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Review of Literature

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Contents List

1.0. Introduction

Government guidelines recommend all healthy adults (18-65 years) complete 150-minutes moderate-intensity aerobic activity weekly (Department of Health, 2011a; Department of Health, 2011b; Garber et al., 2011; Haskell et al., 2007; Nelson et al., 2007) with the aim of expending ~1000 k/cal to lower the risk of cardiovascular disease (CVD; Department of Health, 2011b; Garber et al., 2011). Team sport activity, when sustained for ~8-24-weeks, elicits changes in risk factors of CVD (Barene, Krustrup, Jackman, Brekke & Holtermann, 2014b; Krustrup et al., 2009; Mendham, Duffield, Marino & Coutts, 2014). The Government does not focus on recreational team sport, but physical activity (PA) as a whole, despite the potential of recreational team sports to promote health and reduce disease.

Modified versions of team sports, such as walking football and Touch Rugby League, have emerged to encourage individuals to engage in PA. Numerous leagues have resulted from the Play Touch Rugby League (PTRL) initiative developed in 2013 by the Rugby Football League (RFL). Touch Rugby League is a modified version of Rugby League and is an intermittent team activity (Beaven, Highton, Thorpe, Knott & Twist, 2014). Touch allows players some degree off-pitch recovery however, it is dependent upon the context of the match. A Touch Rugby League match consists of 2 x 20 minute halves, with a single or mixed sex team of 6 players on the pitch at any given time. A tackle is made by touching the ball carrying player therefore reducing risks of repeated high-impact collisions. Accordingly the aim of this review is to provide an overview of modified versions of team sports and the benefits to be gained from participating.

1.1. Participation

PA participation in England has increased steadily over recent years in most populations (e.g. adult, child and disabled; Sport England, 2014). At present 40.6% of men and 30.7% of women, an increase of 853,000 and 555,100 since APS1 respectively, participate in weekly PA (APS 9Q2). Age and socioeconomic status effects participation. Currently 54% of 16-25 year olds and 31.9% over 26 years, an increase of 119,300 and 1.29 million more than ASP1 respectively, take part in weekly PA (APS 9Q2). Lowest participation is among manual workers and the unemployed and highest among managerial and professional workers (APS 9Q2). Despite increased participation, approximately 58% of adults do not take part in weekly PA (Sport England, 2015). Data suggests that more participation is needed, especially in women, over 26 years of age in the lower social classes.

For years males have dominated lifelong participation despite a linear drop-off in participation with increasing age in both sexes (Roberts & Brodie, 1992; Coalter, 2007; Sport England, 2015). Large drop-offs in participation occur between 16-19 years, especially in females (Roberts & Brodie, 1992). It is reported that young women may be deterred by sports competitive nature and, along with other life variables, may account for some female drop off (Coalter, 2007). For 20 years, numerous policies have attempted to reduce this drop off, however the problem has persisted since it was first identified in the Wolfenden Report (The Wolfenden Committee of Sport, 1960). Females are more attracted to social aspects of sport (Coalter, 2007) therefore easily accessible modified versions of team sport sessions (e.g. PTRL) could increase participation levels and subsequently improve health in this population.

1.2. The role of modified versions of team sports in promoting health

Modified versions of team sports involve reduced number of players, smaller pitch dimensions and rule changes (e.g. limited contact) compared to traditional team sports (Bangsbo, Hansen, Dvorak & Krustrup, 2015; Abrantes, Nunes, Macas, Leite & Sampaio, 2012; Filliau et al., 2015). It is argued that modified versions of team sports require lower skill levels therefore beginners spend more time playing rather than mastering skills (Filliau et al., 2015). Demands can be altered to suit different populations with participant's workload manipulated through changes in the number of players, pitch dimensions (Rampinini et al., 2007), verbal encouragement (Manolopoulos et al., 2012) and the opposition (Kempton & Coutts, 2015).

Aerobic activity takes many forms, including team sports, walking, swimming and cycling. Despite the observed physiological, psychological and social benefits, competitive team sports possess negative side effects such as injury, over-training and over-competitiveness (Coalter, 2007). Modified versions of team sports do not require structured training or competitive matches, potentially reducing some negative effects associated with traditional team sports. Short-term participation (~8-24-weeks) in modified versions of team sports reduces several risk factors of CVD, including resting blood pressure (BP) and resting heart rate (RHR; (Barene, Krustrup, Jackman, Brekke & Holtermann, 2014b; De Moura, Marins, Franceschini, Reis & Amorim, 2014; Krustrup et al., 2009; Mendham, Duffield, Marino & Coutts, 2014b; Mohr et al., 2014a; Randers et al., 2012). Long-term participation (>24-weeks) in modified versions of team sports further improves cardiac function and bone mineral density (Krustrup et al., 2010b). Traditional team sports can be time consuming, competitive and participants must abide by rules therefore adherence tends to be low with participants failing to gain the benefits of long-term participation. Modified versions of team sports are less time consuming, less competitive and emphasis social aspects. Adherence to this exercise modality may be higher than that of traditional sports. Such is the potential of modified versions of team sports, the National Health Service (NHS) has endorsed participation as one approach to reduce CVD risk (NHS Confederation, 2013; NHS Inform, 2014).

Much research into the benefits of recreational team sports has used male participants and/or soccer (Barene et al., 2014a; Barene et al., 2014b; Gaudino, Alberti & Iaia, 2014; Krustrup, Dvorak, Junge & Bangsbo, 2010b; Krustrup et al., 2009; Randers et al., 2014; Krustrup & Bangsbo, 2015; Toh, Guelfi, Wong & Fournier, 2011; Schmidt et al., 2013; Knoepfli-Lenzin et al., 2010; Connolly et al., 2014) with very few exploring other sports. Studies have found beneficial effects of regular recreational soccer, for a prolonged period in men, however research investigating women is lacking. Benefits include reduced risk of CVD and type 2 diabetes mellitus (T2DM). It remains unclear how modified versions of team sports (e.g. touch rugby) benefit health and whether said benefits differ between sexes.

1.3. Touch Rugby

Touch was developed in 1960s Australia as a training activity in rugby league (England Touch, 2014). Touch grew in popularity throughout the decade, spreading to New Zealand by 1975 (England Touch, 2014). Touch remains a popular sport in Australia, New Zealand and Samoa and is increasing in popularity in countries including the United Kingdom, United States, Japan and South Africa (Walsh, Heazlewood & Climstein, 2012). The international governing body for Touch (Federation of International Touch) was formed in 1985 with the first World Cup held in 1991 (England Touch, 2014).

Recently there has been the emergence of recreational Touch leagues and initiatives (e.g. PTRL). The purpose of such initiatives is to increase participation encouraging people to be active in a fun and social atmosphere (Touch Rugby League, 2014a). There are over 50 PTRL venues in England hosting regular leagues and ‘turn-up-and-play’ sessions. Research suggests participants can cover 2000-3000 m and expend ~600k/cal an hour. However this data, taken from elite players, is unlikely to accurately represent recreational Touch players (Beaven et al., 2014; Touch Rugby League, 2014b).

1.4. Social Benefits

Historically sport has been viewed as a simple and cheap solution to the physical inactivity crisis. Some have suggested that organised, competitive team sports are not necessarily the solution (Coalter, 2007; Waddington, 2000). Coalter (2007) argues that few people adhere to competitive team sport for the length of time required to develop lifelong health benefits, due to intervening variables (e.g. work, family). Many people are also deterred from team sports due to the competitive nature and the associated negative health consequences (Waddington, 2000). For some, modified versions of team sports, as opposed to individual sports, provides alternative ways to improve mental health and develop relationships (Krustrup et al., 2010b; Ottesen, Jeppesen & Krustrup, 2010; Eime, Young, Harvey, Charity & Payne, 2013). A fun and social atmosphere, evident in modified versions of team sports, allows some participants to enjoy PA over sports competitive nature (Oja et al., 2015; Krustrup et al., 2010b).

Participation in regular PA has been shown to improve overall quality of life (Coalter, 2013; Dugan, Bromberger, Segawa, Avery & Sternfeld, 2015). It is has been suggested that PA disrupts the 'vicious cycle' of deteriorating health by reducing anxiety and isolation (Pedersen & Saltin, 2006). Team sports involve intermittent high-intensity bouts of exercise potentially causing short and long-term health issues (e.g. injury and arthritis). Modified versions of team sports, involving moderate-intensity exercise over 30-40 minutes, are thought to be most effective for improving psychological states, well-being and enjoyment compared to other exercise modalities (Paluska & Schwenk, 2000). Regular participation in moderate-intensity exercise over 30-40 minutes, also improves physical appearance satisfaction and improves depression symptoms (Paluska & Schwenk, 2000). Regular exercise in the form of modified versions of team sports could improve mental and social well-being to a greater extent than traditional forms of PA.

2.0. Demands of team sports

Team sports require repeated maximal effort multidirectional sprints of short duration and distance (e.g. 5-30 m; Mohr, Krustrup & Bangsbo, 2003; Davidson & Trewartha, 2008; Bangsbo, Mohr & Krustrup, 2006; Spencer, Bishop, Dawson & Goodman, 2005; Buchheit, Bishop, Haydar, Nakamura & Ahmaidi, 2010). Such movements are interspersed with jumps, leaps and passing alongside periods of low-intensity activity (Mohr et al., 2003; Davidson & Trewartha, 2008; Bangsbo et al., 2006; Bloomfield, Polman, O'Donoghue & McNaughton, 2007, Lakomy & Haydon, 2004). Low-intensity activity accounts for approximately 70-80% of team sport match time, the remainder involving high-intensity activity. Men are known to cover more distance than their female counterparts in multiple team sports including basketball, soccer and rugby (Montgomery, Pyne & Minahan, 2010; Abdelkrim, El Fazaa & El Ati, 2007; Bangsbo et al., 2006; Mohr, Krustrup, Andersson, Kirkendal & Bangsbo, 2008; Krustrup, Mohr, Ellingsgaard & Bangsbo, 2005; Suarez-Arrones et al., 2014; Roberts, Trewartha, Higgitt, El-Abd & Stokes, 2008; Osgnach, Poser, Bernardini, Rinaldo & di Prampero, 2010; Coutts, Quinn, Hocking, Castagna & Rampinini, 2010). In addition to the disparity in total distance, females perform fewer movements and report lower mean match heart rate (Abdelkrim et al., 2007; Matthew & Delextrat, 2009; Ziv & Lidor, 2009; Montgomery et al., 2010).

Team sports are considered highly demanding and unsuitable for some populations. The emergence of modified versions of team sports allows team sports to be manipulated to decrease the load on players. Demands are manipulated via changes in pitch dimensions, players number, rule changes and encouragement (Rampinini et al., 2007; Manolopoulos et al., 2012), resulting in a practical and accessible exercise option for untrained and diseased populations. For example, in those presenting cardiovascular risk factors, increasing the number of on-pitch players reduces average heart rate providing a safe environment to stimulate health benefits (Mohr et al., 2014a; Abrantes et al., 2012; Casamichana & Julen, 2015). The demands of modified versions of team sports have been reported with players covering 2563-3371 m, reaching speeds of 21 km/h (Mendham, Duffield, Marino & Coutts, 2014a). Andersen et al. (2014b) reported mean heart rates of 149 ± 4 b/min corresponding with ~80% of maximal heart rate. These demands enable participants, trained or otherwise, to engage in physiologically meaningful exercise that can positively impact health.

3.0. Adaptations to modified versions of team sports

Recreational team sports, particularly soccer, sustained on a weekly basis for ~8-24-weeks, have positive effects on risk factors associated with CVD and T2DM (Pedersen & Saltin, 2006; Hu et al., 2005; Krustrup et al., 2010a; Randers et al., 2012). These positive effects occur because of reductions in resting BP (Krustrup et al., 2009; Knoepfli-Lenzin et al., 2010; Schmidt et al., 2014), RHR (Knoepfli-Lenzin et al., 2010; Krustrup et al., 2009; Mohr et al., 2014a), body mass (BM; Krustrup et al., 2009; Mendham, Duffield, Marino & Coutts, 2014a), body mass index (BMI; Krustrup et al., 2009; Mendham et al., 2014a), waist circumference (WC; De Moura et al., 2014; De Sousa et al., 2014; Mendham et al., 2014a), cholesterol (Cornelissen & Fagard, 2005; Krustrup et al., 2009) and increased bone density (Andersen et al., 2014b; Barene et al., 2014a; Helge et al., 2014). These changes have been reported across a range of populations, including men and women who are untrained (Krustrup et al., 2009; Andersen et al., 2014a; Bangsbo et al., 2010), middle-aged (De Sousa et al., 2014; Hu et al., 2005; Mendham et al., 2014a) and hypertensive (Mohr et al., 2014b; Knoepfli-Lenzin et al., 2010; Krustrup et al., 2013) along with pre-menopausal women (Mohr et al., 2014a; Krustrup et al., 2010c), inactive women (Connolly et al., 2014) and individuals with T2DM (De Moura et al., 2014; Mendham et al., 2014a; Schmidt et al., 2014).

3.1. Body Composition

Over weight and obesity are an increasing problem and have received much attention in literature and the media. Excess weight has been linked to both CVD and

T2DM (Maessen et al., 2014; Moore et al., 2013). BMI is a universal measure recommended by the World Health Organisation (WHO) to classify overweight and obese individuals and is a ratio of stature and BM (WHO, 2000; Maeseen et al., 2014). Although a recognised measure, simple and inexpensive to perform, BMI can prove misleading. BMI does not distinguish between lean and fat tissue and fails to consider age, sex or training status (Prentice & Jebb, 2001). Other anthropometric measures can be used alongside BMI (i.e. WC). WC is a measure of central obesity associated with the grouping of several CVD risk factors (Wen-Ya et al., 2013). BMI and WC measures are thought to be superior to alternative methods of assessing body fat such as body roundness index and a body shape index with WC believed to be strongly correlated with total body fat (Maessen et al., 2014; Staiano et al., 2012).

Intermittent high-intensity activity, evident in team sports, is reported to improve body composition when sustained on a weekly basis (Heinrich, Patel, O'Neal & Heinrich, 2014). It is reported that untrained middle-aged men and pre-menopausal women, involved in high-intensity intermittent training, can reduce total body fat and increase lean BM (Krustrup et al., 2010a; Mohr et al., 2014b; Connolly et al., 2014). Connelly et al. (2014) observed a 1.7% decrease in total body fat in 92% of individuals participating in weekly modified versions of team sports. Mendham et al. (2014b) noted reductions in BMI, WC and total BM of 4.5 kg/m^2, 3.3 cm and 1.3 kg respectively, in males following a 12-week programme consisting of modified team games. Barene et al. (2014b) observed reductions in BMI and total BM of 0.3 kg/m^2 and 0.8 kg respectively, in women undertaking 12-week soccer program. These reductions are to a lesser degree than seen men however, greater reductions in total BM (1.4 kg) are reported in women undertaking soccer training over 15-weeks (Mohr et al., 2014a).

3.2. Blood Pressure

Hypertension is a universal medical problem (Pescatello et al., 2004) influenced by diet, BM, exercise, alcohol and smoking (Pescatello et al., 2004; NHS Choices, 2013a). The prevalence of hypertension is higher in men than women, reported as 14.4% and 21.2% in men and 6.2% and 9.9% in women aged 20–29 and 30–39 years, respectively (Berge, Isern & Berge, 2015). Regular, moderate-intensity exercise initiates both acute and chronic lowering of BP in normotensive and hypertensive adults (Pescatello et al., 2004; Cornelissen & Fagard, 2005; Krustrup et al., 2009). Twice weekly 60-minute sessions of team sport activity over a 6-month period caused reductions of ~13 mmHg and ~8 mmHg in systolic blood pressure (SBP) and diastolic blood pressure (DBP), respectively (Krustrup et al., 2010b; Mohr et al., 2014a) amongst hypertensive males. Similar reductions in resting BP have also been reported after 15-weeks of team sport activity (Mohr et al., 2014a). Shorter interventions (e.g. 4-weeks) have produced reductions of ~3 mmHg in SBP and DBP in normotensive and hypertensive males (Cornelissen & Fagard, 2005; Krustrup et al., 2010a). These acute responses are ascribed to reductions in total peripheral resistance and increased vasodilation (Krustrup et al., 2009; Pescatello et al., 2004). Chronic changes in BP are influenced by reductions in RHR, renin and angiotensin 2 (Krustrup et al., 2009; Krustrup et al., 2010a; Pescatello et al., 2004; Reckelhoff, 2001). Collectively, these data suggest a dose-dependent response to teams sport exercise, in that an extended period of exposure causes greater reductions in BP. The mechanisms explaining these changes appear multifaceted.

Irrespective of PA premenopausal women possess lower BP when compared to age-matched men. Men have higher BP over a 24-hour period by approximately 6-10 mmHg than women (Wiinberg et al., 1995), however after the menopause (mean age of 51.4 years) women's BP increases beyond that of men (Reckelhoff, 2001). Although the mechanisms responsible are not clear numerous reasons have been suggested. Differences have been primarily ascribed to fluctuations in plasma renin activity, testosterone and oestrogen concentrations over the life cycle (Reckelhoff, 2001). Plasma renin activity, approximately 27% higher in men, is thought to play a role in controlling BP as it regulates blood volume and aids vasoconstriction (Pescatello et al., 2004; Reckelhoff, 2001; Samimi et al., 2014). Oestrogen stimulates nitric oxide production and lower oestrogen at the menopause could account for higher BP due to increased vasoconstriction (Reckelhoff, 2001; Hart et al., 2009; Joyner, Wallin & Charkoudian, 2015). It has also been suggested that women possess greater arterial stiffness when compared with men of a similar age which could also be responsible for the observed difference (Samimi et al., 2014). There is little known about the effects of team sport activity on men and women therefore substantial research is required to examine acute and chronic BP responses in male and females (Hart et al., 2009; Reckelhoff, 2001, Joyner, Wallin & Charkoudian, 2015).

3.3. Resting Heart Rate

Increased RHR above normal values (~75 b/min) is associated with obesity, hypertension and increased cholesterol (Fox et al., 2007; Neves, Virdis, Sanjuliani & Tibirica, 2013; Palatini & Julius, 1999). High RHR, accompanied by low cardiorespiratory fitness, is a predictor CVD (Fox et al., 2007; Cooney, Vartiainen, Laakitainen, Juolevi & Graham, 2010; Aladin et al., 2014). Reductions in RHR of ~6-

11% are frequently observed after ~12-weeks of team sport activity in healthy, untrained and diseased male and female groups (Krustrup et al., 2009; Barene et al., 2014a; Barene et al., 2014b; Randers et al., 2014; Mohr et al., 2014a; Randers et al., 2010). Krustrup et al. (2009), using a randomized control trial, reported reductions in RHR of ~10% in healthy, non-smoking, untrained men (VO_{2max} = 39.4 ± 0.9 ml/kg/min) following a recreational soccer intervention. Similarly Randers et al. (2010) reported reductions of ~11% following 12-weeks of 2 x 1-hour sessions of modified versions of soccer in healthy, untrained men (VO_{2max} = 40.4 ± 1.2 ml/kg/min). Chronic reductions in RHR are thought to reflect reduced sympathetic outflow and increased capillarisation (Krustrup et al., 2009).

RHR is a significant independent predictor of CVD in men and women, with high RHRs linked to reduced life expectancy (Cooney et al., 2010). Modifiable lifestyle behaviours including psychological stress and smoking increase RHR while regular consumption of omega-3 fatty acids and PA decrease RHR (Cooney et al., 2010; Geelen et al., 2005). Differences in RHR between sexes might also influence mortality risk (Perret-Guillaume, Joly & Benetos, 2009). RHR exceeding 90 b/min in men increases risk of CVD mortality 2-fold and women 3-fold compared to a RHR of ≤60 b/min (Cooney et al., 2010; Okamura, Hayakawa & Kadowaki, 2004; Kristal-Boneh, Silber, Harari & Froom, 2000). Additionally, the female hormone oestrogen contains anti-atherosclerotic and nitric oxide dependent vasodilatory properties which have been identified as the main cause for women developing CVD later in life (Aladin et al., 2014). Further research is needed to understand the adaptive responses in RHR between males and females after training interventions.

3.4. Cholesterol

Cholesterol comprises two components: low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol. LDL-cholesterol makes up 60-70% of total cholesterol and transports cholesterol away from the liver to cells (Rahkovsky & Gregory, 2012; Halasi, 2004; National Cholesterol Education Program, 2002). Conversely, HDL-cholesterol carries cholesterol away from cells, to be broken down or removed as waste (Rahkovsky & Gregory, 2012). Differing concentrations of LDL and HDL-cholesterol are a strong predictor of CVD with too much LDL-cholesterol causing build-up within artery walls (Fan, Ham, Muppidid & Mokdad, 2009; Stanley, 2010). HDL-cholesterol is inversely related with CVD risk with evidence suggesting it has protective effects against atherosclerosis (National Cholesterol Education Program, 2002; Fan et al., 2009; Kokkinos & Fernhall, 1999; Krauss, 2004). However, low concentrations of HDL-cholesterol combined with increased triglycerides, is known to elevate CVD risk (Krauss, 2004).

Cholesterol concentrations alter as a result of sex, age, BMI, smoking and diet (Anagnostis, Stevenson, Crook, Johnston & Godsland, 2015). Premenopausal women are known to have less risk of CVD and lower LDL-cholesterol, compared with their male (Swiger et al., 2015; De Marinis, Martini, Trentalance & Pallottini, 2008). In the absence of hormone replacement therapy post-menopausal women's LDL-cholesterol increases above men of a similar age (De Marinis et al., 2008; Atkins, Walsh, Pignone & Phillips, 2000; Swiger et al., 2015). This suggests the menopause might induce lipid profiles which closely resemble those in men. More research is needed to understand how aging and exercise influence cholesterol between sexes (Anagnostis et al., 2015).

PA has protective effects against CVD by increasing HDL and lowering LDL-cholesterol (Fan et al., 2009; Imamura, Mizuuchi & Oshikata, 2012; Kokkinos & Fernhall, 1999). Changes in cholesterol concentrations have primarily been ascribed to reductions in total BM (Durstine & Thompson, 2001; Krustrup et al., 2009). A 12-week soccer programme resulted in decreased total cholesterol (5%), increased HDL-cholesterol (8%) and significantly decreased LDL-cholesterol (15%) accompanied by decreases in total BM and BMI in men aged 20-43 years (Krustrup et al., 2009). HDL-cholesterol is sensitive to aerobic training and increases, in a dose-dependent manner, with an increase in energy expenditure during team sport exercise programmes lasting ~12-weeks (Krustrup et al., 2009; Krustrup, et al., 2010a; Krustrup et al., 2010b). Repeated high-intensity efforts occur frequently in team sports so may be responsible for changes observed in HDL-cholesterol as little changes are observed with continuous running or strength training (Krustrup et al., 2009; Krustrup et al., 2010b; Nybo et al., 2010).

3.5. Musculoskeletal

PA promotes musculoskeletal health in all ages (Strong et al., 2005; Haskell et al., 2007; Nelson et al., 2007). Team sport activity amalgamates endurance exercise with changes of direction and speed that could promote musculoskeletal adaptation, however risk of injury is increased (Waddington, 2000; Ashton & Twist, 2015). Aside from such concerns, 12-weeks of soccer training, in healthy, untrained males elicited a 5% increase in mean muscle fibre area (Krustrup et al., 2010c). Greater improvements in muscle characteristics are observed in soccer training when compared to those engaged in continuous running. Muscle fibre area was 15% greater

(5546 ± 240 versus 4828 ± 233 μm²) after 12-weeks of soccer compared to continuous running (2.25 ± 0.08 versus 2.07.0.07 kg; Krustrup et al., 2010d). Loss of skeletal muscle mass and strength is more prevalent in women than men (59% and 45% respectively) over the age of 60 years therefore increasing muscle quality and quantity is important for improving metabolism and maintaining strength and physical function in the elderly (Jansseen & Ross, 2005; Janssen, Heymsfield & Ross, 2002; Goodpaster et al., 2006).

PA stimulates bone formation via compression thus improving mineralisation, bone diameter and subsequently reducing osteoporosis and bone fractures (Langsetmo et al., 2012; Vuori, 2001). Several studies have explored the role of soccer training in promoting bone health. Lower-limb bone mineral density and bone mineral content have increased following both 12-week and 12-month intervention in untrained (20-43 years) and older (65-75 years) men and women (45.8 ± 9.3 years; Barene et al., 2014a; Helge et al., 2014; Krustrup et al., 2009). Lower-limb bone mineral content, after 12-weeks of recreational soccer increased by 2% in untrained men (20-43 years; Krustrup et al., 2009; Bangsbo et al., 2015) and 1.4% in pre-menopausal women (Barene et al., 2014b). Such findings suggest that males and females across a range of ages can promote bone health by engaging in regular team sport activity. Increases in bone mineral density are known to occur due to force absorption during weight-baring activities such jumping and rapid deceleration (Muir, Ye, Bhandari, Adachi & Thabane, 2013; Creighton et al., 2001). Team sport activity could be beneficial for promoting bone health reducing age-related loss of bone mass associated with osteoporosis. It is important to note that, although required for bone formation, high loads can increase injury risk.

4.0 Risk Factors associated with taking part in sport

4.1. Risk of injury

Many benefits are derived by taking part in team sport activity, however there are some risks of participation. Competitive team sports, particularly those involving a high number of contacts and changes of direction or speed, present a high risk of injury (Waddington, 2000; Hootman, Dick, & Agel, 2007). The lack of control of intensity in competitive team sports is thought to increase the likelihood of non-contact injuries (e.g. strains and sprains; Waddington, 2000). Several authors have identified high injury incidence in team sports including soccer, basketball, rugby league and rugby union (Flood & Harrison, 2009; Gabbe, Finch, Bennell & Wajswelner, 2005; Chalmers et al., 2012; Hume & Marshall, 1994 as cited in Waddington, 2000). Injury can have a severe impact on participants' lifestyles, affecting general health, family and work commitments. Modified versions of team sports (e.g. touch rugby) involve minimal contact and a reduced risk of injury. Despite limited contact being involved in touch rugby, Beaven et al. (2014) reported that elite games are much faster than 15/13-a-side rugby. Along with potentially poor fitness of recreational participants and the multidirectional nature of touch rugby this can increase injury risk. Nevertheless modified versions of team sports can promote physical, social and mental well-being whilst minimizing the cost of injury to participants and society.

4.2. Intensity

Much literature has explored the physiological benefits of team-sport activity on markers of health. However, some would argue that there are implications and risks associated with team-sport activity when used as health promoting exercise

(Waddington, 2000). Intensity of play needs consideration as high intensities might not be suitable for some populations particularly those presenting cardiovascular risk factors, due to the high internal load placed on the body. In addition, sport requires two or more opposing players and consists of a fluid motion throughout a match. It is difficult for a single player to control the movement and intensity at which certain skills are performed. This lack of control over intensity and directional changes, combined with minimal contact, can result in high rates of injury. Intensity can be somewhat controlled, via pitch size and number of players on the pitch. With a reduction in player numbers more high-intensity runs and improved technical actions are observed (Aslan, 2013; Randers et al., 2014). These results are highly influenced by a number of factors including age, sex, ability and the level of physical fitness (Aslan, 2013; Randers et al., 2014).

5.0. Conclusion

It is apparent from research that current PA levels are higher than previous years. However, many are not involved in any PA or are doing too little to obtain the potential health benefits. For numerous reasons, including the associated negative health consequences, competitive, organised sport is not thought to be the solution to the physical inactivity epidemic (Coalter, 2007). It is has been suggested that regular participation in modified versions of team sports can positively impact many aspects of health. Decreases in BP, RHR, cholesterol levels and anthropometry measures have all been observed during consistent participation in modified versions of soccer (Krustrup et al., 2010a; Krustrup et al., 2010c; Mohr et al., 2014a; Barene et al., 2014b; Krustrup & Bangsbo, 2015), however research in modified versions of other sports (e.g. rugby) is lacking. The intensity of modified versions of team sports can be manipulated to make it suitable across populations through manipulations in rules, pitch dimensions and number of players (Randers et al., 2014b). This presents an opportunity for research, using initiatives such as PTRL, into the motives behind participation and associated health benefits of participation over a prolonged period.

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A quantitative and qualitative evaluation of a 10-week Play Touch Rugby League programme for improving physical activity and health in adult men and women

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Abstract

The aim of the study was to examine the health benefits and quantify the match demands of a Touch Rugby League program in adult men and women. Using a non-randomised, mixed model design, 16 participants (male n= 8, female n = 8) completed a 10-week Touch Rugby League program organised by the Rugby Football League. Participants had health markers including resting heart rate, resting blood pressure, cholesterol and anthropometric measure, taken at baseline, week 5 and week 10. GPS data was collected over the 10-week intervention and was used to examine differences in match demands between the sexes. Match demands were consistently higher in males than females over the 10-week intervention. Resting heart rate, when compared to baseline, was *likely lower* and *possibly lower* at week 10 in males and females respectively. At week 10 diastolic blood pressure was *likely lower* and *very likely lower* in men and women respectively when compared to baseline values. High-density lipoprotein cholesterol remained *unclear* throughout the 10-week intervention in both males and females. Low-density lipoprotein cholesterol was *likely higher* in males and *possibly lower* in females at week 10 compared to baseline. In conclusion, regular participation in Touch Rugby League has favourable effects on cardiovascular risk factors in healthy men and women.

Declaration

This work is original and has not been

previously submitted in support of a Degree,

qualification or other course.

Signed ....

Date 25th September 2015 ....

Contents List

1.0 Introduction

Regular physical activity is known to reduce the risk of developing cardiovascular disease (CVD), type 2 diabetes mellitus (T2DM), atherosclerosis and some cancers, through the modification of risk factors such as blood pressure, cholesterol and total body mass (Maessen et al., 2014; Malhotra, Noakes & Phinney, 2015; Dobbelsteyn, Joffres, MacLean & Flowerdew, 2015). Concerns about increasing obesity are confirmed by worldwide figures from 2014 that show more than 1.9 billion adults were classed as overweight, of which 600 million were obese (World Health Organisation, 2015). Excess body mass and obesity are widely recognised risk factors in the development of CVD (Choi et al., 2015). However, despite warnings concerning the health implications of excess body mass and increased sedentary behaviour, physical activity guidelines set by Government are yet to be met (Luke & Cooper, 2013; Malhotra, Noakes & Phinney, 2015). These guidelines state that adults (18-64 years of age) should undertake a minimum of 30-minutes aerobic activity of a moderate intensity on at least five days a week (Department of Health, 2011; Garber et al., 2011; Haskell et al., 2007). Reducing sedentary behaviour and increasing physical activity can elicit changes in CVD risk factors, promote health and reduce the likelihood of disease (Chau et al., 2015).

Blood pressure (BP), resting heart rate (RHR), cholesterol, body mass index (BMI) and waist circumference (WC) are all used by practitioners to asses CVD risk (NICE, 2014; Grundy, Pasternak, Greenland, Smith, & Fuster, 1999). Recent studies have demonstrated that recreational soccer and small-sided games, when played weekly for 8-24 weeks, can present favourable reductions in CVD risk factors among a variety of populations. Several studies have reported reductions in BP following short-term interventions in untrained normotensive men and women (Krustrup et al., 2010a; Krustrup et al., 2009; Barene, Krustrup, Jackman, Brekke & Holtermann, 2014a) as well as in men and women with T2DM (De Sousa et al., 2014), habitually active men with mild-to-moderate hypertension (Knoepfli-Lenzin et al., 2010; Krustrup et al., 2013) and sedentary premenopausal hypertensive women (Mohr et al., 2014). Short-term soccer training can also lower RHR by approximately 7-11 bpm in premenopausal inactive (Connelly et al., 2014) and hypertensive women (Mohr et al., 2014) and in healthy untrained (Randers et al., 2010) and mildly hypertensive men (Knoepfli-Lenzin et al., 2010). Total cholesterol is also known to decrease with soccer training by ~5%, along with decreased low-density lipoprotein (LDL) cholesterol and increased high-density lipoprotein (HDL) cholesterol (Krustrup et al., 2009). These changes in lipid profile are often accompanied by marked reductions in total body mass and BMI that are not observed with different exercise modalities such as continuous running or strength training (Nybo et al., 2010; Krustrup et al., 2009; Mohr et al., 2014; Krustrup, Dvorak, Junge & Bangsbo, 2010b; Krustrup et al., 2010c). It has been suggested that WC should be used alongside BMI when predicting CVD risk given the problems of using BMI alone (World Health Organisation, 2000; Maessen et al., 2014) and that a large WC has been associated with increased CVD risk in both men and women (Koster et al., 2008; Doppelsteyn et al., 2015). Waist circumference provides a measure of central obesity and is thought to be strongly correlated with total body fat mass and associated with increased risk of hypertension and T2DM (Wen-Ya et al., 2013; Staiano et al., 2012). Reductions in total body mass, BMI and WC of 0.7-1.6 kg, 0.3-1.4 kg/m^2 and 3.3-5.4 cm, respectively, have been well documented in soccer (Krustrup et al., 2009; Barene et al., 2014a; Krustrup et al., 2013; Randers et al., 2012;

Schmidt et al., 2013, Andersen et al., 2014; De Sousa et al., 2014) but less so in other sports. The aforementioned changes in CVD risk factors provide a unique opportunity to utilise modified versions of team sports to promote health.

Greater exposure to regular physical activity is known to cause large reductions in BP and there appears to be distinct differences between male and female responses. Premenopausal women are known to have a BP approximately 6-10mmHg lower than age-matched men (Wiinberg et al., 1995). This difference has been attributed to variations in plasma renin activity, testosterone and oestrogen concentrations over the life cycle (Reckelhoff, 2001). Reductions in BP of approximately 13 mmHg and 8 mmHg in systolic blood pressure (SBP) and diastolic blood pressure (DBP) respectively, have been observed in programmes lasting between 15 and 24-weeks (Krustrup et al., 2010b; Mohr et al., 2014). Slightly shorter intervention periods (~12-weeks) have also elicited reductions in RHR of ~6-11% in healthy, untrained and diseased individuals of both sexes (Krustrup et al., 2009; Barene et al., 2014a; Barene, Krustrup, Brekke & Holtermann 2014b; Randers et al., 2014; Mohr et al., 2014; Randers et al., 2010). Similarly, 12-week soccer programmes have also presented reductions in total cholesterol (~5%), LDL-cholesterol (~15%) and increases in HDL-cholesterol (~8%; Krustrup et al., 2009; Krustrup, et al., 2010b; Krustrup et al., 2010c). Shorter interventions of 4-weeks have also produced reductions in BP (e.g. ~3mmHg in both SBP and DBP; Cornelissen & Fagard, 2005; Krustrup et al., 2010d), decreased total and LDL-cholesterol (e.g. 0.1-0.2mmol/L; Krustrup et al., 2010a; Krustrup et al., 2009) and reductions in RHR (e.g. 6bpm; Krustrup et al., 2009) in both men and, to a lesser extent, premenopausal women. However, there appears to be limited research on the health benefits of taking part in a physical activity program for a period between 4 and 12-weeks. Regular physical activity not only results in physical benefits but also mental and social benefits. Individuals involved in team sports are known to present improved social well-being, mental health and overall life satisfaction compared to those taking part in individual activities such as jogging (Eime, Young, Harvey, Charity & Payne, 2013). Regular participation has also been proven to improve mood, emotion and self-esteem and reduce feelings of anxiety (Penedo & Dahn, 2005; Coalter, 2013; Dugan, Bromberger, Segawa, Avery & Sternfeld, 2015).

There has been limited research using modified versions of team sports, other than in soccer, to assess the match demands and benefits to health. Soccer is not a universally popular sport and, as all sports present different match demands, it is important to investigate other sports and if they provide similar health benefits. Recently there has been an increase in the emergence of recreational leagues and initiatives, for example the Rugby Football League's (RFL) Play Touch Rugby League (PTRL) initiative. Such initiatives aim to create a social atmosphere encouraging participation and physical activity (Touch Rugby League, 2014). Touch Rugby League is a high intensity, intermittent team sport with only six players on the pitch at any given time. Unlike other rugby codes (Rugby Union and Rugby League), Touch Rugby League implements an unlimited substitution rule that is determined by the players themselves, therefore allowing players adequate recovery off-pitch (Beaven, Highton, Thorpe, Knott & Twist, 2014). Touch Rugby League can comprise either single sex or mixed sex teams; however, research is yet to investigate the benefits and perceptions of health between the sexes and Touch Rugby as a whole. Therefore the aim of this study is three-fold: (1) to investigate the health benefits of a 10-week Touch Rugby League programme in men and women, (2) to quantify match demands of Touch

Rugby League in both men and women and, (3) explore participants' perceptions of physical activity and Touch Rugby League.

2.0 Methods

2.1 Participants and Design

After ethical approval from the Faculty of Life Sciences Research Ethics Committee, 16 participants (male n = 8, female n = 8), aged 20-45 years. Smokers and/or medically managed hypertensives were excluded from the study (Andersen et al., 2014a). All participants were randomly selected from a single weekly PTRL programme in the North West of England. All participants were initially contacted via the RFL after which the researcher distributed Participant Information Sheets (Appendix 1) to those who had expressed an interest. All participants provided written informed consent (Appendix 2).

The study employed a non-randomised mixed model design with two independent groups (male and female). A sample size of 16 (8 per group) was calculated using G*Power (G*Power, Universität Kiel, Germany) with an alpha level of 0.05, a power of 0.8 and effects sizes of 4.0-4.5. Effect sizes were calculated from changes expected in the key dependant variables (e.g. resting SBP and HR, cholesterol and waist circumference) as reported in previous studies (e.g. Krustrup et al., 2009; de Sousa et al., 2014; Mohr et al., 2014).

On the first visit participants completed a questionnaire and had baseline health markers of resting heart rate, resting blood pressure, waist circumference, cholesterol, stature and body mass taken. Over the next 10-weeks participants attended one 60-

minute PTRL session per week, during which movement demands (using global positioning system [GPS]), heart rate were recorded. All health markers were again taken before the sessions in the fifth and tenth weeks. In addition, focus groups were conducted with some participants after the 10-week period exploring perceptions of Touch Rugby League and any health benefits. All 16 participants attended at least 80% of the PTRL sessions and therefore were included for analysis in this study (Wallace & Cumming, 2000). A schematic of the study design is shown in Figure 1.

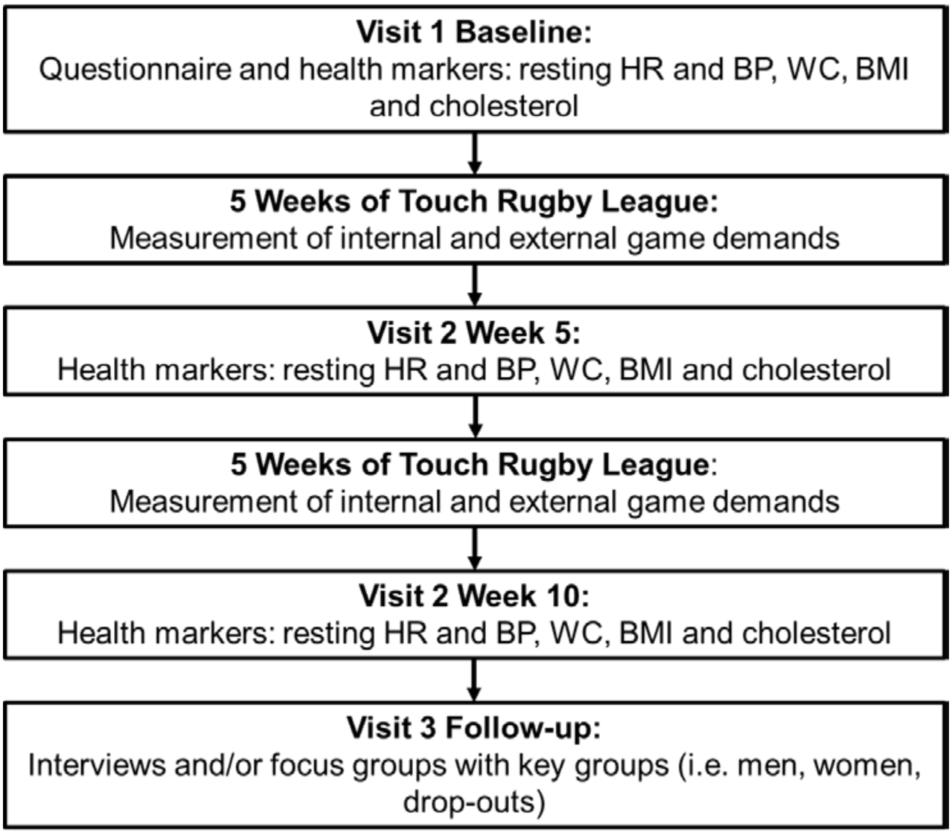

Figure 1. Schematic design of the study for male and female participants. HR = heart rate; BP = blood pressure; WC = waist circumference; BMI = body mass index.

2.2 Questionnaire

A short biographic questionnaire (Appendix 3) was hand distributed to all participants before any testing commenced. The self-designed questionnaire aimed to capture information about: lifestyle, current physical activity, Touch and perceived health benefits. A pilot questionnaire format and questions had been trialled prior to testing on a different PTRL program. The questionnaire was adjusted according to feedback from the pilot to increase validity. Each questionnaire had an individual identification code along with a detachable interview agreement sheet. The detachable sheet was for participants to fill out if they were prepared to take part in the interviews or focus groups after the 10-week intervention period. All questionnaires and corresponding identification codes remained confidential. Questionnaires were subsequently coded for analysis (Bryman, 2012).

2.3 Health Markers

2.3.1 Heart rate and blood pressure

Resting heart rate was recorded using a heart rate monitor (Polar Electro Oy, Kempele, Finland) and calculated as the lowest average value over a one minute period after being seated for 5 minutes with heart rate being recorded every 20 s (Randers et al., 2012). Manual resting systolic and diastolic blood pressure was obtained using a stethoscope (Littmann, Select 3M Health Care, Neus, Germany) and sphygmomanometer (WelchAllyn, Durashock Handheld Aneroid, Spenglers, Cachan, France) and expressed as the mean of three measurements after the participant had been seated for 5 minutes (Lee et al., 2010; Mendham, Coutts & Duffield, 2012).

2.3.2 Blood cholesterol

A 40μL capillary blood sample from a finger on the non-dominant hand was taken to assess total, low density lipoprotein (LDL) and high density lipoprotein (HDL) cholesterol. Samples were analysed using a portable analyser (Cholestech LDX, Cholestech Corporations, California, USA).

2.3.3 Anthropometry

Stature (Harpenden Stadiometer, Holtain, Crymych, Dyfed, UK) and body mass (Seca 213, Seca, Hamburg, Germany) were measured from which body mass index (BMI) was calculated as body mass divided by stature squared. Waist circumference was measured 2.5 cm above the navel while standing and at the end of a normal expiration, with values reported to the nearest 0.5 cm (Koster et al., 2008; Staiano et al., 2012).

2.4 Assessment of internal and external match demands

All Touch Rugby matches were played outdoors on a natural grass surface. Movement characteristics were recorded using a global positioning system device (Catapult S4, Melbourne, Australia), that was also fitted with tri-axial accelerometers and gyroscopes sampling at 100 Hz providing greater accuracy on speed, high-intensity efforts and acceleration (Gabbett, 2010; Gabbett, Jenkins & Abernethy, 2012). Fifteen minutes before each match GPS units were activated to allow the acquisition of satellites (range). The GPS unit was positioned on the participant and worn in a custom made vest with the unit located between the scapulae. Participants also wore a heart rate monitor (Polar Electro, Oy, Finland), ensuring the electrodes were moist and in contact with the skin of the chest. Each player wore the same device each week to discount for any intra-model variability (Randers, Nielsen, Bangsbo &

Krustrup, 2014). Participants completed a 10-15 minute warm-up before the matches, with any data recorded during this time being excluded from analysis. Thereafter, participants took part in a Touch Rugby League match lasting approximately 40 min (2 x 20 min) during which data were recorded and stored by the GPS unit for later download. During matches, the times participant entered and left the field of play were recorded live via hand notation. Heart rate (b/min) was recorded during matches and used to calculate each individual's average and peak heart rate. GPS was used to measure: absolute (m) and relative (m/min) distance covered at low intensity (<9 km/h), moderate intensity (9-13 km/h) and high intensity running (>13 km/h; Randers et al., 2014), total absolute (m) and relative (m/min) distance covered, peak and average speed (km/h) and energy expenditure (cal/kg). Previous literature suggests that 10Hz Catapult units possess higher levels validity and inter-unit reliability than sampling rates of 1Hz, 5Hz and 15Hz (Johnston, Watsford, Kelly, Pine & Spurrs, 2014). These 10Hz units have been identified as having good reliability and only small variations in distances of 15 and 30 m (CV of 1.3% and 0.7% respectively; Castellano, Casamichana, Calleja-Gonzalez, Roman & Ostojic, 2011; Johnston et al., 2014) but some limitations remain, regardless of sampling rate, in movements performed at speeds >20km/h (Johnston et al., 2014).

2.5 Focus Groups

All participants, as they had completed 80% of the sessions, were asked if they wish to take part in a focus group on completion of the study. Three men and three women took part in the focus group lasting ~15-20 minutes at their training venue. Some participants who had previously volunteered to participate in the focus group did not attend for reasons outside of the researcher's control (e.g. work and family commitments). The focus group was semi-structured and split into two main areas of focus: (1) physical activity and (2) Touch Rugby League, which were then followed by summary questions. The areas of focus aimed to explore general physical activity levels, their perceptions of Touch Rugby and the health and social benefits they believe both Touch Rugby League and physical activity could produce (Appendix 4). The focus group was recorded using a digital audio-recording device and later transcribed for analysis (Bryman, 2015).

2.6 Statistical Analysis

All data were log transformed to reduce bias due to non-uniformity of error and analysed using the ES statistic with 90%confidence intervals (CI) and % change to determine the magnitude of effects. Magnitude-based inferential statistics were employed to provide information on the size of the differences allowing a more practical and meaningful explanation of the data (Batterham and Hopkins, 2006). Thresholds for the magnitude of the observed change for each variable was determined as the within-participant standard deviation (SD) in that variable x 0.2, 0.6 and 1.2 for a small, moderate and large effect, respectively (Cohen, 1988; Hopkins, Marshall, Batterham & Hanin, 2009). Threshold probabilities for a meaningful effect based on the 90% confidence limits (CL) were: <0.5% most unlikely, 0.5–5% very unlikely, 5–25% unlikely, 25–75% possibly, 75–95% likely, 95–99.5% very likely, >99.5% most likely. Effects with confidence limits across a likely small positive or negative change were classified as unclear (Hopkins et al., 2009). All calculations were completed using a predesigned spreadsheets to make both within participant and between group comparisons (Hopkins, 2006).

3.0 Results

Findings from the questionnaires and focus group will not be analysed in this section but rather contextualised in the discussion.

3.1 Heart rate and blood pressure

When compared to baseline, resting heart rate in males was *very likely lower* (-17.3%, -0.9 ± 0.73) at week 5 and *likely lower* (-20.1%, -1.10 ± 0.95) at week 10. However, differences were *unclear* in both males and females (-2.6%, -0.09 ± 0.85 and -2.8%, -0.13 ± 0.7, respectively) from week 5 to week 10. Changes in resting heart rate in females was *unclear* from baseline to week 5 (0.3%, 0.02 ± 0.61) but were *possibly lower* at week 10 compared to baseline (-6.3%, -0.32 ± 0.44). Compared to baseline, SBP in males was *likely lower* at week 5 (-9.2%, ± -0.79 ± 0.67) and week 10 (-9.9%, -0.86 ± 0.52), but *unclear* from week 5 to week 10 (-0.8%, -0.19 ± 0.45). In females, changes in SBP was *unclear* from baseline to week 5 (-1.2%, -0.22 ± 0.59) and from baseline to week 10 (-1.3%, -0.24 ± 0.77). However SBP was *likely lower* at week 10 compared to week 5 (-2.5%, -0.32 ± 0.32). Changes in DBP in males was *unclear* from baseline to week 5 (-2.0%, -0.24 ± 0.82) and from week 5 to 10 (-0.8%, -0.13 ± 1.39) but a *likely lower* when week 10 was compared to baseline (-3.8%, -0.46 ± 0.52). DBP in females, however, was *likely lower* at week 5 (-5.6%, -0.54 ± 0.58), *very likely lower* at week 10 (-9.8%, -0.97 ± 0.5) when compared to baseline, and *possibly lower* at week 10 compared to week 5 (-4.4%, 0.28 ± 0.34).

3.2 Blood Cholesterol

Total cholesterol produced an *unclear* response in males from baseline to week 5 (2.1%, 0.07 ± 0.3). However when compared to baseline total cholesterol in males was *possibly higher* (9.1%, 0.29 ± 0.26) at week 10 and *likely higher* from week 5 to week 10 (8.7%, 0.58 ± 0.48). Changes observed in females total cholesterol were *possibly lower* (-6.3%, -0.33 ± 0.48) at week 10 compared to baseline and *likely lower* (-6.7%, -0.3 ± 0.27) at week 10 compared to week 5, however, was *possibly higher* (4.1%, 0.2 ± 0.34) at week 5 compared to baseline.

Changes in HDL-cholesterol in males, remained *unclear* from baseline to week 5 (-7.2%, 0.23 ± 0.44), baseline to week 10 (22.1%, 0.6 ± 0.45), and from week 5 to week 10 (0.7%, 0.03 ± 0.3). HDL-cholesterol also remained *unclear* in females throughout the 10 week program (baseline to week 5 = 0.1%, 0.0 ± 1.06; baseline to week 10 = 5.2%, 0.24 ± 0.73; week 5 to week 10 = 16.9%, 0.47 ± 0.79).

When compared to baseline, LDL-cholesterol in males was *likely higher* at week 5 (17.0%, 0.47 ± 0.44) and at week 10 (6.0%, 0.34 ± 0.71) but was *unclear* (6.5%, 0.38 ± 0.67) at week 10 compared to week 5. Changes observed in LDL-cholesterol in females were *unclear* (0.4%, 0.01 ± 0.27) from baseline to week 5 but *possibly lower* at week 10 compared to baseline (-5.0%, 0.14 ± 0.26) and *likely lower* at week 10 compared to week 5(-7.5%, -0.34 ± 0.31). All health markers are shown in Table 1.

Table 1. Health markers in male and female participants at baseline, 5 and 10-weeks of a PTRL intervention. Values are means ± SD.

3.3 Anthropometry

	Baseline	5 Weeks	10 Weeks
Resting Heart Rate (b/min)			
Male	79 ± 14	67 ± 18	68 ± 17
Female	82 ± 14	80 ± 15	75 ± 11
Systolic BP (mmHg)			
Male	139 ± 15	127 ± 6	126 ± 9
Female	126 ± 6	126 ± 9	124 ± 6
Diastolic BP (mmHg)			
Male	85 ± 6	81 ± 4	80 ± 5
Female	80 ± 7	75 ± 10	72 ± 10
Total cholesterol (µL)			
Male	4.4 ± 1.2	4.2 ± 0.5	4.4 ± 0.7
Female	4.7 ± 0.8	5.1 ± 0.9	4.6 ± 1.0
HDL cholesterol (µL)			
Male	1.2 ± 0.3	1.1 ± 0.2	1.1 ± 0.3
Female	1.6 ± 0.3	1.5 ± 0.4	1.6 ± 0.4
LDL cholesterol (µL)			
Male	2.2 ± 0.7	2.7 ± 0.5	2.6 ± 0.6
Female	2.3 ± 0.7	2.6 ± 0.5	2.3 ± 0.7
Body mass (kg)			
Male	84.3 ± 11.8	83.8 ± 11.8	84.3 ± 11.9
Female	74.1 ± 14.3	74.2 ± 13.9	72.9 ± 13.4
Waist Circumference (cm)			
Male	85.7 ± 8.2	86.2 ± 8.0	86.6 ± 7.8
Female	84.6 ± 11.6	85.7 ± 12.5	84.0 ± 12.5
BMI (kg/m²)			
Male	26.7 ± 3.9	26.7 ± 3.9	26.7 ± 4.2
Female	28.3 ± 4.5	28.3 ± 4.5	28.0 ± 5.1

Changes in body mass of males participants remained *unclear* from baseline to week 5 (5.1%, 0.29 ± 0.69), baseline to week 10 (6.0%, 0.34 ± 0.71) and from week 5 to week 10 (6.5%, 0.38 ± 0.67). Body mass in females was *possibly higher* from baseline to week 5 (5.1%, 0.24 ± 0.44) but was *unclear* from baseline to week 10 (3.3%, 0.15 ± 0.74) and from week 5 to week 10 (2.9%, 0.14 ± 0.74). Males waist circumference also produced *unclear* responses from baseline to week 5 (4.6%, 0.42 ± 0.91), baseline to week 10 (5.6%, 0.5 ± 0.92) and week 5 to 10 (4.7%, 0.44 ± 0.88). When compared to baseline, waist circumference in females was possibly higher at week 5 (5.4%, 0.37 ± 0.56), but was unclear from baseline (2.8%, 0.19 ± 0.73) and week 5 (1.8%, 0.12 ± 0.72) at week 10. BMI in males was *most likely trivial* at week 5 (-0.5%, -0.03 ± 0.07) and week 10 (0.1%, 0.0 ± 0.05) compared to baseline from week 5 to 10 (0.5%, 0.03 ± 0.06). In females, changes in BMI, when compared to baseline, were *most likely trivial* at week 5 (0.2%, 0.01 ± 0.03) but remained *unclear* from baseline to week 10 (-1.3%, -0.08 ± 0.57) and week 5 to 10 (-1.6%, 0.09 ± 0.56).

3.4 Internal and external responses to PTRL training intervention

Total distance (m and m/min) and average speed were all *likely lower* in females when compared to males (-15.6%, -1.08 ± 0.91). When compared to male, peak speed was *most likely lower* in females. Low (<9 km/h) and moderate (9-13 km/h) intensity activity were both *very likely lower* in females compared to male participants (-24.5%, -1.34 ± 1.12 and -32.2%, -2.07 ± 1.12 respectively). However high intensity activity (>13 km/h), when compared to males, was *most likely lower* (-60.3%, -6.98 ± 1.64) in females but heart rate, when expressed as a percentage of the session heart rate max, was *unclear* in females compared to males (-1.9%, -0.45 ± 1.48). Energy expenditure was *likely lower* in females compared to males (-15.0%, -0.92 ± 0.99). All internal and external demands are shown in Table 2.

Table 2. Internal and external demands of PTRL training for male and females participant. Values are mean ± SD**.**

	Male	**Female**
Total Distance (m)	3005 ± 403	2533 ± 277
Total Distance (m/min)	75.2 ± 10.1	63.4 ± 6.9
Average Speed (km/h)	4.5 ± 0.6	3.8 ± 0.4
Peak Speed (km/h)	24.8 ± 1.4	18.7 ± 1.0
Low Intensity Activity (m/min)	14.9 ± 2.6	11.3 ± 2.6
Moderate Intensity Activity (m/min)	18.4 ± 3.0	12.6 ± 2.6
High Intensity Activity (m/min)	3.4 ± 0.4	1.4 ± 0.3
HR (% session max)	70.3 ± 2.4	69.1 ± 4.2
Energy Expenditure (k/cal)	3.4 ± 0.5	2.9 ± 0.4

4.0 Discussion

The primary aim of this study was to examine the health benefits of a 10-week Touch Rugby League programme in men and women. It was observed that 10-weeks of Touch Rugby League for healthy men and women produced reductions in RHR, SBP, DBP and BMI. Increases in total cholesterol were observed in both men and women over the 10-weeks with men displaying increases and women decreases in LDL-cholesterol. It became apparent from the questionnaires and focus group that many participated in PTRL to enhance health physically, socially and mentally. Many participants, particularly women, indicated in the questionnaires that 'relieving stress' was the second most important reason, after 'good for health' as the reason they took part in physical activity, specifically Touch Rugby League. A distinct theme that emerged from both the questionnaires and focus group was that males and females regarded friendships and socialisation as a key reason for their involvement and continuing participation in PTRL. These results suggest that the intermittent nature of recreational Touch Rugby League is sufficient to produce cardiovascular and physiological adaptions as well as enhancing social and mental aspects to positively influence health.

The reduction in SBP (13 mmHg and 2 mmHg) and DBP (5 mmHg and 8 mmHg) in both men and women respectively, is of a degree thought to be beneficial to health (Pedersen & Saltin, 2006). Such results are similar to those of previous research with males reporting larger reductions in SBP than females (Mohr et al., 2014; Krustrup et al., 2009; Krustrup et al., 2010d; Pedersen & Saltin, 2006). The observed lower resting blood pressure may be explained via the acute responses of exercise including reductions in total peripheral resistance, sympathetic outflow and increased vasodilation (Krustrup et al., 2009; Krustrup et al., 2010c; Pescatello et al., 2004). If this form of exercise was to be sustained for a longer period (i.e. >1 year) chronic changes to resting blood pressure, such as further lowering of RHR, renin and angiotensin 2, may be detected (Krustrup et al., 2009; Krustrup et al., 2010c; Pescatello et al., 2004; Reckelhoff, 2001). Irrespective of physical activity young, healthy, normotensive males typically report higher resting blood pressure than young, pre-menopausal females. This is primarily thought to be due to the incapability of vascular sympathetic nerves to initiate vasoconstriction and the increased oestrogen levels in females promotes nitric oxide facilitated vasodilation (Joyner, Wallin & Charkoudian, 2015; Reckelhoff, 2001). Vasodilation as a result of oestrogen levels in females can also contribute to reductions in RHR. However, as evident in this study women often present a higher RHR than their male counter parts (Krustrup et al., 2009; Mohr et al., 2014). At baseline, both male and female participants' RHR were above normal values of 75 b/min. Elevated RHR, above normal, is associated with various risk factors of CVD including obesity, cholesterol and hypertension (Fox et al., 2007). However, 10-weeks of PTRL, in addition to habitual physical activity, decreased male and female RHRs by 11 b/min and 7 b/min respectively, bringing them within normal values. The greater reductions in both SBP and RHR in male participants may reflect the higher internal and external match demands presented in Table 2. Male Touch Rugby League players covered more distance at a higher average speed and covered more distance at high intensities along with producing greater peak speeds than female participants. This increase in high intensity activity presented by the males may be more effective in lowering RHR, therefore reducing CVD risk factors, than mainly low and moderate intensity activity evident in females playing Touch Rugby League (Guiraud et al., 2012).

LDL-cholesterol increased in males and decreased in females with HDL-cholesterol remaining unchanged in both sexes during the 10-week intervention. Total cholesterol reflected the changes of LDL-cholesterol, increasing in males and decreasing in females. Numerous studies have reported reductions in LDL-cholesterol as a result of physical activity interventions (Fan, Ham, Muppidi & Mokdad, 2009; Imamura, Mizuuchi & Oshikata, 2012; Krustrup et al., 2009). However increases in

LDL-cholesterol are less well documented. Although diet was not controlled in this study, one possible reason for the increased LDL-cholesterol in males may be due to diets high in trans-fats and saturated fats. During the focus group one male eluded to the fact that his diet was rather poor and could be improved. High consumption of trans-fats and saturated fats are known to be a primary cause in increasing levels of total cholesterol and LDL-cholesterol (Anagnostis, Stevenson, Crook, Johnston & Godsland, 2015; Stanley et al., 2010). Furthermore, changes in cholesterol levels are often a result of changes in total body mass and BMI (Krustrup et al., 2009; Durstine & Thompson, 2001; Mohr et al., 2014). The results of the present study show little or no difference in body mass, BMI or WC, particularly in males. This could, to some extent, have resulted in the small differences observed in cholesterol levels. However, this is in contrast with current literature which have reported considerable reductions in WC, BM and BMI after 12-weeks of training in habitually active men (Kneopfli-Lenzin et al., 2010; Krustrup et al., 2009). Additionally the demands of PTRL, along with the duration of the intervention, may not have been sufficient to elicit high levels of energy expenditure and the associated changes in anthropometric measures. However the males' reported in the questionnaire taking part in more physical activity on a weekly basis than females. It is therefore possible that the males body mass was more stable than the females at the start of the study. Although females' body mass produced *possibly higher* and *unclear* descriptives, increasing females physical activity levels via PTRL produced slight reductions in mean values of body mass and BMI over the 10-weeks. Such reductions in body mass could account for the lower LDL-cholesterol also present in females after the 10-weeks intervention.

4.1 Limitations

There are multiple methodological limitations that have been identified in the current study. For example, the relatively small study size limits the validity and therefore the results should be interpreted with care when applied to a larger population. Additionally, to allow further interpretation of the cholesterol and anthropometric data, food diaries and body fat analysis would be necessary. Lastly, to further identify reasons for participation a more in depth sociological examination and interpretation of participants would be necessary.

4.2 Conclusion

It is evident from both the literature, and this study, that participation in regular physical activity positively impacts physical, social and mental health in both men and women. By means of participation in Touch Rugby League participants improved friendship groups and mental health with many participants attributing this to the fun, 'all-inclusive' and 'social' atmosphere emphasised in PTRL. Furthermore participation in PTRL alleviates various risk factors of CVD. PTRL has resulted in reductions in resting SBP and DBP as well as decreased RHR to that of, or below, normal values to an extent that positively impacts upon health. It is also suggested that the small changes observed in cholesterol levels and body mass could be of benefit to health if participation continued over a longer period.

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List of Appendices

Appendix 1.

Participant Information Sheet

A quantitative and qualitative evaluation of a 12-week Play Touch Rugby League programme for improving physical activity and health in adult men and women

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part.

Thank you for reading this.

What is the purpose of the study?

The purpose of this study is to investigate the health benefits of a 12-week touch rugby in adult men and women.

Why have I been chosen?

You have been chosen because you are a member of a Play Touch Rugby League team, aged between 20 and 45 years and you do not smoke or take medication for hypertension.

Do I have to take part?

It is up to you to decide whether or not to take part. If you decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect the standard of care you receive in any way.

What will happen to me if I take part?

You will be given this information sheet to keep and asked to sign the consent form. After this, the researcher will fully explain what the study entails and the procedures involved. You will then be asked to fill out a short questionnaire on your current lifestyle and Touch experience. Your resting heart rate and blood pressure will then be measured along with height, weight, waist circumference and blood cholesterol. Blood cholesterol will be taken from a finger prick sample on your non-dominant hand. You will then be required to participate in the weekly Touch rugby sessions organised by the Play Touch Rugby League for a total of 12 consecutive weeks. In each of these touch sessions your movements will be tracked by you wearing a small data logging box in a tight fitting vest (global positioning system) and your heart rate by means of a monitor strapped around your chest. Measures of resting heart rate, blood pressure, height, weight, waist circumference and blood cholesterol will be taken again at weeks 6 and 12 of the research project. After the 12 week period the researcher will contact you if you have indicated on the questionnaire that you are prepared to take part in an interview or focus group. This will explore your current physical activity, touch routines and your actual and perception of health benefits of physical activity. These will be organised around your schedule and convenience.

What are the possible disadvantages and risks of taking part?

Blood will be sampled from a finger prick at three time points during this project. These will be taken by a trained researcher who will minimise all risks associated with blood sampling. The study also requires you to attend your weekly Play Touch Rugby League sessions for 12 weeks and take part in the interview or focus group if you wish. The training sessions will be part of your normal exercise routine while the interview/focus groups will be arranged at a convenient time for you.

What are the possible benefits of taking part?

As a result of taking part, you will be informed of how your resting heart rate, blood pressure, weight, waist circumference and blood cholesterol have changed over the course of the 12 weeks. You will also receive a report on your movements and heart rate during the training sessions.

What if something goes wrong?

If you wish to complain or have any concerns about any aspect of the way you have been approached or treated during the course of this study, please contact Professor Sarah Andrew, Dean of the Faculty of Applied and Health Sciences, University of Chester, Parkgate Road, Chester, CH1 4BJ, 01244 513055.

If you are harmed by taking part in this research project, there are no special compensation arrangements. If you are harmed due to someone's negligence (but not otherwise), then you may have grounds for legal action, but you may have to pay for this.

Will my taking part in the study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential in password protected folders so that only the researcher carrying out the research will have access to such information. All data will be coded to ensure anonymity.

What will happen to the results of the research study?

The results of this project will be written up into a Masters dissertation and might be published in an academic journal but any data included will in no way be linked to any specific participant. You are most welcome to request a copy of the results of the project should you wish.

Who is organising and funding the research?

The Department of Sport and Exercise Sciences at the University of Chester will be involved in organising and carrying out the study.

Who may I contact for further information?

If you have any questions about the project, either now or in the future, please contact:

Name: Ruth Ashton
Email: r.ashton@chester.ac.uk

Thank you for your interest in this research.

Appendix 2.

University of Chester
QUI DOCET IN DOCTRINA

Title of Project: A quantitative and qualitative evaluation of a 12-week Play Touch Rugby League programme for improving physical activity and health in adult men and women

Name of Researcher: Ruth Ashton

Please initial box

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions. ☐

2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving any reason and without my legal rights being affected. ☐

3. I agree to take part in the above study. ☐

Name of Participant	Date	Signature
Researcher	Date	Signature

Appendix 3.

University of Chester

RFL

Personal Details

Club: ___________________________ **Age:** ________ **Sex:** M / F *(please circle)*

Marital Status: Single ☐

Married ☐

Divorced ☐

Cohabiting ☐

Other ☐

How many people live in your household?

____

Are there any dependents in your household? If yes, how old are they?

____

Current employment status: Full-time ☐ Retired ☐

Part-time ☐ Full-time carer ☐

Unemployed ☐ Full-time house-maker ☐

What is your average annual household income?*

Less than £15,000 ☐ £15,001 - £20,000 ☐ £20,001 - £30,000 ☐

£30,001 - £40,000 ☐ £40,001 - £50,000 ☐ More than £50,001 ☐

*based on data from the ONS.

University of Chester RFL

Questionnaire

1. **What sports/physical activities, other than touch, do you currently take part in, if any?** *(please tick all that apply)*

Football ☐ Rugby league ☐ Rugby union ☐ Netball ☐ Tennis ☐

Running ☐ Swimming ☐ Basketball ☐ Hockey ☐ Golf ☐

Cycling ☐ Badminton ☐ Rowing ☐ Aerobics ☐ Keep-fit ☐

Gym ☐ Other ☐

If other, please specify:

____

2. **How often do you participate in sport/physical activity?** *(please tick the most appropriate)*

Less than once a month ☐ Once per week ☐ 2-3 times per week ☐

4-5 times per week ☐ More than 6 times a week ☐

3. **How much time, each week, do you spend being physically active?**

Less than 2 hours ☐ 2 – 4 hours ☐ 4 – 6 hours ☐

6 – 8 hours ☐ More than 8 hours ☐

4. **What are your feelings towards general physical activity?** *Please rank the following statements in order of importance, 1 being the most important and 7 the least important.*

Good for health ☐ Maintain physical appearance ☐
To socialize with others ☐ To relieve everyday stresses ☐
To lose weight ☐ I don't enjoy physical activity ☐
It gives me enjoyment ☐ Other ☐

If other, please specify:

____

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5. **How would you rate these aspects of your own health?** *Please tick the most appropriate answer for each statement which corresponds most closely to your desired response.*

	Very Poor	**Poor**	**Average**	**Good**	**Excellent**

General health					
Physical health					
Mental health					
Social health					

6. Briefly outline any health benefits you think you may get from doing regular physical activity.

____

____

7. How or where did you hear about Touch Rugby League?

Friends ☐ Newspaper advert ☐ Advert at a rugby league club ☐ Teacher ☐

TV Advert ☐ Coaches at rugby league clubs ☐ Other ☐

If other, please specify:

____

8. How long have you played Touch Rugby League? ***(only tick the most appropriate)***

First session ☐ <2 months ☐ 2 - 4 months ☐ 4–6 months ☐ > 6months ☐

9. Why did you decide to take part in Touch Rugby League? *Please tick the most appropriate answer for each statement which corresponds most closely to your desired response.*

	N / A	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
My friends play						
I used to play contact rugby						
I wanted to try something new						
To socialize						
To help lose weight						
For other health reasons						
I play touch for other reasons than stated above						

If other reasons, please specify:

____

10. Briefly outline any health benefits you think you may get from taking part in Touch Rugby League.

____

____

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11. What do you enjoy most about Touch Rugby League sessions? *Please tick the most appropriate answer for each statement which corresponds most closely to your desired response.*

	N / A	Strongly Disagree	Disagree	Not Sure	Agree	Strongly Agree
Keeping fit						
To feel healthier						
For fun						
To socialize						
Friendship						
To gain confidence						
Good value for money						
Other						

If other, please specify:

____

Thank you.

✂ -

You are invited to take part in a 15-20 minute focus group discussion at the end of this study. Please fill out the details below.

☐ Yes, I am happy to be contacted regarding the focus groups.

☐ No, I do not wish to be contacted.

Name: ____________________________

Telephone number or email: ________________________________

Appendix 4.

<u>Focus Group Schedule</u>

Follow-up Questions:

Quote response then...

What do you mean by...?

Can you tell me more about...?

Can you explain what you

Thank you for agreeing to take part in this study, can I ask you to confirm that you have read and understood the participant information forms and are therefore aware of the potential use of this data.

This interview aims to gather your views and experiences of PTRL.

Are we able to begin the discussion?

Physical Activity

Can I start by asking what you think physical activity is?

How would you describe your current level of physical activity?

- How do you think this compares to other people of a similar age?
- Have you always been physically active?
- Has this changed over the 12-weeks at all?

Can you tell me a little bit about why you take part in physical activity?

- Health, enjoyment, appearance, socialise, weight control, relieve stress?

What, if any, do you think the health benefits are of taking part in physical activity?

- What about other aspects of health (mental/social) other than physical health?

Touch Rugby

What experiences of rugby did you have before playing Touch?

- School? Work place?
- League, union, sevens?

How did you first become aware of Touch rugby?

Now that you have been playing touch for at least 12-weeks, do you think you will continue playing?

- Can you tell me why?
- What do you find most enjoyable about the sessions?

What, if any, do you think the health benefits are of taking part in Touch?

- BP, cholesterol, HR, weight loss?
- You've spoken about short-term benefits but what about any long term benefits?

Do you think your health has altered at all over the 12-weeks?

- For the better or for worse?
- In what way?
- Why do you think it has changed?

<u>Summary</u>

What do you think you have got out of taking part in Touch?

What have you got out of taking part in this study?

Finally, I have asked all the questions that I would like to ask, do you have anything you would like to add or you would like to ask me?

Thank you for your time.