hippisley-Cox et al. (2008a) to investigate the transportability of the model in a cohort from a different patient database to the derivation study. The QRISK algorithm used in the study was largely the same as the algorithm used in the internal validation study, however a notable difference was that this QRISK algorithm excluded patients who had been prescribed statins before the start date of the study.

Comparing the cohorts from both validation studies, the participant characteristics were largely similar, suggesting that both cohorts are representative of the general population. Following the prediction score calculation, the Framingham equation over-predicted risk by 23%, and QRISK under-predicted by 12%. 7.9% of the cohort would be reclassified from high to low-risk or vice versa depending on which equation was used. 132,076 patients would be high-risk with Framingham and low-risk with QRISK. Conversely, 14,245 would be reclassified from low-risk to high-risk if using QRISK rather than Framingham, and these patients had a 10-year observed risk of 23.7%, which exceeded the threshold for high-risk.

Overall the QRISK was a more accurate predictor than the Framingham equation, with the under-prediction partly explained by this patient database generally having a lower recording of patients having a family history of CHD, which can increase risk by 50% or more. Crucially, in collaboration with the internal validation study, the QRISK

Risk Factor	**Measured In**
Age	Years
Sex	Male of female
BMI	kg/m^2
Smoking status	Current or non-smoker
Systolic blood pressure	mmHg
Left ventricular hypertrophy	Yes or no
Ratio of total serum cholesterol to HDL levels	Continuous
Current prescription of 1 or more anti-hypertensive	Yes or no
Townsend deprivation score	Continuous
Family history of CVD in 1st degree relative aged below 60 years	Yes or no

Table 2. Risk factors and units of measurement required for original QRISK algorithm calculations. Since then, additional risk factors of self-assigned ethnicity and postcode, as well as several interactions have been included.

has outperformed the Framingham equation in databases that represent around 80% of the GP practices in the UK.

An external validation by different researchers was conducted by Collins and Altman (2010), with exclusion criteria identical to previous research. This study compared QRISK to the ‘Anderson Framingham’ and the ‘Cox Framingham’ equations. The Anderson Framingham equation was the same as the original Framingham equation, whereas the Cox Framingham equation was developed in 2008 as a gender-specific version of Framingham. The analysed cohort consisted of 1,072,800 patients.

Of the three prediction tools compared in this study, QRISK was the most accurate, with performance of both Framingham equations notably reducing in accuracy as risk increased in both men and women. The Anderson Framingham equation over-predicted risk by 23%, the Cox Framingham over-predicted risk by 18% and the QRISK under-predicted by 12%. Using the National Institute of Health and Clinical Excellence (NICE) recommended threshold of 20% or above being at high risk, 85,010 patients would be reclassified depending on whether the Anderson Framingham or the QRISK equations were being used. 57,199 of these patients were men who would be downgraded from high-risk using the Framingham, to low-risk using QRISK.

QRISK again proved to be the most accurate cardiac prediction tool used in this study of UK patients, which reflects the derivation based on UK populations. As displayed in Table 1 and 2, the QRISK contained additional risk factors compared to the Framingham, but these additions are routinely collected during medical investigations, so do not significantly increase data collection time, yet can contribute to more accurate cardiac risk scores.

QRISK2

To account for changes in population characteristics and the development of data quality available, the QRISK undergoes annual reviews (Collins and Altman, 2010). Models to assess social deprivation became increasingly developed, and were integrated into QRISK2. Another development was the inclusion of self-assigned ethnicity in the risk prediction. Different ethnic groups are exposed to different risk factors, and are naturally more susceptible to some than others, resulting in large heterogeneity in CVD risk (Hippisley-Cox et al., 2008b). Self-assigned ethnicity is often more accurate than ethnicity assumed by country of birth, or geographically inferred ethnicity (Hippisley-Cox et al., 2008b). Particularly due to the increasing levels of ethnic minorities with UK nationality, place of birth is no longer a valid way to assume ethnicity. Without measures of social deprivation and self-assigned ethnicity, those in more affluent areas may be at risk of over-prediction. Also those of South Asian ethnicity are also at high risk of CVD, reflecting the need for some measure of ethnicity (Hippisley-Cox et al., 2008b). QRISK2 also included several interactions between risk factors as shown in table 2 (Collins and Altman, 2010).

The derivation of the QRISK2 algorithm again used the QRESEARCH database, and included data from 1,535,583 patients (Hippisley-Cox et al., 2008b). The methods were largely similar to those used in the derivation study to establish the original QRISK algorithm (Hippisley-Cox et al., 2007). Exclusion criteria remained identical to previous derivations. Patients also had to be aged 35-74 for their results to be included in the study (Hippisley-Cox et al., 2008b). The first diagnosed CVD event on the QRESEARCH database was used as the primary outcome measure, and these included angina and myocardial infarction, stroke, and TIA.

The validation cohort used 750,232 patients from the QRESEARCH database that were not involved in the derivation study (Hippisley-Cox et al., 2008a). This study compared QRISK2 with QRISK, as well as the modified Framingham score. The modified Framingham score was calculated by conducting the standard Framingham equation, however multiplying the result by 1.4 should the participant be a South Asian male. The QRISK2 marginally outperformed the QRISK algorithm when comparing predicted risk with observed risk using D statistic and R^2 value, and both were substantially more accurate than the modified Framingham equation. There were considerable differences in risk factor prevalence across different ethnic groups, and also within ethnic groups with regards to gender, justifying the inclusion of self-assigned ethnicity in the QRISK2 algorithm. There were 112,156 patients who would be classified as high-risk with their modified Framingham score however 46,094 of these would be reclassified to low-risk if the QRISK2 was used instead. There were 78,024 patients categorised as high-risk using QRISK2 of which 15.3% would be reclassified as low-risk using Framingham, however the observed risk of these 11,962 patients was 23.3%, indicating that QRISK2 had correctly categorised them.

The modified Framingham score used in the study remained a poor measure as it did not discriminate between ethnic diversity within the South Asian population, and didn't provide any guidelines for females with South Asian ethnicity in the UK.

An independent, external validation (Collins and Altman, 2010) was conducted with the same exclusion criteria as in the QRISK2 derivation and validation study (Hippisley-Cox et al., 2008b). The validation cohort analysed consisted of 1,583,106 patients, and the study again compared QRISK2 with QRISK and modified Framingham scores. The QRISK2 and QRISK again outperformed the modified Framingham equation, and the QRISK2 only marginally outperformed the QRISK. 45% (79,592) of male patients classified as high-risk with the Framingham would be reclassified as low-risk with the QRISK2, and of those patients the observed risk was 14.00%, which fell well below the NICE-recognised 20% threshold. The corresponding statistic for females was 25,478 patients being reclassified, with an observed risk of 13.36%.

There have been nearly 3.9 million patients involved in the derivation, internal validation and external validation of the QRISK and then QRISK2 algorithm, representing around 14% of the UK population for the age range used in these studies. Consequently it is likely to be a fair representation of the UK population as a whole, particularly when compared to the Framingham algorithm. The annual reviews of the QRISK will endeavour to the risk score accurate, with further updates of the algorithm allowing for application to individuals between the ages of 25 and 84 (Brotons et al., 2016), which allows the algorithm to be applied to a greater portion of the population.

NICE Recommendations

The National Institute for Health and Care Excellence (NICE) are responsible for developing guidelines and setting quality standards for public health and social care in the UK to minimise the prevalence of ill health. Amongst other things, they are accountable for the quality of NHS treatment and care. In 2008, the original guidelines were developed for dealing with cardiac prediction tools, and at that point there was limited literature regarding the QRISK algorithm, as QRISK development only began in 2007. It was felt the evidence supporting the use of the QRISK over Framingham wasn't conclusive, and using the Framingham would not compromise individual patient care in the short-term.

In 2010 however, NICE reviewed cardiovascular prediction literature published since 2008, and concluded that the QRISK and then the QRISK2 had become recognised tools for predicting cardiac risk (Mayor, 2010). A NICE statement from Dr Fergus Macbeth, Director at the Centre for Clinical Practice recommended, "healthcare professionals use the tool that best suits their requirements". These changes from the previous recommendation of using Framingham show that QRISK is becoming increasingly recognised in a clinical setting, and consequently, the primary data required to calculate QRISK2 will be recorded more frequently during clinical assessments and the quality of data will improve, allowing for further improvements of the QRISK2 in future algorithm updates.

A frequently used tool within the NHS to quantify cardiovascular disease is 'Heart Age', which is based on a tool used by the Joint British Societies for the prevention of cardiovascular disease (JBS3) (NHS Choices, 2014). Although it may appear to be a separate tool, the JBS3 risk prediction tool is actually based on research from the QRISK (JBS3, 2014).

Success of Existing WHP Interventions on modifying CVD Risk Factors

The literature has shown that WHPs can significantly influence the prevalence of the reversible risk factors associated with CVD (Cahalin et al., 2014, Racette et al., 2009, Nilsson et al., 2001, Ogunmoroti et al., 2016), however large heterogeneity exists amongst research methods and data reporting due to the highly individualised nature of interventions. Programmes should be tailored to each organisation, to ensure objectives are culturally, resourcefully, and financially appropriate on both an individual and company-wide level (Arena et al., 2013). These multi-faceted interventions have shown to be the most effective forms of workplace wellness (PricewaterhouseCoopers, 2010), as they are able to engage employees through numerous channels (Goetzel and Ozmlnkowski, 2008, Mills et al., 2007). For this reason, it is important for research to be transparent when it comes to interventions and results to allow for the transition from scientific literature into practical recommendations for organisations to use.

Body Composition

There have been several reviews conducted looking at the effect of WHP on body composition, with mixed outcomes. A 2009 review (Anderson et al., 2009) concluded interventions that utilised better nutrition and physical activity either in combination or alone, showed modest reductions in weight. It was reported that generally in 6-12 month follow-ups, there was a net weight loss of around 2.8lbs (1.3kg). When examining BMI, within 6 to 12 month follow-ups there appears to be a net loss of around 0.47kg/m². The validity of this review paper can be generalised to white-collar workforce, where there are existing cases of overweight individuals and chronic disease risks. A 2011 review (Groeneveld et al., 2011) made similar conclusions, and particularly among high-risk populations, there was strong evidence that interventions including both individual counselling and group education sessions were able to have positive effects on weight. The review also found strong evidence supporting interventions having an effect on body fat percentage, which can be argued is a better predictor for CVD risk than weight alone. The most recent review conducted a meta-analysis looking at dietary and physical exercise interventions on weight outcomes (Verweij et al., 2011). The conclusions agree with previous reviews that interventions can cause a significant reduction in body composition measures including weight, BMI and body fat percentage. It was concluded that currently there are an insufficient number of studies to conduct a meta-analysis on WC, with the lack of research on WHP and WC also being stated elsewhere (Atlantis et al., 2006).

Research from the United States has shown that just a 6-month intervention was able to produce significant improvements in body fat, and of the 26% of employees from the intervention group classed as high-risk at baseline, nearly 60% were reclassified as low-risk following the intervention (Milani and Lavie, 2009). The intervention included health education, nutrition counselling, smoking cessation counselling, and promotion of physical activity. Elsewhere similar effects were observed after just a 12 week intervention (Radler et al., 2015), with significant reductions in weight, BMI and WC. Interestingly the intervention used online education materials in addition to health checks and weekly education topics, which proved successful. Importantly, weekly education topics were on items of interest to participants, such as food labels, food shopping and eating out. During 12-month programmes, monthly education meetings may be more appropriate, and have also been implemented in WHPs (Racette et al., 2009). They were used as part of a larger programme, which also included pedometers, on-site Weightwatchers meetings, monthly newsletters, walking maps and weekly visits from a registered dietician or exercise specialist. Only a small, non-significant reduction in WC was observed, however there were significant improvements in other measures of cardiovascular risk factors.

Research from Australia supports the findings of USA research, with interventions containing a large exercise component (150 mins of supervised exercise a week for 6 months) significantly improving WC (Atlantis et al., 2006). The cohort used in the study was otherwise healthy, however due to the sedentary nature of their work, they were able to improve energy expenditure and consequently their body composition. Elsewhere, overweight and obese Australian study participants have shown that a 14-week intervention can improve body composition in an intervention group compared to a control group (Morgan et al., 2011). Interventions included a handbook, online resources, dietary feedback, pedometer and financial incentives, and were effective at reducing BMI, weight, and WC significantly more than a control group.

It has been suggested from European studies that short-term interventions are not appropriate for changing body composition, and studies should track over a longer period to see whether changes are likely to relapse (Mache et al., 2015). A 12-month intervention, combining physical activity with nutrition counselling, saw no significant change in body weight. An 18-month intervention however, has shown to be successful at significantly reducing BMI at both 12 and 18-month follow-ups (Nilsson et al., 2001). The participants were mainly women aged 40-50, and working in the public sector, who were identified as high-risk via questionnaires investigating family and personal medical history, current lifestyle and medical treatment. Despite the reduction in BMI, no significant change in waist:hip ratio was observed. Even though no change in some measures of body composition were observed here, interventions have the power to prevent body composition from worsening, which is still of benefit. Research from Denmark found that an intervention group did not significantly change their weight, however the control group significantly increased their weight (Nisbeth et al., 2000).

Blood Pressure

There is substantial research concluding that workplace interventions can have a positive effect on employee blood pressure. In individuals with hypertension, a stress reduction intervention has shown to be effective at reducing SBP significantly more than a control group (McCraty et al., 2003). The intervention consisted of a 16-hour programme, delivered over 3 days within a two-week period, and after the programme employees were encouraged to practice techniques for a following 3 months. One participant in this intervention group was permitted to completely cease taking hypertensive medication as a result of the intervention. There were also improvements is DBP, although due to the control group also improving their DBP, there was no significant advantage to the intervention. 6-month interventions have also shown to be successful amongst employees displaying at least one CVD risk factor (Arao et al., 2007). Counselling combined with environmental and social support helped an intervention group to significantly reduce SBP by 5.1 mmHg, and DBP by 2.7 mmHg. Similar results were observed in a 2009 study comparing the effects of an assessment and intervention group, with just an assessment group over 12 months (Racette et al., 2009). It was found that there were significant improvements in SBP and DBP in both groups, suggesting that standard care alone may be capable of improving blood pressure outcomes. Research targeting overweight and obese individuals has also created favourable outcomes on blood pressure, where dietary interventions led by nutritionists were linked with 9 mmHg reductions in SBP, and 8 mmHg in DBP within 6 months. Research on Malaysian university staff has reported not only improvements in hypertensive employees, but significant improvements were also reported in those at risk of becoming hypertensive, who had a mean blood pressure of 132.0/82.4 mmHg at baseline (Eng et al., 2016). The intervention used was low-intensity, and simply utilised health checks, and educational seminars over a 6-year period.

Literature has shown blood pressure reductions in general populations. A recent study (Ogunmoroti et al., 2016) tracked employees from a health care company over four annual health checks, and trends revealed a consistent reduction in blood pressure during annual health checks from 126/78 mmHg in the first year, to 121/76 mmHg 3 years later, which is almost to within 'ideal levels' of 120/80 mmHg (Gray et al., 2014b). The number of study participants with blood pressure below 120/80 significantly increased during the intervention (Ogunmoroti et al., 2016). There may also be an effect of intervention intensity, with trends showing a high-intensity intervention (a combination of individual and environmental intervention and management commitment programmes) is capable of reducing blood pressure to a greater magnitude than a moderate-intensity intervention (individual and environmental interventions) (Goetzel et al., 2010). The difference between high and moderate-intensity interventions was the leadership structure, where individual sites were given responsibility of running their own interventions, whereas the moderate-intensity group was slightly more generic in their approach. Short-term intense interventions have also proved successful, with meeting for two hours, four times a week for 4 weeks, on top of diet and exercise plans significantly reducing blood pressure (Aldana et al., 2005). This study reported a 31% increase in the number of participants with normal SBP levels, and a 46% increase in the number with normal DBP. Even just 4-day interventions consisting of lectures, self-education training and counselling, has significantly improved both DBP and SBP (Muto and Yamauchi, 2001). At 6 and 18-month follow-ups, the improvements began to diminish, calling into question the long-term changes observed as a result of short-term interventions. Exercise interventions are also an effective way of reducing SBP, with both resistance training, and all-round physical activity significantly reducing SBP during a 6-month follow-up (Pedersen et al., 2009). Favourable outcomes have resulted from internet based tracking systems allowing employees to record and monitor their own blood pressure (Watson et al., 2012). Intervention employees were asked to record blood pressure twice a week, and results were automatically uploaded to a website, that allowed them to track their progress, and gave them individualised messages, compared to a control group who had access to a blood pressure machine, but not the website. Significantly more people in the intervention group experienced reductions in SBP and DBP over 10 mmHg and 5 mmHg respectively.

Despite blood pressure recordings being relatively inexpensive and time-efficient, a Canadian study found that 25.4% of employees were unaware they had hypertension, with resting blood pressure levels above 140/90 mmHg (Levesque et al., 2015). The prevalence of high blood pressure was reported in an Austrian study where around a third of female and half of male employees had high blood pressure (Luger et al., 2015). Research has shown positive effects of interventions, particularly in those exceeded recommended values on SBP and DBP using a range of interventions, and this justifies its inclusion in WHPs.

Blood Lipids

Studies investigating the effect of WHP on blood lipids also vary greatly in intervention duration. 3-month interventions show mixed results with a highly successful Canadian intervention seeing significant improvements in TC, LDL, HDL and TC-HDL ratio (Levesque et al., 2015). The intervention used was simple, with groups competing to see the greatest change, with the motto 'eat better, move more and quit smoking'. These results are contradicted in a diet-based 3 month intervention, where educational sessions were provided outside of working hours (Braeckman et al., 1999). There were no changes observed in HDL, and interestingly HDL actually increased in the control group, who only received the initial health screening. This study did find however that in a subgroup of employees with baseline TC exceeding 6.5 mmol/L, there was a significant reduction. Nutritional interventions over a 6-month period had better results, with both an energy deficit, and a general low-calorie diet effectively reducing TC and LDL within 12-weeks, and at 6-month follow-up there was a significant increase in HDL. A 'lipid clinic' was one part of a successful intervention, which alongside educational sessions and referrals for high-risk employees, saw significant increases in HDL and TC-HDL ratio (Milani and Lavie, 2009), whereas an intervention of a similar length with just cholesterol education found little change in HDL level (Fritsch et al., 2009). Interestingly however this intervention did see significant improvements in TC and LDL, although the cohort having hyperlipidaemia at baseline can explain this.

High-risk employees show favourable outcomes regarding blood lipids. University employees using a treadmill workstation saw reductions in TC and LDL which were significant between 3 months and 9 months (John et al., 2011). HDL trends were also encouraging, although not significant. Blood lipid changes occurred here in the absence of weight loss. A 2001 study saw significant reductions in LDL and TC-HDL ratio, and significant increases in HDL among high-risk employees (Nilsson et al., 2001). The intervention was comprehensive, and used a combination of group sessions and individual counselling throughout the study duration. Another intensive intervention on high-risk employees using a 12-week intervention had different findings (Rouseff et al., 2016). Within 12 weeks, there were significant reductions in TC and LDL, however when follow-up measures were continued for 12 months, it was revealed that by the 6 month measurements, these levels had started to return back to baseline levels. Interestingly, HDL levels began to increase following the intervention, despite dropping slightly during the intervention.

Although the results from short interventions are mixed, when looking at long-term changes, literature utilising long-term interventions are promising. A 3-year intervention was reported to be effective at evoking significant improvements in TC and LDL, and trends show non-significant increases in HDL over the duration (Short et al., 2010). Although details on the intervention used aren't reported, the results are supported by a 4-year study, utilising a low-intensity intervention focused on environmental changes, and campaigns that specifically encouraged more walking (Naito et al., 2008). The study focused specifically on HDL levels, and found a significant increase from baseline to 5-year measurements.

From this summary of existing research into the area, it is clear that there are several significant gaps in the literature. Notably there is very little representation of UK-based organisations in publications, and also much of the research only tracks risk factor changes over a 12-month period or less. With health changes, long-term maintenance is vital as interventions are looking to improve individual's health for more than just the duration of the WHP, and should result ultimately in a sustainable lifestyle change. With different rules and regulations across different countries, it is important that there is literature investigating UK workplaces, as it is difficult to compare results between countries, particularly to reflect small and medium-sized companies in the UK.

THE EFFECT OF A THREE-YEAR WORKPLACE HEALTH PROGRAMME ON EMPLOYEE QRISK2 RELATIVE RISK SCORES: A UK-BASED CASE STUDY

Compared with other western countries, there is little peer-reviewed literature originating from the UK looking at workplace health programmes, with much information coming from commissioned reports that are not subject to peer-review. It is important for research to reduce these shortcomings and provide evidence-based suggestions for best-practice WHPs. The present study will investigate if a 3-year workplace health programme positively influences cardiovascular health, with the primary hypothesis that QRISK2 relative risk scores will decrease between the first and third health check. The secondary hypothesis is that the associated CVD risk factors (BMI, body fat percentage, waist:height ratio, SBP, DBP, TC, HDL and TC-HDL ratio), will also improve over time as a consequence of the WHP.

Case Study Information

Wellness Academy is a UK-based company that provides health interventions to many organisations in the UK. They conduct health checks for employees, as well as designing and implementing comprehensive wellness programmes for a range of industry sectors. Once ethical approval was granted, a data transfer agreement was set up between Wellness Academy and the University of Birmingham, to allow for use of data for consenting individuals. Prior to the data being accessed by University researchers, Wellness Academy cross-referenced their consenting employee database with the inclusion and exclusion criteria of this study, and anonymised the data set.

The inclusion criteria for the present study were that participant must be employed by the case study company, be aged between 25 and 84, have attended three health checks, and have no prior history of cardiovascular disease.

All data included in this study were retrospective; consent was obtained at the time of their health checks allowing for use of their data for research purposes, with a copy of the consent forms used being included in the appendix. Employees were informed that no information would allow for identification of individuals, and the present study also respects the right of the case study company to remain anonymous.

All data used in the present study were collected from a UK-based global software provider. The nature of the work is largely office-based, and consequently employees are relatively sedentary in the workplace. To combat potential inactivity and associate ill-health, the company had considered employee health and wellness as a business priority, and had implemented a wellness strategy to improve the health of its employees.

Alongside health checks, a series of health interventions were available to employees such as: a sugar reduction campaign, swimathon, fitness club and medical care promotion, a 'Fit for Life' Challenge, as well as a week dedicated to each of: hydration, eye health, cycling to work and back injury awareness, and then physiotherapy and holistic massage was offered throughout the year. These interventions develop and progress annually, based on employee feedback and participation levels, with some new ideas being brought in, and others adapted to better suit the needs of the company.

There were three health checks provided to the company, taking place in May 2012, May 2013, and autumn 2015. Employees were informed in advance of the health checks via email, and although not compulsory, the company encouraged participation, and to support this the checks were fully subsidised by the company. Employees were required to book 45-minute time slots on a first come first served basis, during work hours. The health checks took place on-site across 3 company locations in England, UK, always within a 2-week period, in a conference room, providing privacy whilst also providing ample room for equipment to be set up. Preceding each health check, employees were required to complete a questionnaire that investigated self-assigned ethnicity, postcode, smoking status, and age, as well as personal medical history, current medical prescriptions and family medical history, specifically heart disease and diabetes. There were also self-reported measures of activity level, smoking status, and alcohol consumption, which were based on UK Government Guidelines in place at T1.

Methodology

Trained Wellness Academy staff who collect data and offer advice on improving health collected health data at T1 and T2. During T3, researchers from the present study were involved in the data collection process under the supervision of Wellness Academy staff. During data collection, employees were blinded to their results, and received individualised feedback on results once data collection was completed.

40μL blood samples were obtained utilising finger stick blood draw, and an Alere Cholestech LDX® Analyzer machine. An employee was classed as 'fasted' if they had not consumed any food or drink (other than a small amount of water) on the day of the health check. In this case an Alere Cholestech LDX® Lipid Profile•GLU

Cassette was used to measure TC, HDL cholesterol, non-HDL cholesterol, triglycerides, LDL cholesterol, TC/HDL ratio, and glucose. However if the employee had consumed anything other than water prior to their appointment on the day of the health checks, which is common for afternoon assessments, an Alere Cholestech LDX® TC•HDL•GLU cassette was used which was able to quantify TC, HDL cholesterol, non-HDL cholesterol, TC/HDL ratio, and glucose. The Alere Cholestech LDX® Analyzer was calibrated at the start of each day to ensure accurate measurements throughout.

Following blood profiling, blood pressure was obtained using an electronic blood pressure cuff. Participants were seated in a chair, with legs uncrossed, and feet flat on the floor, and the left arm in a rested position placed palm up alongside them. If the initial recording exceeded 140/90 mmHg, a second test was conducted 5 minutes later. If this second test also exceeded 140/90, a third test was conducted later in the health check while the participant was lay supine, following their body composition testing.

Height and weight were obtained using an electronic scale with a height stick, with weight recorded to the nearest tenth of a kilogram, and height recorded to the nearest millimetre. For this report, although mean values for weight are reported, BMI values were instead chosen for statistical analysis, as it puts weight in perspective of an individual's height.

Body composition was measured using a Bodystat 1500 device, utilising bioelectrical impedance technology. Electrodes were placed at the distal end of the tibia, as well as over approximately the third phalanges on the dorsal side of the foot, and the distal radioulnar joint and third metacarpal on the dorsal side of the hand. Data was input regarding gender, age, height, weight, and activity level. From this, the Bodystat device could calculate body fat percentage, BMI and lean weight percentage, and also suggest recommended values for each of these as well as for body weight. The final measure of body composition was waist circumference (WC), using a tape measure in line with participant’s navel, which was later calculated as a waist to height ratio. For the purpose of this report, WC has been represented as waist-height ratio, as it puts WC in perspective of an individual’s height, allowing taller individuals to have a larger waist and vice versa. WC mean values and standard deviations are still included in the results.

The questionnaire filled out by the employee prior to the health check contained self-reported measures for smoking status, alcohol consumption, and activity levels. Based on this information, the healthcare professional was able to place participants in one of four activity categories: Active (3+ hours of activity a week), Moderately Active (1.5-3 hours of activity a week), Moderately Inactive (0.5-1.5 hours of activity a week), and Inactive (0-0.5 hours of activity a week). Smoking status was split into: Never smoked, Quit smoking over 5 years ago, Quit smoking within the last 5 years, and Current smoker. The alcohol consumption question provided three options to obtain general drinking habits: I don’t drink, I consume less than 14 units a week (for females) or 21 units a week (for males), I consume over 14 units a week (for females) or 21 units a week (for males).

Following health checks, employee data was input into a QRISK2 calculator (ClinRisk, 2016). The data required for the QRISK2 calculator was: Age, Sex, Ethnicity, Postcode, TC/HDL ratio, SBP, BMI, Smoking status, Diabetes status, Prevalence of Chronic kidney disease, atrial fibrillation, rheumatoid arthritis or on blood pressure treatment, as well as angina or heart attack in a 1st degree relative under 60 years old. The primary measure of this study was employee's QRISK2 relative risk score. The justification for using relative risk rather than absolute risk, was that relative risk gives a better comparison of an individual's risk in the context of their age, sex and ethnic group, whereas absolute QRISK2 score may increase even should all health measures improve. Relative risk was calculated by obtaining a QRISK2 score of a 'healthy person' of the same age, sex and ethnic group, and then dividing the individual's QRISK2 score by the QRISK2 score for the 'healthy person'. The characteristics used in the 'healthy person' score are no adverse clinical indicators, a TC-HDL ratio of 4.0, SBP of 125 mmHg, and a BMI of 25 kg/m2 (ClinRisk, 2016). The mean QRISK2 scores have been reported in the results, however there was no statistical analysis on absolute QRISK2 score.

The final element of the health check is the counselling session which allows the employee to understand more about the data collected, and work with the healthcare professional to set health goals based around their wellness numbers. The goals set are completely individualised, and largely based on ways to reduce their cardiac risk and associated risk factors. Should the healthcare professional identify any cause for concern beyond the scope of the 45-minute health check, employees may be encouraged to allow the healthcare professional to forward results to the employee's GP, to allow for further investigation.

Statistical Analysis

Frequency distributions and tests of normality were used to characterise the data. For normally distributed risk factors, a one-way, repeated-measures ANOVA was run separately for male and female participants. For significant within-subject effects, pairwise comparisons were then used to establish where changes took place. If risk factor data was not normally distributed, then a Log10 transformation was conducted, and frequency distributions and means were investigated again. Should the transformation normalise the data (Shapiro-Wilk > 0.05), then a one-way repeated-measures ANOVA was used on the transformed data set as above. If the Log10 transformation was unable to normalise data, then a non-parametric Friedman test was conducted on the original data set, and should this be significant, a Wilcoxon signed rank test allowed for post hoc analysis. The significance level used was 0.05. Analyses were performed using IBM SPSS Statistics 22.

RESULTS

Health checks were well received, with many employees recognising the benefit of their company placing increased emphasis on health through greater collaboration outside of work as well as within. Encouragingly, participants often attended appointments with questions regarding diet and health, and many remembered their previous year's results and were keen to show improvement. Common questions included "what is the best way to reduce my caffeine intake", and "when is the best time of day to weigh myself". During T3, all bookings were attended promptly. The company CEO has written articles online highlighting the importance of health in the long-term development of the company, specifically allowing for improved employee quality of life alongside increased work capacity resulting in more successful business.

Participant characteristics are outlined in Table 3. Consent was obtained from 54 employees, however 21 of these had no attended all three health checks, so did not meet inclusion criteria. Of the 33 participants included in this study, 91% improved at least one risk factor between T1 and T3. Of a possible 8 risk factors in question, there was a mean improvement in 3.76 ±1.97 (range 0 to 7). 66% improved their QRISK2 relative risk score. With regards to body composition, 15% reduced their BMI, 27% reduced their waist-height ratio, and 21% lowered their body fat percentage. Regarding blood lipids, 54% lowered their TC, 60% increased their HDL, and 73% improved their TC/HDL ratio. 67% lowered their SBP, and 61% lowered their DBP.

Primary Outcomes

Our primary hypothesis was that there would be a reduction in participants' QRISK2 relative risk scores from T1 to T3. Data for male participants underwent a Log10 transformation to normally distribute the data, as initial analysis revealed a non-normal distribution. There was a significant change in relative risk (p=0.023). As shown in figure 1, there was a relatively large reduction in relative risk from 1.62±0.95 at T1 to 1.36±0.68 at T2 although this was not significant (p=0.091), and between T2

		Male	Female
Age (years)		40±9	41±9
		#	%
Gender			
	Male	27	82
	Female	6	18
Do you have a history of heart disease			
	Yes	0	0
	No	33	100
Do you have diabetes			
	Yes	1	3
	No	32	97
Do you have a history of high blood pressure?			
	Yes	3	9
	No	30	91
Ethnicity			
	White	27	82
	Indian	4	12
	Pakistani	0	0
	Bangladeshi	0	0
	Other Asian	0	0
	Black Caribbean	1	3
	Black African	1	3
	Chinese	0	0
	Other	0	0

Table 3. Self-reported participant characteristics at baseline (T1), as recorded on the pre-health check questionnaire

and T3 the mean relative risk increased slightly to 1.41±0.89, although this was again non-significant ($p=1.00$). During this analysis, there was one data set for males removed from the analysis due to changing medication affecting the QRISK2 score. Amongst females, relative risk was 2.28±2.38 at T1, 2.33±3.09 at T2, and 2.42±2.98 at T3, although the changes were not significant ($p=0.585$). Means for absolute QRISK2 scores can be found in Table 4.

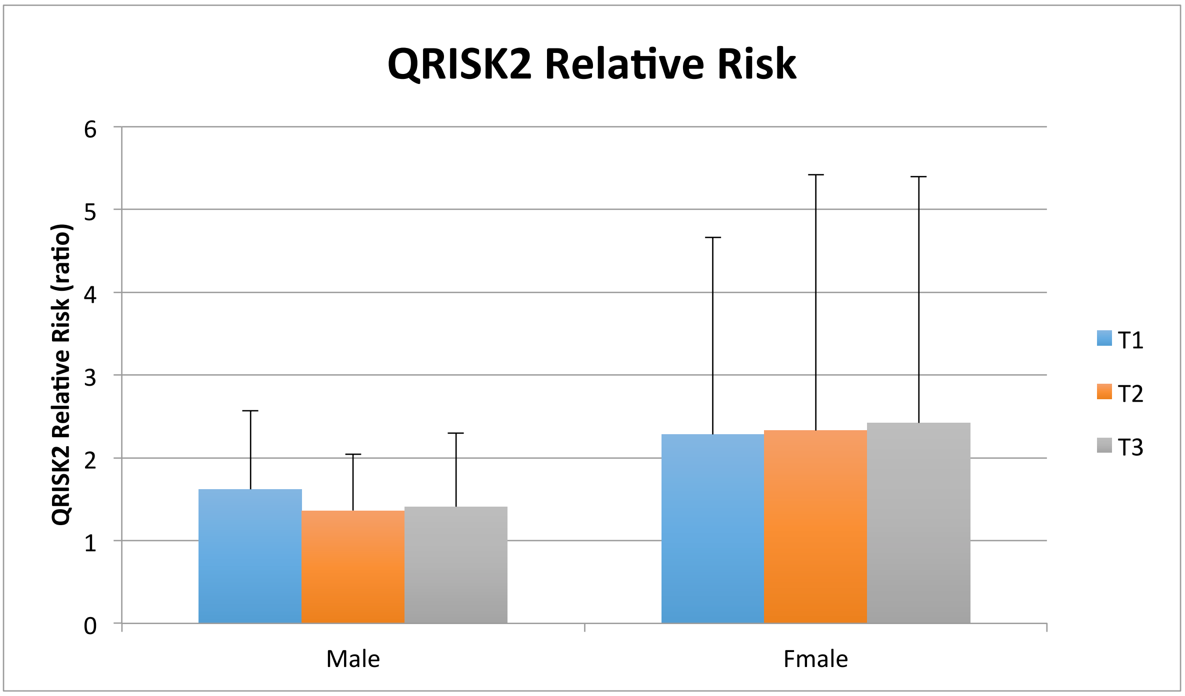


Figure 1. Changes in QRISK2 relative risk for male and female participants between T1 and T3. Once data for male participants underwent a log10 transformation, it was revealed a significant change in relative risk score was seen. There was no significant change in female participant relative risk scores.

Secondary Outcomes

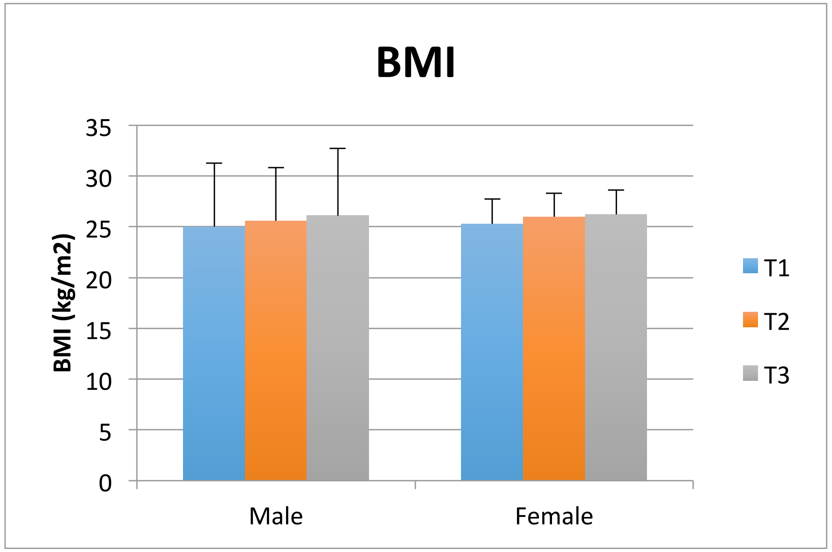
The second hypothesis of the study was that there would be significant improvements in secondary measures of health, which included measures for body composition, blood pressure, and blood lipids. The results have mixed support for this hypothesis, with some of these secondary measures, improving, while others did not significantly change, or even worsened.

As shown in figure 2, male participants showed a significant increase in BMI with time ($p<0.01$), with post hoc analysis revealing a significant increase from 25.0±2.44 kg/m² at T1 to 26.1±2.42 kg/m² at T3 ($p<0.01$). At T2, the mean BMI was 25.6±2.34 kg/m² however the changes between T1 and T2, and T2 to T3 were not significant ($p=0.072$ and $p=0.074$ respectively). For female participants, there was an increase in BMI at all time points from 25.3±6.26 kg/m² at T1, 26.0±5.25 kg/m² at T2 and 26.2±6.62 kg/m² at T3 (figure 2), however these changes were not significant ($p=0.328$). Male employees illustrated non-significant changes in body fat percentage from 20.6±4.02% at T1, 21.2±3.92% at T2 and 21.4±4.64 at T3 ($p=0.576$), and females, although displaying higher body fat percentage followed a similar pattern. Mean body fat percentage for female participants was 30.3±8.98% at T1, 31.5±7.26% at T2 and 31.6±10.29% at T3 ($p=0.240$) (figure 2). There was a significant change in waist-height ratio in females ($p=0.012$). Post hoc analysis revealed that there was a significant increase between T1 and T3 from 0.49±0.09 to 0.53±0.10 ($p=0.042$), although the change from T1 to 0.50±0.09 at T2 was not significant ($p=1.000$), and neither was the change between T2 and T3 ($p=0.085$). Mean values reveal the majority of this change occurred between T2 and T3. For males, waist-height ratio was 0.51±0.05 at T1, 0.51±0.05 at T2 and 0.52±0.05 at T3, which was not significant ($p=0.160$, figure 2). Results for weight and waist circumference did not go through statistical analysis, however mean values are shown in table 3.

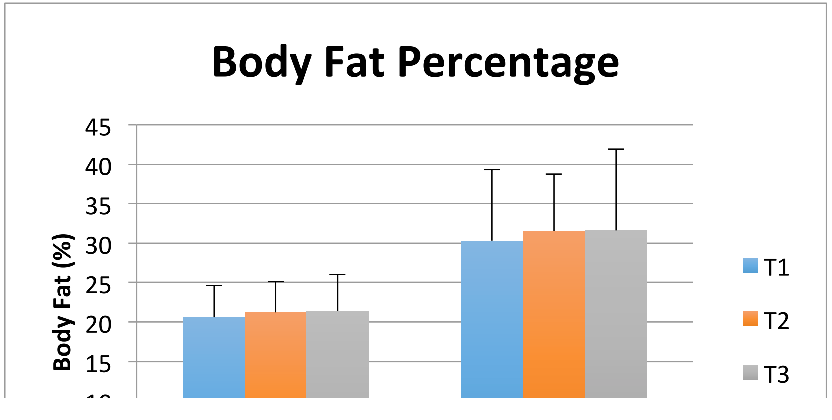
There was a significant reduction in DBP for male participants ($p=0.032$, Figure 3). Post hoc analysis revealed a significant decrease from 84±9.4 mmHg at T1 to 80±7.7 mmHg at T2 ($p=0.020$). There was a small increase in DBP for males from T2 to

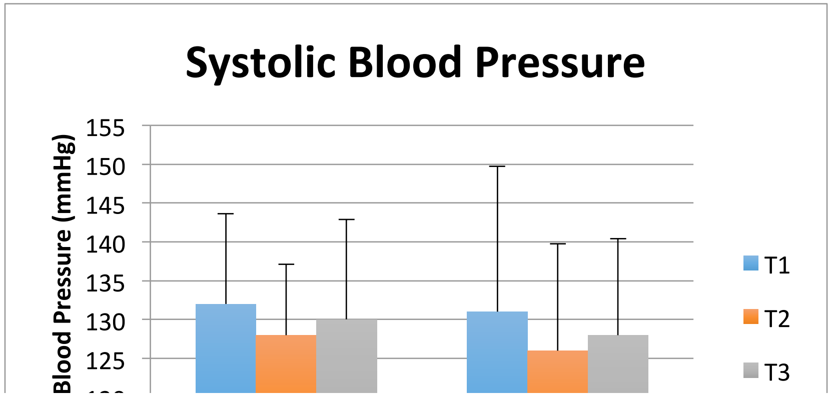
81±9.7 mmHg at T3, although this was not significant (p=1.000). Female participants showed similar patterns, although not significant (p=0.466). DBP initially fell from 84±10.9 mmHg at T1 to 81±12.3 mmHg at T2, however then increased to 83±8.2 mmHg at T3. There were no significant changes in SBP from either females (p=0.681) or males (p=0.093), as shown in Figure 2. For male participants, SBP was 132±11.6 mmHg, 128±9.1 mmHg and 81±9.7 mmHg, and for females 131±18.7 mmHg, 126±13.8 mmHg and 128±12.4 mmHg at T1, T2 and T3 respectively.

There was a significant increase in TC-HDL ratio for male participants (p=0.049, Figure 3). However it is important to note that the statistical test used for this measure was a non-parametric Friedman test, as both the original and Log10 transformed data were not normally distributed. Wilcoxon signed ranks test went on to reveal a significant decrease between the mean ranks of T1 and T3 values (p=0.042). There was non-significant reduction from T1 to T2 (p=0.067), which continued into T3 (p=0.686). For females there was non-significant change in TC-HDL Ratio (p=0.285). Mean TC/HDL ratios for male participants were 5.0±2.38 at T1, 4.4±1.70 and 4.3±1.66 at T3. Mean TC/HDL ratios for female participants were 3.7±1.13 at T1, 3.6±0.74 at T2 and 3.3±0.71 at T3 (figure 3). TC levels did not significantly change for females or males in this study (p=0.665 and p=0.754 respectively, Figure 3). Mean values for males were 5.00±0.90 mmol/L at T1, 5.01±0.94 mmol/L at T2 and 4.86±0.99 mmol/L at T3. For females, mean TC values were 4.96±0.89 mmol/L at T1, 4.77±1.08 mmol/L at T2 and 5.04±0.78 mmol/L at T3. Regarding HDL, analysis revealed no significant change in female participants (p=0.417, Figure 3), with mean values of 1.44±0.42 mmol/L, 1.37±0.42 mmol/L and 1.53±0.15 mmol/L at T3. Male data sets underwent a Log10 transformation to normalise distribution, before undergoing a repeated measures ANOVA. The ANOVA revealed no significant change in male HDL ($p=0.069$). Mean values were 1.11±0.31 mmol/L at T1, 1.23±0.35 mmol/L at T2 and 1.22±0.33 mmol/L at T3. During health checks, participants may have had LDL, triglycerides and blood glucose measured as part of the lipids assessment, however there was substantial missing data in these categories, as many participants attended at least one of their health checks in a fasted state, in which case LDL, TRG and blood glucose levels were either not measured, or have different recommended levels. For this reason, LDL, triglyceride or glucose values were not included in the analysis due to the lack of data sets from 3 consecutive health checks ($n=14$).


BMI
BMI (kg/m2)
35
30
25
20
15
10
5
0
Male
Female
T1
T2
T3


Waist-Height Ratio
Waist-Height Ratio
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Male
Female
T1
T2
T3


Body Fat Percentage
Body Fat (%)
45
40
35
30
25
20
15
T1
T2
T3


Systolic Blood Pressure
Blood Pressure (mmHg)
155
150
145
140
135
130
125
T1
T2
T3

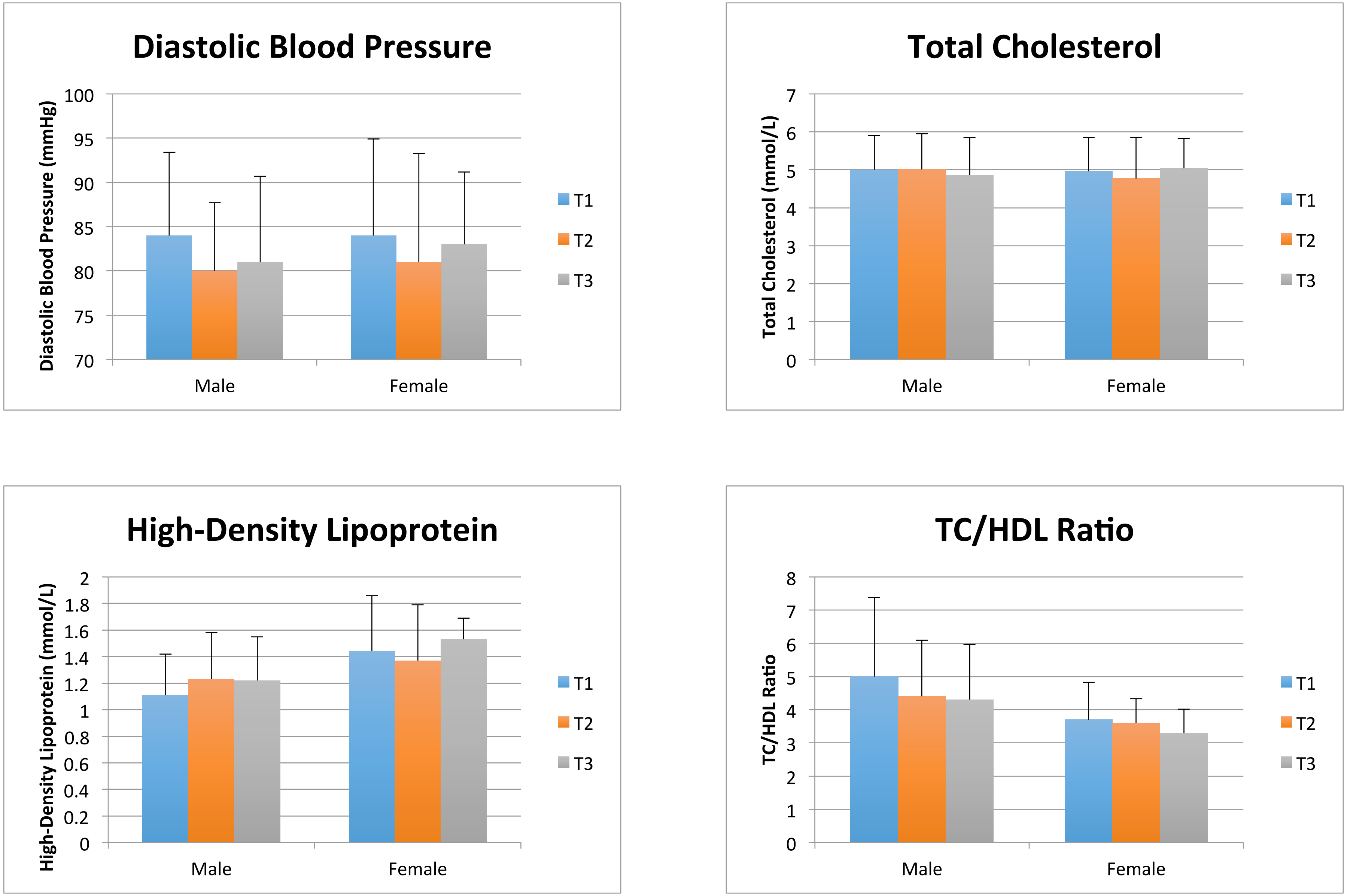


Figure 3 Changes in diastolic blood pressure, total cholesterol, high-density lipoprotein and TC/HDL ratio amongst male and female employees, at all three time points

Measure	Female T1	Female T2	Female T3	Male T1	Male T2	Male T3
Cardiovascular Risk						
QRISK2 (%)	2.78 ±3.10	2.87 ±2.99	3.63 ±3.61	3.93 ±5.86	3.07 ±2.88	4.14 ±3.81
Body Composition						
Weight (kg)	73.00 ±18.25	74.33 ±14.81	74.80 ±18.21	78.56 ±10.09	80.11 ±9.71	81.24 ±10.33
Waist Circumference (cm)	84.9 ±16.46	85.0 ±14.55	90.0 ±17.62	91.0 ±9.24	91.2 ±9.44	92.2 ±10.13

Table 4. Displaying means and standard deviations for measured outcomes which did not undergo statistical analysis as similar measures were used (relative risk rather than QRISK2, BMI rather than weight and waist-height ratio rather than waist circumference)

	Female T1	Female T2	Female T3	Male T1	Male T2	Male T3
Smoking Status						
Never Smoked	4	4	4	17	17	17
Quit >5 years	2	2	2	6	6	6
Quit <5 years	0	0	0	2	3	3
Current Smoker	0	0	0	2	1	1
Alcohol Consumption						
0 units/wk.	0	0	0	2	2	3
<14/21 units/wk.	6	6	5	19	20	20
>14/21 units/wk.	0	0	1	4	3	2
Physical Activity						
Active	2	1	1	9	5	8
Moderately Active	2	1	3	8	10	15
Moderately Inactive	0	1	1	7	7	4
Inactive	2	3	1	3	5	0

Table 5. Showing the number of employees falling into each lifestyle category at each time point. Relatively little change was seen which may be due to a good profile at T1 meaning no change was required

Lifestyle-Related Risk Factors

As shown in table 5, amongst female participants (n=6) there was no ch smoking status for the duration of the study, however encouragingly the current smokers amongst female participants. In males, one participant T1 and T2, however had then started smoking again when T3 health ch conducted, there was also another participant who quit between T2 and

Based on UK Government guidelines in place at T1, guidelines for alcol consumption that should not regularly be exceeded were below 14 units females, and below 21 units a week for males. The only change in fem consumption came between T2 and T3 where one participant increasec units/week to >14 units/week. Encouragingly amongst the male popula were 2 non-drinkers in the study population (n=25) at T1 and T2, and th to 3 at T3. The number of participants exceeding the 21 units/week gui decreased by 1 participant at each time point.

Between T1 and T3, the number of inactive participants decreased as s 5, however interestingly the number of participants classed as active als The majority of participants were part of the ‘moderately active’ categor which is encouraging.

DISCUSSION

This study aimed to test whether a workplace health programme was able to improve the cardiovascular health of a group of employees within the case study company. Using a retrospective, within-subject case study scenario, results from health checks conducted at 3 time points in at a UK-based software company were analysed. The results suggest that in the male population, workplace health programmes are able to evoke a significant change in male QRISK2 relative risk scores, as well as trends showing improvements in blood pressure, HDL and TC-HDL Ratio for female participants, and blood pressure, TC, HDL and TC-HDL ratio for male participants.

Primary Outcome: QRISK2 relative risk

To the best of our knowledge, this is the first study to use the QRISK2 outcomes as a measure during workplace health programme assessment in a working population, which makes it difficult to compare scores with current research in the area. For male participants, the reduction in relative risk between T1 and T2 is encouraging, and despite the small increase between T2 and T3, the relative risk at T3 is still lower that it was during the initial health checks, which supports the use of WHPs. For female participants, there are steady increases in relative risk at both T2 and T3 however this may be partly down to a small sample size, which is a weakness of the present study.

With female participants displaying lower absolute QRISK2 scores than male participants, one may assume that females are relatively healthier than the male participants, however when looking at relative risk, female participants in this study were actually at a higher relative risk compare, than male participants. This justifies our inclusion of both absolute QRISK2 scores, and relative risk scores, despite analysis only being conducted on relative risk scores.

A 2014 study (Gray et al., 2014) looked at characteristics of a group of male steel workers in South Wales, UK, and at baseline the average QRISK2 score was 5.8±2.0%, which is slightly higher than the male participants' baseline scores observed in the present study, although the average age of participants in aforementioned study was 48±3 years, and the average BMI was 28.9±4.3kg/m², which are both relatively high compared to values found from this research of 40±9 years, and 25.0±2.3kg/m² respectively which may explain some of the difference. Further research using QRISK2 score in the workplace is required to allow for increased validity in comparison with other reported risk scores.

There are several studies which have looked at the effects of a WHP on various other cardiac risk scores, and generally the risk does improves as a result of the intervention, which justified the primary hypothesis of the current study, however as different risk equations integrate different risk factors, it possible that an individual could improve their risk score using one calculation, however experience no change using an alternative risk calculation. Racette et al. (2009) used the Framingham equation to quantify cardiac risk and found that the number of employees classed as 'low risk', defined having less than two risk factors outside the recommended range, significantly increased during the 1-year intervention. Intervention components included on-site WeightWatchers® group meetings, on-site exercise programmes, lunchtime seminars each month, weekly visits from a dietician, exercise specialist and team competitions. It is noteworthy however that 89% of the participants in aforementioned study were female, whereas the present study was comprised of

82% males. Makrides et al. (2008) also used Framingham as the measure of cardiovascular risk, and found that the intervention group, who received a 12-week programme including exercise prescription, group education on coronary risk factors, stress reduction and nutrition, and smoking cessation, saw a significantly greater reduction in cardiac risk than the control group at both 3 months (0.52 difference) and 6 months (0.74 difference). The intervention used in that study was an intense 12-week programme, and what makes comparison with the present study difficult is that changes were only tracked for 24 weeks, so there is no evidence to identify whether changes were maintained over the next 6 months. With the present study obtaining health information at 12-month intervals at minimum, it means that some changes in risk factors could potentially not be identified. A study by Glasgow et al. (1995) found little change in Framingham risk score, which may be due to the intervention only using tobacco cessation and dietary components, with notably a lack of an activity-based intervention. A study by the same group two years later (Glasgow et al., 1997) also used Framingham, and again found no change in Framingham score. This study did not measure blood pressure, so to calculate Framingham scores, age and gender-specific SBP scores were used, which is a weakness of the study as the intervention may have improved SBP, and consequently lowered participants' Framingham scores. The importance of an exercise intervention is a significant one, and the present study may have illustrated more convincing results if the exercise component of the intervention was more pronounced.

More recent, short-term interventions have displayed favourable outcomes on cardiovascular risk scores. Within 12-weeks internet –based interventions combined with weekly education showed non-significant improvements in Framingham risk score (Radler et al., 2015). Despite the intervention focusing on nutrition, what made the intervention arguably more successful than that of Glasgow et al. (1995) was ongoing communication between participants and a registered dietician via email and telephone, which allowed any questions to be answered. As with aforementioned study, the study design used in the present research also had no control group, which makes it difficult to attribute changes to intervention alone. Canadian research over 3 months had significant improvements in Framingham, with relatively little structure to their intervention (Levesque et al., 2015). The incentives for groups who achieved the most impressive health improvements however could be the reason behind significant changes in such a short time. These studies however did not include long-term follow-ups, so there is no information about whether these improvements were maintained.

Freak-Poli et al. (2011) used the Absolute CVD risk assessment tool and found no change in cardiovascular risk from baseline to the 4-month follow-up, despite seeing significant improvements in many of the contributing risk factors. What this suggests is that although cardiovascular risk is a useful tool, it should not be used in isolation, and that even if cardiovascular risk doesn't change as a result of an intervention, it doesn't mean the intervention hasn't improved health. The primary hypothesis of the present study was that QRISK2 scores would be lower in the third health check that in the first, and although this only proved true for male participants, it warrants the inclusion of associated risk factors alongside tracking general cardiovascular health to investigate in more detail what risk factors changed, and what may be responsible for a change or no change in overall cardiovascular risk. Many studies choose to report risk factors without an overall measure of cardiovascular risk (Thorndike et al., 2011, Nilsson et al., 2001, Groeneveld et al., 2011, Eng et al., 2016, Robroek et al., 2011), which allows for greater transparency of changes than reporting cardiovascular risk alone.

Cardiovascular risk scores themselves have been called into question regarding their validity (Liew et al., 2013), however even if the absolute QRISK2 score is not perfectly accurate, a within-subject design can track changes over time, which can indicate whether one's QRISK2 score is increasing or not. There is literature supporting QRISK2 as a more valid measure of cardiovascular risk for the UK population than others, including the Framingham, although there are still a large proportion of QRISK results which show 'false positive' outcomes (Marsh, 2011). There is also some doubt amongst UK GPs as to what cardiovascular risk scores should be used in what situation, with some even preferring to use CVD risk scores as an education tools rather than as a clinical tool (Liew et al., 2013). QRISK2 scores are a way of quantifying risk scores to help illustrate what potential lifestyle changes can do to one's overall cardiovascular risk score, so for this reason it definitely has a place to be used within a healthcare setting. For this reason also, it is important for research to not focus purely on a cardiovascular risk score, and to report the secondary measures involved simultaneously. An interesting development in cardiovascular risk scores is the derivation of a lifetime risk score, which may identify those who are young, so have their high cardiovascular risk masked by their age in a 10-year risk calculation (Brotons et al., 2016). This may go on to be an important development and help in the accuracy of cardiovascular risk score algorithms. The QRESEARCH group have published a lifetime risk calculator online, and it has formed the basis of *Heart Age* tool, commonly used by GPs in practices across the UK.

Body Composition and Obesity

Our results showed a significant increase in male BMI between T1 and T3, which goes against the secondary hypothesis of this study. BMI does not distinguish between muscle and fat, although a significant increase in BMI paired with no significant change in body fat percentage, as we have observed, suggests that at least some of the BMI increase is a result of increasing body fat. Research looking at the effects of WHPs on body composition have shown mixed results. A 2011 meta-analysis (Thorndike et al., 2011) investigating WHPs and employee weight concluded that generally interventions report a weight reduction of around 3 pounds (1.4kg) is observed at around 6-12 months of an intervention, and in more long-term studies, weight loss of around 7lbs (3.2kgs), are achievable of a 5-year period. These results are very different to the weight change seen in the current study, which shows a weight gain over the 3-year period. The analysis of the 2011 meta-analysis reveals however that there was large heterogeneity in interventions, making comparison difficult. In support of the present study however, it was reported that some studies may have recorded weight as an outcome, however not included it in the analysis due to non-significant data, and thus those studies were omitted from the meta-analysis, potentially skewing results to favour weight-loss. This may also go some way to explaining why the results of the current study are so different to conclusions from the 2011 meta-analysis.

Looking specifically at BMI, research has shown decreases of 0.7kg/m² after 12 months (Nilsson et al., 2001). The mean baseline BMI value was 28.8kg/m² which was considerably higher than baseline BMI values of 25.25kg/m² for females and 25.04kg/m² for males recorded in the present study. Notably that research did focus on a high-risk population, defined as having a cardiac risk score of 8 or above on their scale ranging 1-20, based on sum of risk scores from individual risk factors. The notion that significant reductions in BMI may only be observed in high-risk groups is supported elsewhere in literature (Groeneveld et al., 2011), which states that among mixed populations, there was no evidence for an effect of WHPs on body weight and consequently BMI, however there was strong evidence for significant changes among populations classed as high-risk at baseline. Considering baseline BMI scores observed in the current study, the results may be explained by not having a relatively high BMI at baseline, thus there was a lack of motivation to change. A 2000 study (Nisbeth et al., 2000) found that in participants who had 'no need to change', there was actually a non-significant trend of weight increasing by 0.6kg in the 12-months study duration which supports this reasoning. In the present study, the weight increases observed were slightly higher than this, warranting further investigation, however it can go some way to explaining the increase in weight, and consequently BMI observed in this study. In 2012, a report by the Health and Safety Executive for the UK government reported the average interviewer-measured BMI for the UK population sample was 27.3kg/m² for men, and 27.0kg/m² for women (Moody, 2012) putting the present study population well below the average UK levels, suggesting a lack of perceived need to change.

As expected, females had higher body fat scores than males which is in agreement with current literature (Gallagher et al., 2000). Few studies report changes in body fat percentage, although with increases in portable technology, it is becoming more time efficient to analyse body fat so an increase in reporting of body fat percentage in the coming years may be expected. Milani and Lavie (2009), saw a reduction in body fat percentage from 26.7% at baseline to 24.4% post-6 month intervention, although this wasn't split into male and female, which makes it hard to compare to baseline figures. The intervention included weekly classes held on-site, addressing weight control and nutrition, which could have contributed to the body fat reduction, whereas for the intervention used in the present study, this sort of weekly intervention was not in place. Having consistent (weekly) communications about a popular topics such as weight control and nutrition may be of benefit, however where a company is split between multiple sites, it makes logistics difficult which is why the case study company from this research does not have such measures in place. The validity of bioelectrical impedance body fat percentage measurements has been called into question previously (Loenneke et al., 2013, De Lorenzo et al., 2000). Hydration level can play a role in recordings, and during health checks hydration level on the day isn't assessed, so results could even vary within a few hours should a participant consume large quantities of water between tests. An alternative is skinfold measurement, which has been reported as more accurate in the literature, provided that the person administering the measurements in well-trained, and ideally the same person each time, to reduce variability in positioning (Loenneke et al., 2013). It has been suggested that there are differences between all of skinfold measurements, bioelectrical impedance, and DEXA scans, so they should not be used interchangeably, and one method should be repeatedly used (De Lorenzo et al., 2000). With this in mind, for the purpose of the health checks, bioelectrical impedance may continue to be the best method to use.

Our third measure of body composition was waist:height ratio, which significantly increased between T1 and T3 for females, with mean female values at T3 exceeding the mean value for the male participants. In males there was no significant change in waist-height ratio. In the existing literature, there is again mixed results when it comes to waist measurements, with a 2010 meta-analysis (Groeneveld et al., 2011) concluding that of the two high-quality studies included in the analysis, neither showed any significant effect on hip circumference. Nilsson et al. (2001) measured waist:hip ratio, and reported no significant changes, although they didn't report differences between males and females, however a 2009 study (Racette et al., 2009) did measure males and females on gender appropriate WC, and also found no significant change, supporting results observed for the male participants. One study of note (Atlantis et al., 2006) found significant improvements in WC as a consequence of an intervention with a high-exercise component. The intervention group partook 20 minutes of moderate-to-high intensity exercise at least 3 times a week, and then also whole body resistance-training for 30 minutes, at least 3 days a week.   All exercise sessions were supervised to ensure adherence, which may not be practical for many workplace, and many participants exceeded these recommended levels. As a results of the intervention, the mean WC significantly fell from 86.3cm at baseline, to 82.1cm post-intervention. The main outcome in this study was improved physical fitness, which did also significantly increase as a consequence of the 24-week intervention. Interestingly, there was no significant change in BMI was found, reinforcing the need to have multiple measures of body composition. Despite it being reported that much of the mean body composition changes were concentrated in a single subject, results from this study warrant obtaining more details regarding activity during health checks. Rather than simply categorising employees into one of four categories, it would be more appropriate to instead detail exercise type, intensity and duration, which may be crucial to inducing change in WC. As mentioned, the exercise component of the present study was not tracked, and although employees were encouraged to exercise more, a more structure exercise programme may be crucial for changes in waist circumference.

It is noteworthy that there is evidence of improvements in cardiovascular risk factors, even if not accompanied by reductions in body weight (Racette et al., 2009). It further warrants the need for health checks as a way of quantifying health risks that aren't as obvious as body composition. An employee may lose motivation if they are unable to see physical changes to their body as a result of changing lifestyle factors, however their health could be dramatically improving, and it is important to be able to quantify this in order to keep employee motivation high during WHPs. WHPs may also focus on stemming age-related weight gain, which has been reported as being just as important as actually reducing weight, when it comes to looking at a nationwide picture of body composition (Goetzel et al., 2010). Research into age-related weight gain has shown that amongst a 14,500 sample of males and females, aged 45 to 64, of white and African American descent, there was an increase in weight (Juhaeri et al., 2003). Worryingly the study concluded that individuals born later, actually gained more weight as they aged, so actions that can help to slow, or reduce this age-related weight gain will be of vital importance when it comes to improving the health of the nation. Interventions that prevent weight gain, such as research by Atlantis et al (Atlantis et al., 2006), which had a high exercise prescription intervention, should be praised, as well as those which can actually aid weight-loss. Without a control group, it is difficult to investigate whether the intervention were able to slow down age-related weight gain compared to participants who did not take part in an intervention. Future studies, where possible, should include a comparison group.

Blood Pressure

Results in the present study show significant improvements for male DBP between T1 and T2, with a slight 'rebound' between T2 and T3. Similar, non-significant, patterns are replicated for male SBP, as well as both SBP and DBP in females. Previous research suggests interventions are able to evoke a significant reduction in blood pressure. Mean baseline recordings of SBP in the present study (131 mmHg for females, and 132 mmHg for males) were slightly higher than those reported in the literature. Ogunmoroti et al. (2016) found a significant increase in the number of employees who fell within the ideal blood pressure category over a 4-year period, with mean SBP values of 126, 124, 123 and 121 mmHg for years 1 to 4 respectively. Other studies shorter in duration have reported SBP significantly fall from 127 mmHg to 121 mmHg, and 121 mmHg to 116 mmHg in 12 months (Racette et al., 2009), and 124 mmHg to 122 mmHg (p=0.08) (Milani and Lavie, 2009) within 6 months. Comparing this to results of the present study, even though similar mean value reductions were observed between T1 and T2, the lack of significance was likely due to a high standard deviation around these means, with larger sample sizes, particularly with female participants being favourable. Most people in the UK have SBP values between 120 and 140 mmHg so baseline values recorded fall within this range (Blood Pressure Association, 2008), so again there was less requirement for improvement within the sample. Although the results between T1 and T2 are encouraging, the slight rise between T2 and T3 warrants further investigation. Research from Sweden started with similar baseline values to those of the present study, and saw a non-significant reduction in SBP within 12 months, and a small increase at 18 months, despite the intervention continuing until the 18 month follow-up (Nilsson et al., 2001). As much of the research in the literature focuses on relative short-term effects of WHPs on risk factors, it makes it difficult to find a comparable study to see if a slight 'rebound' is normal after a 12-month follow-up.

The literature regarding DBP is relatively conclusive, in favour of interventions aiding a significant decrease. This agrees with the results observed for male participants between T1 and T2, although for both males and females, like with SBP, there is a slight 'rebound' between T2 and T3, although from T1 to T3 the mean values still show that there is a non-significant improvement. DBP from the present study is slightly higher than values recorded in the literature, although the reductions are similar. Within 6 months, Milani and Lavie (2009) saw a reduction from 81 mmHg to 79 mmHg ($p=0.01$), although data beyond this follow-up was not collected. Large reductions were observed in a 2009 study (Racette et al., 2009) where one worksite reduced DBP from 84 mmHg to 77 mmHg within 12 months, however the average BMI of study participants was 32.9kgm^2, which may have provided relatively more room for improvement than in the study population used in the present research. Research into high-risk participants has also shown reductions of 5.4 mmHg within 12 months, so amongst high-risk participants, such large reductions within a year are not rare. More modest improvements have been reported in research using mixed participants (Goetzel et al., 2010, Ogunmoroti et al., 2016) where reductions of around 1 mmHg a year are reported.

Long-term interventions have also reported favourable improvements in blood pressure, with low-intensity interventions (Eng et al., 2016). This is one of the key advantages to utilising the workplace as a healthcare location, as it provides access to a group over a sustained period of time. The intervention in the aforementioned study used health checks and education programmes and saw significant improvements within hypertensive and individuals at risk of hypertension. Their healthy participants saw no change in either SBP or DBP which again supports the results observed in the current study, and justifies future UK-based research to investigate a larger participant group, with a subgroup of high-risk individuals.

Links between blood pressure and stress are well-reported (Landsbergis et al., 2013), and changes in business approach may have influenced blood pressure levels of employees measured in this study. During the course of this study, the case study company underwent large changes in the responsibility structure, and adopted an ‘agile’ approach, with lower managerial levels given increased responsibility. Without a control group it is hard to quantify the magnitude of this influence, however there is likely to be some effect.

Blood Lipids

The results show a decrease amongst female participants for TC between T1 and T2, and then an increase exceeding baseline levels between T2 and T3, although all these changes were non-significant. For males, TC levels stayed relatively constant from T1 to T2, however between T2 and T3 there was a small drop, although these changes were also not significant. The literature produces mixed results on TC changes, with health interventions evoking a mixture of TC decreases, or no significant increases. A 2002 study in from Scotland (Leslie et al., 2002) saw both diet interventions used, produce significant reductions in TC from 5.4 mmol/L to 5.2 mmol/L in the energy deficit group, and 5.7 mmol/L to 5.36 mmol/L in the 'generalised low-calorie diet' group. Although not specifically recruiting from a high-risk population, the baseline levels of TC were considerably higher than those recorded in the current study population, which may reflect the significant improvements reported for their participants. This is supported in other research (Braeckman et al., 1999) where there was no significant change in TC for the intervention group, agreeing with results observed in the present study, however when focusing on a subset of employees who had baseline cholesterol levels greater than 6.5 mmol/L, there was a significant improvement. One study with similar baseline values to those in the present study (Milani and Lavie, 2009), saw a non-significant reduction from 190 mg/dL (4.91 mmol/L) to 184 mg/dL (4.76 mmol/L), using a similar intervention, with the addition of weekly education classes held on-site, this supports results observed in this study. Research comparing intervention intensities (Goetzel et al., 2010) found that only the high-intensity intervention group had a significant reduction in TC with the mean reducing from 195.2 mg/dL (5.05 mmol/L) to 191.0 mg/dL (4.94 mmol/L). Both the moderate-intensity intervention, and the control group experienced non-significant increases in TC, which argues the case that maybe the current intervention wasn't intense enough to evoke a significant decrease in TC. The only dietary intervention offered by the present case study company was a sugar reduction campaign, which may not have been appropriate to reduce TC levels. Comparing the averages from the aforementioned study, the present study mean values from T1 to T3 show a greater improvement in TC, so significance may be somewhat limited by the relatively small sample size. The differences between the moderate and high-intensity interventions were integrating health objectives into management goals, providing management training on health-related topics, presenting feedback on interventions and targets, and providing wellbeing ambassadors with additional training. The central theme of these additions compared to the moderate-intensity intervention was passing responsibility from wellbeing being a head office initiative, to being organised and run by colleagues on-site, which proved effective.

Our results show a non-significant increase in HDL, with females experiencing greater increase between T1 and T2 compared to T2 to T3, while males experienced greater change between T2 and T3 compared to T1 to T2. The literature shows either significant increases or non-significant increasing trends. Research has shown that HDL levels can significantly increase in groups who only received health checks, without any other aspect of an interventions (Racette et al., 2009), which supports the theory that knowledge of cholesterol levels alone is enough to encourage an increase in HDL, which is a strength of our study design. Nilsson et al. (2001) experienced similar patterns to those in the present study, with a 0.1 mmol/L increase in the first 12 months, however levels then fell before the 18-month measurements, which is similar to results observed in male participants in the present study, where very little changed between T2 and T3. This timescale of change warrants further investigation to examine the ideal length of time between measurements. Another area of interest is that during the first 12 months of the current intervention, the female HDL mean levels fell slightly, and although not significant, there is research that has also found a decrease in HDL as a result of an intense-12 week intervention (Rouseff et al., 2016). The population used in this sample had a large female contingent (78%), and saw HDL levels drop from 48.3 mg/dL (1.24 mmol/L) to 47.1 mg/dL (1.22 mmol/L). Despite the change being relatively small, it proved highly significant (p=0.008). It is important to remember that although results may not be statistically significant, studies have shown that just a 1% increase in HDL levels can create a 3-5% reduction in cardiovascular risk over a 3-5 year follow-up period (Gordon et al., 1989). It is also noteworthy that current NHS guidelines suggest a healthy HDL level should be above 1 mmol/L, so for both males and females in the present study, the mean values meet this requirement and thus generally can be considered in good health when it comes to HDL.

TC-HDL Ratio significantly decreased when a non-parametric Friedman test was run on the male data set. Female data however did not significantly change. Literature supports these findings, with reductions of 13-15% reported (Milani and Lavie, 2009, Racette et al., 2009). As with HDL, Racette et al. (2009) found a significant decrease even in the group that received a health check and no other intervention. The decrease in mean male TC-HDL ratio between T1 and T2 was around 12.5%, so fits closely with other published results, and the rate of improvement slows can be due to value being within normal levels. Female data being non-significant can be attributed to the small sample size (n=6).

Lifestyle Risk Factors

Smoking, alcohol consumption, and physical activity are usually directly targeted by WHP interventions, rather than being a measurable risk factor change. Generally the distribution of staff within each risk factor category showed little change (Table 5), however this can be down to a relatively healthy profile of employees within these risk factors (particularly smoking and alcohol consumption) at baseline.

Smoking

In the duration of this study the was one smoker who quit between T1 and T2 however they then started smoking again before T3, during which time one other participant had quit smoking. In 2011, those working in a professional occupation had a smoking level of 10%, which is relatively lower than the 31% recorded for those working in routine occupation category (Office for National Statistics 2013). The levels recorded in the present study are representative of the professional workers category, with 2 of the 33-person sample smoking at baseline. Comparing this to the WHP literature is difficult because the levels of smoking vary substantially from country to country. A study from Canada (Makrides et al., 2008) found that the intervention group reduced smoking by more than 34 cigarettes a week more than the control group, however in Canada, and estimated 25% of the population aged over 18 are smokers, so there is greater scope for improvement compared to the current study sample of 33 participants where there were only 2 smokers at baseline. High smoking rates were also recorded in a 2001 Scandinavian study (Nilsson et al., 2001) which focused on individuals at high cardiovascular risk. At baseline smoking levels were 65%, which reduced to 37% after 12 months and then slightly rose again to 40% after 18 months. The increase from 12 to 18 months is similar to results observed in the present study, with one participant who re-started smoking between T2 and T3, and reinforces the fact that support is still required once an individual has made the lifestyle change in order to see the change through to a maintenance stage, as illustrated by the transtheoretical model of health behaviour change (Prochaska and Velicer, 1997). This high smoking level is supported by a Danish study (Nisbeth et al., 2000) which found that 16 of the 56 employees in their intervention group were smokers, however only 3 committed themselves to quit smoking during the intervention, and at 5 month data collection, only one had managed to quit. Considering the relatively small smoking population in the current study, it would be easy to forget about including a smoking cessation element into the wellbeing intervention, however smoking is one of the major risk factors for cardiovascular risk (Makrides et al., 2008, Nisbeth et al., 2000), and the WHP in this study could benefit from the addition of a smoking cessation intervention.

Alcohol Consumption

Our study found that very few (n=4) participants were exceeding alcohol consumption guidelines at T1, and this reduced to 3 participants at T3. As the present study population had a relatively low number of participants exceeding guidelines, it is likely that the small decrease is due to most of the participants not requiring a change. A 2015 survey revealed that in the UK, 27% of individuals in managerial and professional occupations had exceeded 8 units for men, and 6 units for women in their heaviest drinking day in the previous 7 days (Health & Social Care Information Centre, 2014). Due to the different data collection methods it is hard to compare this with the current study, however suggests the pre-health check questionnaire could simply add another question looking at the distribution of alcohol consumption over a standard week. In this study, the company did not include an alcohol awareness campaign, however this may be beneficial to educate those who are at high risk. This study is somewhat limited by data collection methods, as alcohol consumption is self-reported, and also falls into just one of three categories (0 units a week, <14/21 units a week, >14/21 units a week). While this method is simple, and is capable of identifying those at the greatest risk, it makes it difficult to track whether alcohol consumption is actually increasing or decreasing over the 3-year study. A UK study (Khadjesari et al., 2015) investigating alcohol intake in employees found that online health screenings were not particularly effective at attracting individuals at high-risk, however a low-intensity alcohol awareness programmes as part of a broader WHP has shown to be effective in reducing alcohol consumption in an Australian population (Richmond et al., 2000). Based on this information, awareness sessions accessible for all employees and the addition of alcohol counselling during one-on-one health checks may be most appropriate for evoking change amongst employees exceeding consumption guidelines.

Activity Level

Modest changes were observed in activity level during the study, particularly in the number of males moving from the 'moderately inactive' and 'inactive' categories to the 'moderately active' category, however a workplace may benefit from more specific physical activity interventions. An intervention such as the one utilised in a study by Atlantis et al. (2006), containing a mixture of moderate-to-high intensity exercise and resistance training, may help to improve body composition measures, specifically WC, which will in turn reduce the central fat storage that presents such a risk to CVD. Nisbeth et al. (2000) gave employees an individualised, 12-month exercise plan incorporating exercises and activities they enjoyed, and found that adherence levels were high. Of the 29 who were willing to participate, 22 (76%) continued with the plan for the study duration. The dietary intervention in comparison however, proved to have considerably lower adherence levels (18%), likely due to family not agreeing with the need to change, which makes cooking difficult, whereas exercise can be less likely to require family changes, and one can take individual responsibility for it. Encouragingly, for those who took up the exercise plans, there were favourable changes in other CVD risk factors (Nisbeth et al., 2000). Recent UK-based research suggests employees should be made more aware of the dangers of sedentary work, and should spend at least 2 hours a day either stood, or engaged in light activity such as walking, during the working day (Buckley et al., 2015). Using multiple strategies to engage with all employees in the target population is critical to increasing physical activity adherence, as is a supportive environment in the workplace (Pronk and Kottke, 2009).

These self-reported measures, also including date of birth, ethnicity, postcode, any current medication and personal and family medical history, are a potential weakness of the study design. Although shortcomings of previous research have been overcome by obtaining measurements of height and weight during health checks rather than self-reporting these values (Mache et al., 2015), as it has been suggested participants are more likely to report favourable outcomes for self-reported measures in subsequent health checks, despite a lack of behavioural change (Soler et al., 2010). The study found no discrepancy in D.O.B. information obtained at each health check, however some inaccurate recordings may arise from data such as smoking status, or medical history, either on purpose, or by accident.

An additional inclusion to the health check could be a measure of nutrition, and general dietary habits, as Framingham risk score is inversely correlated with nutritional behaviour (Huang et al., 2014). It is thus sensible to assume that there are existing links between QRISK2 and nutritional habits too. Only 30% of adults in the UK meet the 5-a-day guidelines for fruit and vegetables (Townsend et al., 2014), and saturated fat intake is recommended to account for less than 11% of dietary calories. Despite this, recent figures show the mean saturated fat intake in adults is around 12.8% of calorie intake (Heart UK, 2010). Despite the guidelines for salt intake being 6g per day, in 2011 men consumed on average 9.3g, and women 6.8g (Townsend et al., 2014). Sodium consumption is a large contributor to increased blood pressure, thus increasing overall risk of developing CVD.

Nutritional data collection could be in the form of a food diary for the week leading up to the health check, although again this would require self-reported data, which is not preferable (Cahalin et al., 2015). Equipping the health care professional with more information about an employee’s diet can lead to tailored advice and information about how it can be improved, rather than providing generic advice about what factors could be increasing TC and LDL levels in the blood. It will also give the healthcare professional the opportunity to take a look at a written record of an employee’s diet rather than asking them to recall their diet during health checks, where important information may be forgotten about.

A similar addition to the health checks could include a self-reported stress tool to quantify employee stress levels. Stress reduction interventions have been successfully used in previous research (McCraty et al., 2003, Makrides et al., 2008), and would allow for analysis investigating links between stress and health, which could then be linked to different managerial levels. Similar to the food diary, this could be completed online, in the fortnight prior to the on-site health checks. The benefits extend to providing help to users as it could provide more regular feedback for individuals while also being relatively low-cost to maintain. It would rely on regular data input from employees however it could be used as a platform for wellness vendors to confidentially monitor individual’s progress and also allow employees to access helpful materials and contact wellness providers. This tool could track simple health measures such as weight, BMI and even blood pressure if employees had access to a measuring device in their workplace. These tracking tools for use between health checks, support the notion by William Haskell that the new medicine isn't what happens during health checks, but rather what the individual does to improve health between the checks. Even the best intervention is ineffective without participation and engagement with the relevant individuals, so any way of increasing adherence to the programme is of tremendous benefit.

The existing literature displays large heterogeneity, mainly in the interventions in place, but also consequently in the results, and currently there is no 'best practice' considered in the industry. It calls for greater transparency in WHPs in order to allow meta-analysis to be carried out to look for patterns in intervention characteristics and their effectiveness. Ideally literature should reach the point where each country has a database of WHP research that have shown to be effective in a population representative of the country's demographics and reflect the resources available in an area. Even research conducted as geographically close as Scotland (Leslie et al., 2002) showed vast differences from the present study's participant's characteristics at baseline, and thus the intervention required is completely different. With a more substantial wellness database, information regarding particular industries (office workers, education workers etc.) could also be developed, allowing for best practice patterns to be drawn upon and applied in the workplace.

Retrospective Research

Whilst retrospective data was necessary in order to have enough data to use during this research, there are several limitations to the study design. Arguably the most significant weakness of the study design was a lack of control group, which is often reported in workplace health literature (Task Force on Community Preventive Services, 2010, Osilla et al., 2012, Dornan, 2010). Consequently, the lack of a control group in a pretest-posttest design means that there is a causality limitation present, and changes observed in risk factors cannot be attributed to the wellness programme alone. One difficulty is that the health checks themselves, as well as being used for data collection, can also be considered a form of wellness intervention as they educate employees with health information that they can then utilise and apply to improve health, so it is difficult to isolate collecting data without providing health education to employees. This is again a common limitation reported in workplace health literature (Radler et al., 2015, Freak-Poli et al., 2011), with some studies comparing the effects of a ‘health check and intervention’ group, with a ‘health check alone’ group (Racette et al., 2009).

With a control group in place, it would allow us to run an analysis on the changes in risk factors between an intervention and a control group, to see if an intervention is able to slow the rate of worsening compared to a control group. The conclusions were somewhat limited as the changes in risk factors cannot be solely attributed to the effect of the intervention, however a control group would allow for this analysis. A practical recommendation about a control group is to use a workforce on a different site, as this design will limit any interference that may be experienced should one worksite be split into an intervention, and a control group. However then this allows for less consistency in workplace culture and behaviours.

Participants in the present study were not a randomised selection of employees from the company, as the health check, and therefore study participation, were completely voluntary. Employees who partook may be more likely to have an interest in addressing their health, and thus skewing the results, as healthy employees may be less likely to attend, as they did not require any health information. This is however a common limitation of WHP literature, as employers can incentivise participation, however cannot make WHP participation compulsory.

Retrospective data collection meant data collection intervals were inconsistent in the present study. While results suggest there may a benefit to testing employees at 12-month intervals, it is not valid to ignore the possibility that some of the results were as a consequence of being the first year of a wellness intervention, rather than the length between testing sessions being the influencing factor.

Should health checks be conducted annually?

Looking at patterns in the data, there are several patterns emerging which may favour annual health checks rather than bi-annual checks. This is best illustrated in both females and males when looking at changes in male and female SBP, where there in an initial improvement between T1 and T2, however there is then a small ‘rebound’ between T2 and T3. There were similar observations for female DBP and TC, as well as relative risk, DBP and HDL males. Other patterns that bring us to similar conclusions are for waist:height ratio, where between T1 and T2, participants are able to maintain similar levels, however between T2 and T3 there is a relatively large increase. Also for male TC/HDL ratio, there is a vast improvement between T1 and T2, and then the rate of improvement slows down between T2 and T3. If there is a 24-month interval between health checks, then small lifestyle changes made by individuals may be detrimental to their health, and these are not being identified until they have had up to 24 months to cause an effect on cardiovascular risk factors. Particularly with the nature of much work becoming increasingly sedentary, and the associated decline in energy expenditure (Buckley et al., 2015), office-based employees as used in the present study are at high-risk of deteriorating health. With annual health checks however, any changes in health are identified relatively early, and can be corrected accordingly. This is particularly true for risk factors such as blood lipids and blood pressure, which require additional equipment to quantify, as opposed to body composition, which can be roughly assessed by the naked eye.

With the lack of a control group in the current study design, it is difficult to attribute these patterns to the duration between health checks being the independent variable, or whether it was due to the interval between T1 and T2 being the inaugural year of the company's wellness programme. Research that has looked at the same company's annual health profile for the 24-months following health programme initiation has found that between 12-month and 24-month measurements, the improvements in SBP, and TC were actually greater than in the initial programme year (Goetzel et al., 2010). This study did not complete statistical comparison between rates of change between baseline, 12-months and 24-months to test if the differences were significant, so these comments are drawn from patterns in data. DBP also continued to fall in the second year of the intervention, albeit at a slower rate of improvement. There were also improvements in nutrition and physical activity, which were not obvious from 12-month results. There were small improvements in BMI from 12-months to 24-months ($0.1 kg/m^2$). These results support the fact that with annual health checks, employees may be able to continue improvements, albeit some risk factors may improve at a slower rate than in the inaugural programme year. It certainly warrants further research investigating the effect of intervals between health checks on rates of improvement.

An ideal study design to assess this would have multiple 12-month intervals in succession, and then after 4-5 years, randomly assigned one group to continue with

12-month intervals, and another group changing to 24 or even 36-month intervals. This would then allow for a direct comparison of the effects of different intervals between health checks, whilst also allowing both groups to be exposed to similar workplace cultures outside of the health checks.

Is increased transparency of results required?

Many WHPs have findings reported the grey literature, however these largely only include positive health changes, and the analysis included in this, while insightful, is rarely appropriate for results to be included in larger analysis studies. This lends support to the notion that many WHPs currently being offered in the UK are ‘cosmetic’, using interventions as an attractive employee benefit rather than as a serious health tool. One of the aims of this study, was to provide a transparent look into how a workplace intervention can change health markers of employees over the first 3 years of a wellness programme, paying particular attention to cardiovascular health. Arguably the most important stage was including results and analysis of all variables measured, rather than just reporting the significant improvements that have been found. With more substantial analysis of all WHP results, it will allow for a better-informed transition from research-based interventions to practical solutions capable of changing the health of a workforce. Future research into the area should follow the example of reporting on all risk factors measures regardless of the outcome, to allow for common themes and best practice interventions to be identified. As shown in the present study, there should also be analysis run separately for male and female participants. The justification for this is that for several of the risk factors measured (WC, waist-height ratio, body fat percentage) the recommended values are gender dependent. Health improvements in only one gender may be due to interventions not allowing one gender opportunities for engagement. Likewise, analysis could also include changes by age category, looking at whether some age groups improved more than others, and explaining any differences.

When results are reported, it is important to include baseline values as a way of comparing populations between studies, and also including absolute changes in risk factor values, rather than percentage changes or simply tracking changes of the number of employees in each risk category. A 2006 study (Burton et al., 2006) looked at health changes within a sample of 7026 employees in North America. Although the changes in the percentage of employees exhibiting risk factors only displayed modest changes, there was risk 'churn' simultaneously occurring. The number of physically active individuals only increased by 1.3% between T1 and T2, however around 8% of employees moved from inactive at T1, to active at T2, and around 7% of employees moved from active at T1 to inactive at T2. The risk factors that illustrated the greatest churn were physical activity, life dissatisfaction, stress, and weight. The implications of this study are that it is important to perform a within-subject analysis when investigating changes in risk, which will allow for identification of areas where employees seem to 'yo-yo' in and out of. The present study results have shown that behavioural changes are by no means permanent, so being able to provide an environment where employees can maintain and sustain the positive changes they're making is paramount.

All publications should also be reporting intervals between data collection, so employers can understand what time scale is most appropriate when setting targets. Much of the UK grey-literature doesn't reference a time scale for the changes in health, which makes it difficult for organisations to develop any research-based expectations. As the review on current literature has shown, there is great heterogeneity between research, so a greater volume of high quality research is required in UK workforces in order to transfer scientific findings into practical solutions which companies can implement into their health programmes.

Can government intervention play a role in developing WHPs?

There is greater need for government interventions to support businesses who are actively promoting and improving employee health, which could incentivise the uptake of workplace wellness in the UK economy. As previously discussed, a well thought out wellness strategy rolled out across the UK could even impact on a national level, such as lower healthcare costs to the NHS, as the preventative nature of WHP allows employers to absorb some of the costs associated with ill-health. The unique benefits of a workplace as a health intervention location are widespread, and integrating the WHP into the culture of the workplace can remove many of the barriers to participation. Government interventions could be in the form of tax incentives and subsidies, which may encourage small and medium-sized employers to implement health programmes who require low-cost solutions to justify implementation (PricewaterhouseCoopers, 2010). It was announced in the 2013 UK Government Budget, that there would be a new tax exemption for companies who were aiding faster return to work via health interventions (HM Treasury, 2013). Healthcare providers averaged the necessary spending on interventions to be between £150 and £250 per employee (HM Treasury 2013), which could save basic rate taxpayers around £40, higher rate taxpayers around £80, and additional rate tax payers around £90 (HM Revenue & Customs, 2013). The 2014 budget estimated government spending on this new tax exemption would be around £10 million for the tax year 2014/15, extending to £20 million by the 2018/19 budget (HM Treasury, 2014). Aiding faster return to work is a way of reducing costs associated with ill-health in the workplace, and this intervention shows the government are integrating preventative measures into the healthcare system, particularly with an employer focus which is encouraging. Government publications have highlighted the aim of this tax exemption is to complement the work done by the NHS, rather than replace it (HM Treasury, 2013). Further government interest is illustrated by commissioned reports such as that by PricewaterhouseCoopers (2008) looking at the current state of UK WHPs, and the Boorman Report (Boorman, 2009) investigating health within NHS staff. This desire to take the front line of healthcare out of hospitals is encouraging, and can alleviate the burden of ill health on the NHS if successful.

Currently the most common reason for not investing in wellness programmes is a lack of information (Black, 2008), therefore an organisational body should be in place to investigate national standards of wellness interventions to ensure a high-quality service at all worksites. By setting minimum standards, including data collection and evaluation, there will be more information to allow for analysis of successful wellness interventions. From this there can then be an increase in resources available to organisations looking to implement health promotion, including tried and tested practical solutions. A 2008 report by Dame Carol Black (2008), suggested that healthy workplaces must become the norm, and this will begin with education young people about the links between health and work in schools and further education. One of the main recommendations of the report was to raise awareness of links between health and work, however the first stage of this needs to be an increase in the data available, particularly in the UK, which this report aims to contribute to.

We have focused on government interventions here, however it should be in conjunction with trade unions or regional councils (Black, 2008), who could begin to implement some of the ideas discussed to test the impact. Many organisations who are in an ideal place to help advise, such as the European Association for cardiovascular prevention and rehabilitation, are not currently as involved as they potentially should be (Guazzi et al., 2014). Setting minimum standards for data collection would be the first step, with a view to increasing the benchmark to specific interventions.

Other governments are also showing increased commitment to WHPs. Previously in the US, workplace health has been conducted by employers as a means to reduce healthcare costs, however a significant step was the decision by the USA government to invest US$15 billion in health and wellness promotion (PricewaterhouseCoopers, 2010). In order to qualify for this support, programs must be designed with the ultimate goal of promoting health or preventing disease, and available to all similarly situated employees (Rhodes, 2015). The changes, implemented in 2014, increased the maximum reward available to organisations to 30% of the cost of health coverage (up from 20%), and also rewards of up to 50% of the cost of health coverage of programmes designed to prevent or reduce tobacco use (Rhodes, 2015). In India, to reflect the increase in non-communicable diseases, there has been the recent formation of the National Institute of Health Promotion and Control of Chronic Diseases, which has the vision of 'promoting health by changing lifestyle for the people in India' (Government of India, 2010). This is a clear statement illustrating the importance that the Indian government is placing on preventative medicine. This group will also be responsible for research into efficacy and effectiveness of health promotion interventions, particularly the cost-effectiveness and sustainability of these programmes, which will develop into government resources based on case studies. Similar actions are required by the UK government in order to develop workplace health promotion, and to promote minimum standards in order to collect data that reflects true wellness programmes rather than superficial, ‘random acts of wellness’.

Are third-party wellness vendors preferable to in-house programmes?

The data used in this project was collected by a third-party wellness provider, working in conjunction with the case study company to address their wellness, as opposed to the company operating a wellness programme within-house. As it stands, large organisations are more likely to have wellness programmes in place than small companies (Linnan et al., 2008). Particularly in small to medium-sized companies, such as the case study company used in the present study, a third-party wellness provider may be more appropriate. Firstly due to cost, it is not practical to employ a full-time wellness provider, and also the resources required to implement and evaluate a programme are often not available to smaller companies (Cahalin et al., 2015, Harris et al., 2014). Third parties however can be brought in as and when needed, and is able to draw on experience to plan and execute wellness interventions, which may be a quicker alternative, as well as making economic sense if they are able to provide services at a lower cost than should the company run interventions themselves. As discussed, there is large variability in the existing wellness programmes (Pelletier, 2011), many of which are not appropriately designed or implemented, however third-party providers may help to ensure a more consistent level of service. A strength of the current study which allowed for results to be analysed, was the consistency of data collection methods over a number of years, which allowed for comparative data over the time period. Not only does this improve the effectiveness of wellness interventions, but also comes the increased scope for better evaluation. Even in the US, over half of employees currently have no access to wellness services, because they work at small companies, or businesses where staff are distributed over a large number of sites (Carnethon et al., 2009). A third-party wellness provider may increase the chances of these employees having access to wellness programmes as third-party providers are generally mobile.

The case study company used in the present study utilised ‘wellness champions’ from the existing workforce to bridge the gap between the third-party providers and the workforce. These individuals were volunteers who wished to play a role of an advisory committee to help in the intervention implementation (Goetzel and Ozmlnkowski, 2008, Racette et al., 2009), accomplished through leading by example by living a healthy lifestyle, and participate frequently in order to show commitment to the program (Michaels and Greene, 2013). This helped with data collection, and buying in to the WHP, and should continue to be used in future wellness programmes. Another benefit of involving employees at all stages of intervention planning is that it can reinforce that the programme is for the benefit of employees, increase transparency, notably that individual’s health information will not be shown to employers which is often a concern for employees taking part in the programme (Carnethon et al., 2009, Morrison and MacKinnon, 2008). In small companies, if a WHP is run completely within-house, there is a larger chance that the employee receiving the health check and the one conducting the health check will be familiar to each other, which may prevent the employee from being as honest with their answers, or may even stop the employee from participating at all. The neutrality of a third-party provider may increase this trust, and may help the employee to open up so they can get the maximum benefit from health checks.

Should a business desire to run a wellness programme in-house, then there are resources available to help start a wellness programme (Young and Bhaumik, 2011), which are often developed by organisations in conjunction with experts in the field (Arena et al., 2013). A 2011 report detailed four government designed initiatives available in the UK, with the aim of helping employers to improve the health and wellbeing of their employees, and went on to measured awareness of these schemes (Young and Bhaumik, 2011). The four initiatives in question were Regional Health, Work and Well-being Co-ordinators, Workplace Well-being Tool, Occupational Health Helpline for Small Businesses, and Fit for Work Service. The most recognised of these initiatives was the Fit for Work Service, with 21% of respondents knowing about it. When looking at how many respondents actually use these government-sponsored services however, it was found that less than 2% of the total sample were making use of the services available to them (Young and Bhaumik, 2011).

A weakness of in-house wellness programmes is that often the priorities of the organisers are not aligned with the requirements for the employees. For this reason, it is advisable that an initial wellness audit is conducted by a third-party provider to get an honest and unbiased report on the current state of wellness within the company. In the same way that a company has an unbiased annual audit of their business, the same should be required of their workforce health, which can then go on to form the foundation of the organisation and implementation of the wellness programme.

What are the main barriers to WHP implementation and participation?

The organisation used in this case study research voiced an opinion that they had experienced greater employee engagement as a result of implementing the WHP in their offices, but often organisations are hesitant to implement WHPs for a number of reasons. Many businesses have a negative perception of WHPs, and perceive a large financial investment as integral (Guazzi et al., 2014), however generally businesses are not convinced that programmes are able to improve employee health, or in some cases provide a positive return on investment (Goetzel and Ozmlnkowski, 2008). One reason for this belief may be how media largely focuses on the WHPs which achieve negative results, as this opposes popular beliefs (Goetzel et al., 2014), and is therefore more newsworthy than reporting on the many programmes that have proved successful. Currently employee health is not viewed as important compared to other business priorities, and still considered as an employee luxury (Goetzel and Ozmlnkowski, 2008), which makes it difficult for senior management and stakeholder buy in, and often health programmes are the first area to experience cuts when an organisation is looking for places to reduce spending (Young and Bhaumik, 2011). Aside from business interests, some business are unclear on what laws and regulations are in place surround the field of employee health, so choose to avoid any involvement (Michaels and Greene, 2013), with many employers not wanting to interfere with employees' private lives (Goetzel and Ozmlnkowski, 2008). Utilising third-party wellness vendors can go some way to overcoming this problem, and can work alongside employers to plan a bespoke programme which is in the organisation’s best interests, and doesn’t breach any rules or regulations, as well as making WHPs more accessible for small and medium-sized enterprises. Research by the Department for Work and Pensions sent questionnaires to UK employers asking questions about workplace health and wellbeing, and received responses from 2250 employers (Young and Bhaumik, 2011). 56% of respondents strongly agreed that an employer has a responsibility to encourage employees to be physically and mentally healthy, and a further 32% agreed with this statement. An overwhelming 83% of respondents strongly agree or agree that there is a link between work and health and wellbeing, showing that employers are aware of the potential benefits of such programmes, however interestingly, 51% believe that employees don’t want employers intervening with their physical and mental health.

Figure 4 is taken from Health and Well-being at Work (Young and Bhaumik, 2011), and shows responses when UK employers were asked about the health initiatives offered to their staff. Notably, these results suggest that the most common interventions had achieved a status of ‘standard employment benefits’. As discussed in other literature (PricewaterhouseCoopers, 2008), the demands of the workforce are changing, and employees now expect the top 7 initiatives as a part of all employment, Very few companies seemed to implement initiatives that would be classed as ‘going the extra mile’, such as health screenings, loans on bicycle purchases, weight loss advice etc. which justifies the use of third party wellness vendors to truly align wellness programmes with the requirements of the organisation. Literature has shown than companies with greater staff engagement

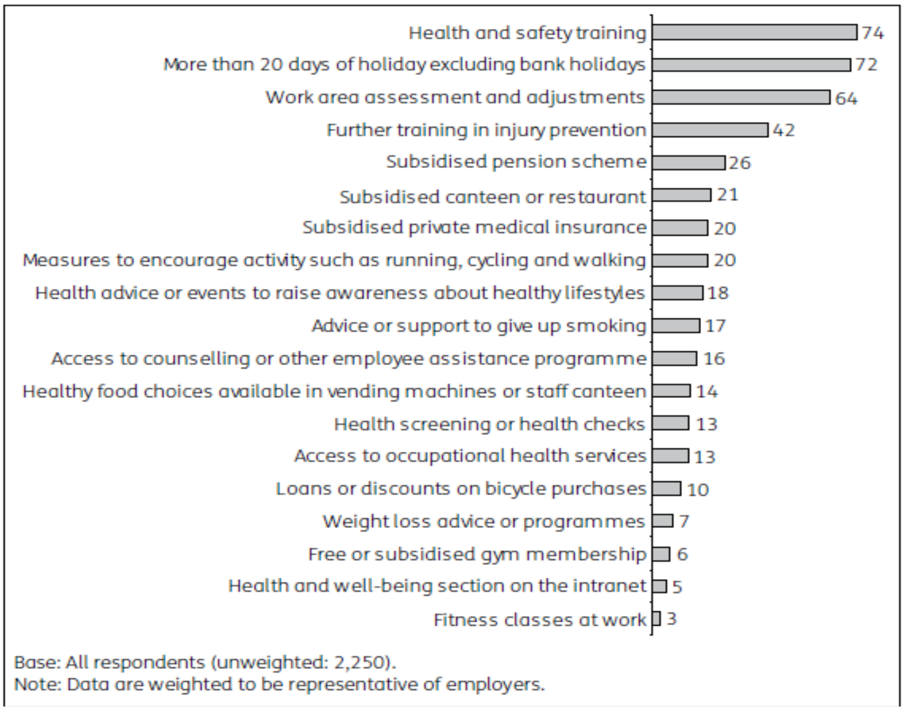


Figure 4: Many of the interventions that companies consider as workplace health, are increasingly becoming standard health and safety schemes, as illustrated by the percentage of UK companies health and wellbeing offerings in the past 12 months, from respondents of a 2011 survey of employees (Young and Bhaumik, 2011).

have lower staff turnover, reduced sickness absence and consistently outperform the FTSE 100 (Black, 2008). On an individual level, the most common factors that may limit participation are insufficient incentives, inconvenient locations, time limitations and a lack of interest in the topics being presented (Person et al., 2010). These findings stress the need for interventions to be highly individualised to each workplace in order to suit the employees and maximise participation, which involves planning interventions around other requirements, as well as making the sessions involve topics and activities of interest to employees. Once the programme is in place, there should be regular evaluation methods to look at participation levels, and to try and find ways to engage as many staff as possible. Feedback from those not participating is arguably more important than feedback from those who are participating. A true needs assessment of the workforce and management priorities again justifies the need for a thorough health audit to be conducted prior to the WHP planning stage to best align the business requirements with the opinions of the employees.

Reflecting some of these barriers to WHPs is the relatively small sample size. Due to the retrospective nature of this study, further participant recruitment was not possible, and the sample was limited to the number of company employees who had attended the 3 consecutive health checks. This meant that of the 33-participant sample, only 6 of these were female. This somewhat limits the external validity of this study, however it is still a significant contribution to the workplace health literature originating in the UK. An alternative to overcome this limitation would be to use health check information from several companies and compare changes over time. Although the number of companies utilising health programmes is increasing, in order to compare multiple companies it would require consistent data collection over a number of years, which is currently not largely conducted in the UK. Ideally the data collection would be using the same techniques and measurements as used in the present study research. While this sample size is relatively small compared to much of the literature originating from the USA (Milani and Lavie, 2009, Ogunmoroti et al., 2016, Salinardi et al., 2013), it is more representative of company size in the UK, where 95% of the 5.4 million business in the UK, consist of between 0 and 9 employees (Rhodes, 2015).

How does employee motivation influence WHP effectiveness?

A more motivated individual is more likely to adhere to the WHP, therefore future studies should incorporate a measure of readiness to change during the health check process. This has been suggested in the literature (Knight et al., 2006), however due to the retrospective nature of the present study, it was not possible to include it in the data collection. Most people are aware of what they should be doing to improve health, however the real difficulty lies in getting individuals to adhere to these healthy lifestyle decisions (Rice, 2010). The responsibility is ultimately with the individual when it comes to making lifestyle changes, and although the healthcare professional provide individual counselling and help with goal setting during health checks, it is up to the individual to take action. Assessing readiness to change can categorise whether an employee wants to make a change to their lifestyle, which can then allow comparison between readiness to change groups. The transtheoretical model of behaviour change was first developed by Prochaska et al. (1992), and clearly defines 5 stages that an individual may be in regarding their willingness to make a change to their current habits. The study suggests that individuals at different stages will require different interventions for optimal adherence, depending on whether they are in the pre-contemplation, contemplation, preparation, maintenance or action stage. By categorising employees into one of these readiness to change categories, and then tracking health changes based upon this, the service, feedback and goal-setting could be adapted to suit the appropriate stage. A way to incorporate stages of change into the methods of future WHPs would be to use a motivational interviewing approach during the counselling part of health checks. Motivational interviewing is based on the transtheoretical model of behaviour change, and is designed to oppose simple advice giving, and encourages identification of an individual's willingness to change (Knight et al., 2006). It has been shown to be a useful technique when used in settings such as addiction, diet and exercise, and there is currently early stage research investigating its effectiveness in a cardiovascular risk setting (Knight et al., 2006, Thompson et al., 2011). Importantly, the skills required for motivational interviewing are transferable with a healthcare professional's existing skill set (Knight, McGowan et al. 2006) so integration into a health check could be relatively seamless.

One way of promoting an individual's progression through the stages of change is to ensure there is a culture of wellness, defined as a workplace culture that supports health (Fonarow et al., 2015), within an organisation. A 2013 meta-analysis reported upon 6 common themes in successful WHPs, including a culture within an organisation where employees were internally motivated to live a healthier lifestyle, and support of the WHP at all organisation levels (Kaspin et al., 2013). A wellness culture can aid in developing an environment where a healthy lifestyle becomes the norm, and employees will receive support should they make healthy lifestyle decisions, which may improve employee participation in interventions offered

(Fonarow et al., 2015). For employees, this may aid the motivation behind behavioural change and accelerate one's progress through stages of change to the action stage, resulting in a more successful WHP (Cahalin et al., 2015). Combined with incentives, which has recently shown to increase participation by up to 23% (Huang et al., 2016), employees may be more likely to adhere to programmes. In workplaces where WHPs are not integrated into the business priorities, there may be less expectation of individuals to change their health, and thus individuals may be less likely to make the changes required. The implications of this are that in addition to individual's undergoing a readiness to change assessment during health checks, there should also be a measure of a company-wide readiness to change during the initial company audit. Recent research has suggested developing a model to provide consistent evaluation of workplace wellness culture, so an increase in literature in this area is to be expected in the coming years (Fonarow et al., 2015).

Can high-risk individuals benefit more from WHPs than healthier counterparts?

The population of participants used in the current study, could be classed as low-risk, due to their health at baseline, and this may be responsible for the lack of significant change in some measurement categories. Some literature suggests that high-risk individuals are more likely to show significant improvements in health as a result of workplace health promotion (Groeneveld et al., 2011, Bennett et al., 2011). Should a large sample size be obtained, then employees could be organised into subgroups of low-, medium- and high-risk based on baseline health check data. From here, analysis can be run to compare the magnitude of changes. In combination with research investigating return on investment, the study results could be vital in providing a research-base to assess where financial resources are best spent to see the greatest improvements in employee health. The baseline characteristics for the participants in the present study suggest that they were a low-risk group at baseline, which may go some way to explaining why so few significant changes were seen.

There is a need for greater case study research in general which carefully analyses health changes, and from this it will allow for research to be translated from scientific literature into practical recommendations. Once this stage has been reached, it may warrant further investigation into optimising specific elements of wellness interventions such as the use of technology, return on investment, incentives, different managerial levels etc.

CONCLUSION

The current study aimed to investigate the effectiveness of a UK-based workplace health programme using cardiovascular risk factor data collected during employee health checks. The current study found evidence that health interventions are able to significantly change QRISK2 relative risk scores amongst male participants ($p=0.023$), although the lack of significance amongst female participants is likely due to a relatively small sample size. Non-significant patterns also show favourable outcomes for males and females from the secondary measures of SBP and DBP, HDL, TC-HDL Ratio and also for male participants only, TC. Body composition however showed an opposite trend, with male BMI significantly increasing between T1 and T3, and female waist-height ratio significantly increasing in the same interval.

With greater scientific research and case study information, more UK organisations are likely to offer health programmes to their employees. With an aging workforce and longer lifespans, this ‘upstream medicine’ is going to be vital in order to keep the workforce healthy, reduce healthcare spending in the UK, and address CVD at sub-clinical levels.

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