Health-Enhancing Physical Activity

During Secondary School Physical Education

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This thesis is submitted as partial fulfilment of the requirements of Liverpool John Moores University for the degree of Doctor of Philosophy by published works. This original work is my own and the majority of it has been carried out at Liverpool John Moores University, and has not been submitted for any other degree award.

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Signed.....

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Abstract

The school context is a key environment for physical activity participation with physical education highlighted as a central vehicle for promoting children's activity. This thesis includes seven publications focused on health-enhancing physical activity within physical education. The research aimed to quantify physical activity levels and their determinants during secondary school physical education lessons, and implement a pedagogical intervention to increase physical activity within classes.

An audit of physical education curriculum provision highlighted that team games were the most prominent activities on offer, though female teachers provided more lifetime activities than male colleagues. A review of published studies revealed that students spent around 30-40% of lesson time in moderate-to-vigorous physical activity (MVPA) during physical education. In intervention studies MVPA increased by 5-10%, depending on measurement instrument. The empirical investigations demonstrated that team games stimulated more MVPA (43.2% of lesson time; $p <$ .01) than other curricular activities. Furthermore, boys were active for 10% more lesson time than girls ($p < .01$). This gender difference may have been related to the typical curricula that girls and boys followed, as individual activities were enjoyed most by girls and team games by boys ($p < .0001$). Girls' data revealed a negative relationship between enjoyment and MVPA ($r = -.4$, $p < .05$), and whilst adiposity had a significant influence on physical activity ($R^2 = .42$, $p < .01$), cardiorespiratory fitness did not account for any variance. A curricular intervention improved girls' MVPA during gymnastics lessons (intervention group = 40% vs. control group = 28%, $p = .008$), without compromising levels of intrinsic motivation or lesson objectives.

The data suggest that physical education has the potential to make a valuable contribution to young peoples' physical activity levels. This potential is more likely to

be realised when teachers include increased physical activity alongside other planned lesson objectives.

1.0 Introduction

This thesis consists of seven peer-reviewed published articles for consideration of the award of PhD by published works. All of the papers relate to the theme of health-enhancing physical activity through curriculum physical education. Of these, two are single authored and five are joint-authored. Each of the empirical studies was designed and conducted by myself, and I made the major contribution to the joint papers. All of the papers were peer-reviewed and accepted for publication in physical education, health education and exercise science journals prior to submission.

2.0 Refereed papers

1. Fairclough, S. Stratton, G. and Baldwin, G. (2002). The contribution of secondary school physical education to lifetime physical activity, *European Physical Education Review*, 8: 69-84. *(Refereed, Principal author)*

2. Fairclough, S. and Stratton, G. (2005). Physical activity levels in middle and high school physical education: a review, *Pediatric Exercise Science*, 17: 217-236. *(Refereed, Principal author)*

3. Fairclough, S. and Stratton, G. (2005). 'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels, *Health Education Research*, 20: 14-23. *(Refereed, Principal author)*

4. Fairclough, S. and Stratton, G. (2003). Cardiorespiratory and musculo-skeletal loading during high school physical education, *Revista Portuguesa de Ciencias do Desporto*, 3(2 [Suppl.]), 129-131. *(Refereed, Principal author)*

5. Fairclough, S. (2003). Physical activity, perceived competence and enjoyment during high school physical education, *European Journal of Physical Education*, 8: 5-18. *(Refereed, Single author)*

6. Fairclough, S. (2003). Girls' physical activity during high school physical education: influences of body composition and cardiorespiratory fitness, *Journal of Teaching in Physical Education*, 22: 382-395. *(Refereed, Single author)*

7. Fairclough, S. and Stratton, G. (2005). Improving health-enhancing physical activity in girls' physical education, *Health Education Research*, 20: 448-457. *(Refereed, Principal author)*

3.0 Structure of the research proposal

This research programme is set in a clearly organised framework. The overarching research aims are firstly presented. Secondly, the theoretical rationale for the research is put forward. This is based on the existing literature in the areas of health-enhancing physical activity and physical education. The rationale provides a health-promotion and pedagogical context to each of the papers presented. The third element of the thesis is a synthesis of the published articles that focuses on their aims, findings and conclusions. This is followed by a summary and critical review of the papers. Finally, conclusions are drawn and recommendations for further study are proposed.

4.0 Aims of the research programme

1. To quantify physical activity levels during secondary school physical education lessons.
2. To establish physical activity levels of discrete groups (i.e., boys and girls, students of differing abilities, and students involved in different types of physical education activities).
3. To investigate factors which determine physical activity during physical education.
4. To design and apply a teaching intervention to increase physical activity during physical education.

In order to achieve these aims a variety of quantitative methodologies were utilised. Objective physical activity monitoring was present throughout five of the empirical papers. Heart rate monitoring and accelerometry measured the respective physiological and movement dimensions of physical activity (Welk, 2002). In the intervention study physical activity was also assessed by direct systematic observation (SOFIT; McKenzie et al., 1991). This method allowed the behavioural aspect of the students' physical activity to be monitored and recorded. Furthermore, behavioural data provided valuable contextual information on student and teacher activity during lessons. Questionnaires were used to collect quantitative data on physical education curricula, and psychological responses of students after physical education lessons. Lastly, laboratory-based methods were utilised to establish levels of cardiorespiratory fitness and adiposity.

5.0 Rationale for the research programme

Regular physical activity participation throughout childhood may provide immediate and long-term health benefits (Malina et al., 2004). However, current levels of physical activity observed in young people are low (Armstrong and Van Mechelen, 1998; Stone et al., 1998), and low fitness levels are associated with clustered risk factors for cardiovascular disease (Andersen et al., 2003). As a result, recommendations for the amount and intensity of physical activity that is beneficial for young people's health have been published (Biddle et al., 1998). Currently, the primary recommendation advocates that young people (aged 5-18 years) engage in at least moderate intensity physical activity for a minimum of one hour each day (Biddle et al., 1998). As the nature of young people's physical activity comprises intermittent episodes of movement of differing intensities (Bailey et al., 1995), the recommended hour of activity can be accumulated from a number of active bouts over the course of a day. While this guideline provides a specific target for young people to aim for, theoretical models of physical activity promotion may be important to inform strategies for participation. One such conceptual framework has been proposed by Welk (1999). The 'Youth Physical Activity Promotion Model' is based on the multi-dimensional correlates of youth physical activity (Sallis et al., 2000). The basis for the model comes from the inter-relationships between 'predisposing', 'enabling', 'reinforcing' and 'demographic' factors (Welk, 1999). Physical education is recognised as playing a primary role in influencing enabling and predisposing factors, primarily through progressive emphasis on competence perceptions, enjoyment, and physical and behavioural skills (Welk, 1999).

In line with Welk's view (1999), various academic and policy documents highlight schools, and physical education in particular as important vehicles for physical activity promotion (Biddle et al., 1998; Department of Health, 2004; Fox et

al., 2004; U.S. Department of Health and Human Services [USDHHS], 2000; Trudeau and Shephard, 2005). The aims of health-related physical education are to engage students in appropriate amounts of physical activity during lesson time; and to provide them with the knowledge and skills to participate in physical activity out of school and through the lifespan (Simons-Morton, 1994). While the rationale for health related aims are sound, they may be compromised by other subject aims. These aims relate to the development of motor skills, aesthetic appreciation, and social, moral, spiritual and cultural awareness (Department for Education and Employment / Qualifications and Curriculum Authority, 1999; Sallis and McKenzie, 1991). As a consequence, physical education lessons often focus on multiple goals, which result in variable physical activity levels within and between lessons (Fairclough and Stratton, 2005a). Previous work has highlighted that this variance may be as a result of pedagogical, inter-personal and environmental factors (Stratton, 1996a), as well as the type of activity that is undertaken (Fairclough, 2003). On average, students spend around a third of physical education lesson time in moderate-to-vigorous physical activity (MVPA). However, this can differ between boys and girls, as well as between students with differing abilities (Stratton, 1996b) and motivation levels (Parish and Treasure, 2003).

Interventions to improve physical education activity levels have generally been successful. In several of these studies, students have engaged in MVPA for over 50% of lesson time, meeting the target set for U.S. physical educators in the 'Healthy People 2010' policy document (USDHHS, 2000). Although this target provides a quantifiable goal for physical educators to aim for, its feasibility is debateable as it is rarely achieved under non-intervention conditions (Fairclough and Stratton, 2005a). Some intervention studies employed training-like regimens (Baquet et al., 2002), while others were built around more sustainable, educational strategies (McKenzie et

al., 2004). Though both types of intervention successfully improved students' MVPA, the latter approach better meets the aims of health-related physical education (Simons-Morton, 1994).

Curricular physical education contributes only a small proportion of students' waking hours (Fox et al., 2004) and in many schools is hindered by restricted frequency and duration of lessons (Hardman, 2000). Conversely, it has been demonstrated that on days when physical education is timetabled, students engage in significantly more moderate and especially vigorous physical activity, than on non-physical education days (McKenzie, 2001). There is also evidence that when school-based physical activity opportunities are restricted, such as on non-physical education days, children do not compensate with greater activity after school (Dale et al., 2000). In addition, total daily activity has been shown to be greater on physical education days, than on non-physical education days (Dale et al., 2000; Myers et al., 1996). Thus, physical education lessons may be important as regularly occurring 'windows of opportunity' for physical activity engagement at moderate intensities, and even more so for vigorous intensities.

However, because of time restrictions imposed on curricular physical education, it is unrealistic for it to be seen as a panacea for combating the increase in childhood inactivity and obesity. Instead, it should be perceived as a regularly occurring educational environment for structured physical activity, which complements other opportunities within the school. When seen in this light, physical education, combined with other school-based physical activity can potentially make a valued contribution to young peoples' activity levels.

6.0 Synthesis of submitted papers

6.1 Paper 1

Fairclough, S., Stratton, G. and Baldwin, G. (2002). The contribution of secondary school physical education to lifetime physical activity, *European Physical Education Review,* 8: 69-81.

Aim: To investigate whether physical education provision in secondary schools promotes lifetime physical activity among students.

The promotion of lifetime physical activity is highlighted as an important goal of physical education (Harris, 2000; Sallis and McKenzie, 1991), and is inextricably linked to the public health benefits of childhood and adult participation in physical activity (Shephard and Trudeau, 2000). In particular, research has demonstrated how school physical education can positively impact on future adult physical activity behaviours in females (Trudeau at al., 1999). Evidence from the UK and USA supports the supposition that lifetime activities (i.e., 'those that may be readily carried over into adulthood because they generally require only one or two people'; Ross et al., 1985, p. 76), during the school years have a greater 'carry-over' value' into adulthood (Sallis et al., 1989; Sallis and McKenzie, 1991; Sport England, 2004). Yet in spite of these findings, team games are far more prevalent than lifetime activities in physical education curricula (Sport England, 2004). Moreover, this situation is mirrored during extra-curricular time.

Fifty-one heads of physical education departments (HoPE) within Merseyside completed and returned postal questionnaires. These focused on the type of activities offered during their curricular and extra-curricular programmes. Chi-square analyses compared the frequency of lifetime activities and team games between curricular and

extra curricular time, key stages[i] 3 and 4, and between male and female HoPE. Team games were most prominent during curricular and extra-curricular time. Although male HoPE provided mainly team games at key stages 3 and 4, female HoPE gave a more balanced range of physical activity opportunities. This study emphasised that the traditional team games-dominated curriculum model is prevalent, especially within boys' physical education departments. Conversely, female HoPE provided comparatively more opportunities for lifetime activities and health-related exercise, signalling that they may value the lifetime activity goal more than their male counterparts.

This study established the structure and content of physical education curricula and extra-curricular programmes in the Merseyside region in relation to lifelong learning activities. Whilst this data provided a baseline of activity, more detail was required about the 'quality' of the curriculum. One quality marker is the amount of MVPA that children engage in during physical education lessons. The next stage of the research process was to establish how active students were during curriculum physical education, through a detailed review of the empirical literature.

6.2 Paper 2

Fairclough, S. and Stratton, G. (2005). Physical activity levels in middle and high school physical education: a review, *Pediatric Exercise Science,* 17: 217-236.

Aim: To systematically review the literature on middle and high school students' physical activity levels during physical education.

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[i] Key stages represent the phases of compulsory education in English state schools. Key stage 3 encompasses the first three years of secondary education (years 7-9), and the last two years are included in key stage 4 (years 10-11).

Forty peer-reviewed published studies were reviewed using established review searches and techniques. Physical activity was measured most often by heart rate monitoring (30 studies) followed by systematic observation (10 studies) and accelerometry (four studies). Intervention studies that aimed to increase student activity during lessons were successful. Under intervention conditions students engaged in MVPA for 47.9% and 31.9% of lesson time when heart rate and observation were the respective measurement instruments. These values were 5-10% greater than those reported in non-intervention studies. Percent of class time in MVPA during fitness-oriented activities and team invasion games averaged 48% and 46%, respectively, which approached the USDHHS (2000) 50% target. Moreover, these levels of activity were generally greater than during other types of activities. Boys were more active than girls, although MVPA values varied depending on the type of activities that the students took part in. In studies that directly compared gender differences in MVPA, findings were equivocal (boys, 40.7%; girls, 40.5%). Investigations that compared the MVPA of students of differing abilities demonstrated that the most highly skilled engaged in MVPA for around 5% more class time than their lesser skilled peers (e.g., Arnett and Lutz, 2003). Percent of lesson time spent in vigorous physical activity (VPA) was much lower than for MVPA (i.e., HR: 21%, observation: 11%). Boys participated at this intensity of activity for 2-3% more time than girls.

Physical activity during physical education is underpinned by educational principles and instructional methodologies, which affect activity during classes. Combinations of these factors influence teaching approaches and styles resulting in a wide variation in MVPA in similar activities. This variance in MVPA narrows when activity becomes a focus of the lesson as found in intervention studies. The type of activities offered within physical curricula also influence student MVPA during

lessons. In addition, differences in MVPA reported between studies were partially dependent on the method used to measure MVPA.

This review revealed the need to conduct empirical studies to quantify physical activity during physical education lessons. As choice of measurement instrument affects reported levels of MVPA it is important to describe results obtained from different measurement methods separately. In subsequent studies, methods of physical activity measurement were combined to provide a more rounded account of the levels and dimensions of physical activity undertaken.

6.3 Paper 3

Fairclough, S. and Stratton, G. (2005). 'Physical education makes you fit and healthy'. Physical education's contribution to young people's physical activity levels, *Health Education Research*, 20: 14-23.

Aim: To assess physical activity levels during secondary school physical education lessons in relation to recommended daily levels.

Data were collected from 122 students (62 boys and 60 girls) from five Merseyside secondary schools. Students were then grouped by age (range: 11-14 years) and ability (teacher assessment). Heart rates were measured during 66 single-sex lessons that covered a typical range of team and individual games, movement activities and individual activities. Heart rate reserve values at the 50% (MVPA) and 75% (VPA) thresholds were calculated for each student. Students engaged in MVPA and VPA for 34.3% and 8.3% of lesson time, respectively, which equated to 17.5 minutes (MVPA) and 3.9 minutes (VPA). Boys participated in significantly more MVPA and VPA than girls, and high ability students tended to be more active than

lesser able peers (NS). Team games and individual activities provided most opportunities for MVPA (~40%), while least MVPA was apparent during movement activities (22.2%).

It is possible that the characteristics and aims of some aspects of girls' physical education curricula did not predispose them to engage in as much whole body movement as the boys. Specifically, girls took part in 10 more movement and eight less team games lessons than the boys. As the monitored lessons reflected boys' and girls' typical curricula, it may be that girls' MVPA during physical education is restricted by curricula design. Overall, students took part in MVPA for around 18 minutes during lessons, which approximates a third of the daily hour of recommended physical activity (Biddle et al., 1998). Considering the diverse educational nature of physical education lessons, this amount of time is encouraging. However, this is limited by the amount of curricular time physical education receives. Physical education's contribution to young people's activity levels must be recognised in the context of other aspects of the school day, and the opportunities made available out of school time by local authority and voluntary organisations.

The study emphasised that some activities within the physical education curriculum are better placed than others to directly impact on health-enhancing physical activity. However, if teachers plan and teach lessons with physical activity objectives in mind, there is potential for physical education to better contribute to students' physical activity levels.

6.4 Paper 4

Fairclough, S. and Stratton, G. (2003). Cardiorespiratory and musculo-skeletal loading during high school physical education, *Revista Portuguesa de Ciencias do Desporto,* 3(Suppl.): 129-131.

Aim: To establish the extent of cardiorespiratory and musculo-skeletal loading during different physical education activities.

Fifty-five 13-year old students (33 boys, 22 girls) wore heart rate monitors and tri-axial accelerometers during 27 non-intensified single-sex physical education lessons. These were categorised as invasion games, net games, movement activities and running/fitness activities. Cardiorespiratory loading was assessed using heart rates $\geq$ 50% heart rate reserve, which represented $MVPA_{HR}$. Mean activity heart rate (ActHR; i.e., mean heart rate minus resting heart rate; Welk and Corbin, 1995) was also calculated as a raw measure of cardiorespiratory load. Tritrac accelerometers were used to measure musculo-skeletal loading. Vector magnitude counts $\geq$ 1000 counts $\cdot$ min^{-1} represented $MVPA_{AC}$ (Rowlands et al., 1999), and mean vector magnitude counts $\cdot$ min^{-1} were used as a raw measure of musculo-skeletal load.

Students who participated in invasion games and running/fitness lessons spent significantly more time in $MVPA_{HR}$ (~ 50%) and $MVPA_{AC}$ (~ 45%) than those who were taught net games and movement activities (~ 15-30%). Moreover, mean values for ActHR and counts $\cdot$ min^{-1} were greatest among students in invasion games and running/fitness lessons. The major finding from this investigation was that invasion games and running/fitness lessons were more effective than other curricular areas at stimulating cardiorespiratory and musculo-skeletal loading. These data were supported by previous investigations assessing MVPA in physical education (Stratton, 1997; McKenzie et al., 1995). The nature of these activities emphasise full body movement, which places a large amount of stress on the major muscle groups. As a consequence, students spent around 50% of lesson time in $MVPA_{HR}$ and $MVPA_{AC}$ during these activities. Conversely, some students were active for between 10% and

30% of lesson time during invasion games and movement activities, respectively. This illustrates the differences in activity levels within and between different physical education activities. These have been attributed to inter-individual, pedagogical and environmental factors (Stratton, 1996a).

Combining methods of physical activity measurement may provide a more accurate picture of the contribution that physical education makes to the respective dimensions of physical activity (Saris, 1986). Heart rate monitors provided information on the students' physiological responses to the activity that they engaged in, whereas accelerometers measured their movement, regardless of any physiological processes that occurred. While this insight is beneficial it should be noted that the two methods have limitations. Heart rate can be affected by emotional and environmental factors, and when accelerometers are attached to the hip, they cannot measure upper body movement. Furthermore, accelerometers cannot differentiate between changes in gradient, or measure activity during water-based activities.

This study reinforced the findings of paper three in that, invasion games and running/fitness activities were best equipped to stimulate MVPA.

6.5 Paper 5

Fairclough, S. (2003). Physical activity, perceived competence and enjoyment during high school physical education, *European Journal of Physical Education*, 8: 5-18.

Aims:

(a) To investigate the relationships between students' levels of MVPA, perceived competence and enjoyment during a range of physical education activities.

(b) To compare levels of MVPA during team games and individual activities.

Seventy-three students aged 11-14 years (40 boys, 33 girls) wore heart rate monitors during 82 single-sex physical education lessons, which were classified as either team games or individual activities. At the end of the lessons each student completed a short questionnaire (Intrinsic Motivation Inventory [IMI]; McAuley et al., 1989) to establish levels of perceived competence and enjoyment in relation to the activity they had just participated in. Data were reduced to MVPA using 50% heart rate reserve thresholds (Stratton, 1996a), and mean values for perceived competence and enjoyment were calculated. Mean MVPA splits were used to compare psychological variables between High and Low MVPA groups.

Boys were more active than girls (42.5% vs. 30.1%) and perceived themselves as more competent, but girls and boys enjoyed lessons to a similar degree. Students who participated in team games spent significantly more time in MVPA than those who took part individual activities (47.9% vs. 25.0%, $p < 0.0001$). Moreover, team games participants reported higher levels of enjoyment and perceived competence. A significant interaction between activity type and gender revealed that boys enjoyed team games more than girls, who in turn enjoyed individual activities more than boys ($p < 0.0001$). However, enjoyment and MVPA were inversely correlated amongst girls ($r = -0.4$, $p < 0.05$), and enjoyment was greatest in the low MVPA group ($p < 0.05$).

The superior levels of MVPA during team games, and the relationship between perceived competence and enjoyment were supported by existing literature (Stratton, 1997; McKenzie et al., 2000; Deci and Ryan, 1985). The association between perceived competence and enjoyment has direct application to physical education pedagogy; because enjoyable and successful experiences are vital predisposing factors (Welk, 1999) for encouraging physical activity participation

(CDC, 1997), it is essential for teachers to promote students' perceptions of their competence through enjoyable and differentiated lessons. This can be achieved by utilising various strategies that place the student at the centre of the teaching and learning process (Fox, 1991; Mandigo and Holt, 2000).

The enjoyment preferences of boys and girls concurred with those expressed in previous research (Dickenson and Sparkes, 1988; Goudas and Biddle, 1993). However, physical education curricula do not always mirror these inclinations (Fairclough et al., 2002). If lifelong participation in physical activity is a goal of physical education, then the different needs and preferences of boys and girls should be recognised during curricula design. The difference in enjoyment between the high and low MVPA groups was supported by earlier work that highlighted students' dislike of perceived high intensity activity during physical education (Dickenson and Sparkes, 1988; Goudas and Biddle, 1993). Clearly, further research is required in this area to establish the relationships between activity levels and enjoyment. Similarly, the negative relationship between girls' MVPA and enjoyment was unexpected. The data intimated that this inverse association may have been related to girls' greater enjoyment of individual activities, during which they typically engaged in less MVPA than team games. Conversely, it has been suggested that girls may not like the physical aspect of physical education because they are socialised to react negatively to perceived physical hardships (Cockburn, 2001). Though this theory cannot be inferred from the available data, it highlights the need to explore these issues further.

This study confirmed the type of activities that boys and girls most enjoy. At the same time it raised questions about the relationship between level of MVPA and enjoyment of lessons, particularly in girls.

6.6 Paper 6

Fairclough, S. (2003). Girls' physical activity during high school physical education: influences of body composition and cardiorespiratory fitness, *Journal of Teaching in Physical Education*, 22: 382-395.

Aim: To examine the relationship between girls' physical activity in physical education lessons, their body composition and cardiorespiratory fitness.

The physical activity levels of 20 girls (aged 13 years) were monitored in 33 single-sex physical education lessons, which covered team games, movement activities and track and field athletics. Accelerometers and heart rate monitors were used to measure girls' volume of movement. Accelerometer data was expressed as mean vector magnitude (Vmag) counts · min^{-1}, while 50% heart rate reserve thresholds were used to establish percent of lesson time in MVPA. During the data collection period the girls also underwent laboratory tests to establish individual values for percent body fat and peak $\dot{V}O_2$. Relationships between the variables were assessed by Pearson product moment correlation coefficients, and linear regression was used to examine the influence of body fat and peak $\dot{V}O_2$ on the physical activity measures. The girls engaged in MVPA for 38.5% of lesson time (SD = ± 23.5%). Almost half of the 33 lessons focused on team games, which may have inflated the mean MVPA value, as these activities stimulate the highest levels of activity (Fairclough and Stratton, 2005b).

As expected, body fat was negatively correlated with peak $\dot{V}O_2$ (r = -0.65, p < 0.01), Vmag counts · min^{-1} (r = -0.65, p < 0.01) and MVPA (r = -0.32). When body fat and peak $\dot{V}O_2$ were entered into the regression analyses, body fat accounted for 42% (p < 0.01) and 10% of the variance in Vmag counts · min^{-1} and MVPA,

respectively. Peak $\dot{V}O_2$ contributed only a negligible amount to the physical activity variance.

These results suggested that girls with greater adiposity are less active during physical education than their leaner peers. Furthermore, Rowland (1999) contends that the health risks may be compounded for girls with greater body fat, as their increased size makes them less predisposed to engage in health-enhancing activity. Girls' cardiorespiratory fitness was comparable to values reported in previous studies (Armstrong and Van Mechelen, 1998; Armstrong et al., 1991). However, these levels probably were not influenced by the amount of activity that the girls took part in during lessons, as physical education does not provide the necessary frequency and intensity of activity to stimulate improvements in cardiorespiratory fitness (Armstrong and Welsman, 1997). The weak correlation between the two measures of physical activity ($r = 0.26$) supports the view that each instrument measured a different dimension of physical activity. Though both instruments are valid measures of physical activity, the intermittent nature of physical education classes may weaken the relationship between them (Stratton and Mota, 2000). The major premise here is that heart rate responses to physical activity temporally lag behind the original movement. Moreover, during stationary periods that follow episodes of activity, heart rate initially remains elevated and then gradually decreases, while accelerometers measure whole body movement. Conversely, after prolonged stationary periods, there will be a delay in heart rate increasing to a level representative of the intensity of activity undertaken.

The results indicated that physical educators should consider inclusive strategies to stimulate appropriate activity levels in girls with excess body fat. Furthermore, it should be made clear that physical education cannot improve girls' levels of cardiorespiratory fitness. Instead, teaching interventions should be employed

to enhance activity levels during lessons, as well as promote physically active behaviours away from the curriculum. Combining heart rate monitoring and accelerometry as measures of physical activity may be beneficial because data on the physiological and movement aspects of activity are provided. On the other hand, the intermittent nature of physical education classes may prevent strong agreement between these two instruments.

6.7 Paper 7

Fairclough, S. and Stratton, G. (2005). Improving health-enhancing physical activity in girls' physical education, *Health Education Research*, 20: 448-457.

Aim:

(a) To assess the effectiveness of a pedagogical intervention to increase MVPA during girls' gymnastics lessons.

(b) To assess the extent to which intrinsic motivation, perceived competence and lesson objectives were affected by the intervention.

Students from two Year 7 classes (age 11-12 years) in one Merseyside secondary school were involved in the study. Each was randomly appointed as a control (CON) and experimental (EXP) class, and was taught by an experienced female and male physical educator, respectively. Following a familiarisation lesson where baseline data were collected, both classes embarked on a series of five gymnastics lessons. Each worked towards the same original lesson objectives and followed the same material content. However, the EXP teacher was required to include MVPA as an additional lesson objective. The EXP teacher planned and

delivered lessons using modified teaching approaches, organisational techniques and equipment set-ups, with the intention of engaging the students in increased MVPA.

MVPA was measured using 50% heart rate reserve thresholds ($MVPA_{HR}$) and systematic observation ($MVPA_{obs}$; SOFIT; McKenzie et al., 1991). SOFIT provided data on the students' activity levels, the lesson contexts in which they occurred, and the behaviours of the teachers over the course of each lesson. After each lesson both classes completed a nine-item version of the IMI (McAuley et al., 1989). This was designed to assess the girls' levels of intrinsic motivation (IM) and perceived competence (PC) of the lesson they had just taken part in. Furthermore, both teachers completed post-lesson evaluations, where they indicated whether they had achieved their lesson objectives.

There were no significant differences in $MVPA_{HR}$ between lessons, but there was a main effect between groups (EXP = 40.8%, CON = 28.9%; $p < 0.01$). Both classes reported similar IM and PC values, which were also stable between lessons. According to SOFIT data, the EXP students engaged in more $MVPA_{obs}$ than the CON class (18.5% vs. 13.5%; $p < 0.05$), and had greater opportunities for skill practice (43.1% vs. 34.7%; $p < 0.05$). Both teachers expressed that they achieved their planned objectives.

The EXP students engaged in $MVPA_{HR}$ for an average of 11.9% more lesson time than the CON class, without a negative impact on their IM, PC, or planned lesson objectives. The intervention was successful because it centred on how the physical education lessons were planned and taught, rather than on the inclusion of high-intensity vigorous activity, which was unrelated to the unit objectives. The delivery of the EXP lessons meant that the students had significantly more time for free skill practice. Such augmented practice occasions may better promote motor skill-learning, and students with superior motor skills are likely to achieve greater

physical activity engagement during lessons (Rink, 1994). The high and stable levels of IM and PC reported by both groups suggested that these variables were largely unaffected by the students' level of physical activity engagement. It is possible that the girls had positive perceptions of gymnastics in comparison to other physical education activities, as they were perceived as being individual, feminine and therefore gender appropriate (Solmon et al., 2003).

The differences in $MVPA_{HR}$ and $MVPA_{obs}$ confirmed that both measurement instruments were concerned with different dimensions of physical activity. Moreover, some of the discrepancies could have been related to students' heart rates remaining elevated during stationary periods following bouts of activity. Thus, different physical activity measures can provide complementary data, which may better inform the development of strategies to engage students in health-enhancing activity during physical education.

This investigation illustrated how MVPA can be increased without compromising planned aspects of learning in gymnastics lessons, whose goals may contrast with cardiorespiratory health-enhancing physical activity. Furthermore, if lessons are thoughtfully planned and delivered in a stimulating manner, then increased activity levels can be attained without negatively affecting student motivation or perceptions of competence. This is significant as these psychological constructs are strongly related to positive attitudes and persistence in physical activity.

7.0 Summary and critical review

The seven peer-reviewed publications form a coherent programme of research that was carried out over a four-year period. Each article sits squarely within the context of health-enhancing physical activity in secondary school physical education. The data illustrated that levels of MVPA were extremely variable within secondary

school physical education lessons. This may be attributed to the combined effect of pedagogical, inter-individual and environmental factors that are common within physical education. Furthermore, it is evident that particular activities such as team games are better suited than other curricular activities at engaging students in appropriate levels of MVPA. As study one noted, team games tend to dominate curriculum time. In contrast, there is evidence to suggest that after compulsory education, the majority of people tend to engage in more individual activities as recreational pursuits (Sport England, 2004), when they are arguably less prepared in these activities. However, recent longitudinal research concluded that intensive and continuous general physical activity participation at school age was a better predictor of adult activity than participation in particular sports and activities (Telama et al., 2005). Thus, from a lifelong physical activity perspective, curricular and extra-curricular physical education should allow a greater breadth of activities to give as wide a physical activity experience as possible. However, increasing the range of activities could also shorten the length of taught units, which may inhibit student progression over time (OFSTED, 2004).

Papers two to five suggested that boys were more active than girls during single-sex physical education. On first inspection, this may be a function of the type of activities that are more typically included in each other's respective curricula. Paper one highlighted that team games are more prevalent within boys' curricula, whereas individual activities have greater prominence in girls'. However, the question of whether boys are more active than girls per se remains unanswered as they were taught separately in the schools used in this research. To better compare boys' and girls' activity levels in physical education, further research is required using co-educational lessons. In the two studies to make these comparisons boys were more active than girls during both co-educational and single-sex classes (McKenzie et al.,

2004; Hannon and Ratcliffe, 2005). Interestingly, one of these studies reported that according to the SOFIT observation instrument, middle-school girls were most active in co-educational settings, compared to single-sex classes (McKenzie et al., 2004). Conversely, in Hannon and Ratcliffe's (2005) investigation girls recorded the most pedometer steps during the game play element of invasion game lessons within single-sex, as oppose to co-educational contexts. Another gender difference related to the association between enjoyment and MVPA in physical education. In paper five girls demonstrated a negative relationship between lesson enjoyment and MVPA. Though the underlying reasons for their levels of enjoyment were not explored, the finding does raise a question about the potential wider effects of efforts to increase physical activity during girls' physical education. The same associations were not demonstrated among boys, though the respective proportion of boys and girls who were monitored in team games and individual activities may have confounded these data. To further explore other possible reasons why girls appear to be the least active gender during physical education, paper six examined the affects of body fat and cardiorespiratory fitness. The results revealed that body fat explained a significant proportion of the variance in physical activity, while cardiorespiratory fitness accounted for very little. Though maturation was not assessed during this study the findings may be of utility to secondary physical educators who teach girls during the time when they experience rapid changes in body composition. A stronger evidence base is required to link increases in adiposity to lower activity and reduced psychological responses during lessons. If such findings are observed in future work, strategies to positively engage girls in physical education during puberty may be appropriate to offset any potentially negative affective responses to lessons. The seventh paper demonstrated that a pedagogical intervention was able to improve MVPA in gymnastics lessons, without any negative consequences to intrinsic

motivation or lesson objectives. These data suggest that it may be possible to enhance MVPA in most physical education activities, regardless of their characteristics and aims.

Though current physical activity guidelines advocate moderate intensity activity as being beneficial for health, there is increasing evidence that cardiorespiratory fitness is also related to health, without being mediated by physical activity (Boreham and Riddoch, 2001). Improvements in cardiorespiratory fitness may be stimulated by VPA (Morrow and Freedson, 1994). Furthermore, fitness has been shown to be associated with coronary risk factors in children and adolescents, with risk factors clustering most strongly in the least fit (Andersen et al., 2003). Levels of VPA reported in the review paper and the empirical studies were low in comparison to MVPA. Therefore, future health-related physical education interventions should have a greater emphasis on VPA, to complement improvements in moderate physical activity.

This programme of research demonstrated that physical activity levels during secondary school physical education are extremely variable. The empirical studies are limited in that the data were derived from between one and three measurements of MVPA on any one student, with the exception of study seven. This presents only a cross sectional picture, and does not provide any information as to how students' activity levels differed over time and between different activities, or as a result of being taught by different teachers. Furthermore, studies three to six might have benefited from the inclusion of contextual data relating to lesson details such as teaching styles, lesson phases, and class management. Information of this nature may bring more accurate interpretation and meaning to objective physical activity measures in the physical education context. Similarly, the use of the IMI in studies five and seven gave a valid indication of the students' intrinsic motivation, enjoyment

and perceived competence during lessons. Conversely, IMI data did not provide any information as to the reasons behind the students' psychological ratings. Combining qualitative follow-up interviews would have gone some way to addressing this issue.

The intervention described in paper seven successfully improved MVPA. However, one baseline lesson may not have been sufficient to match the two classes on all variables. Furthermore, the extent of change between the activity levels of the two classes may have been different had the intervention lasted longer than five lessons. On the other hand, six-week units of work were typical of the physical education programme in the school where the research was conducted. Given the difficulties in accessing schools to participate in research of this nature, some compromise on study duration and design may be inevitable. Moreover, though each of the studies was constrained in some way, they were all conducted in 'real life' contexts, without drastic changes to lessons or learning environments. In this sense, they retained a real degree of ecological validity, which is important when researching in such social contexts.

This programme of research applied aspects of Welk's (1999) Youth Physical Activity Promotion Model. It was evident from the findings that the predisposing factors relating to perceived competence and enjoyment were associated with physical activity participation in lessons. However, the inverse associations observed between enjoyment and MVPA among the low-active students and girls suggest that the proposed positive relationship between predisposing variables and activity participation may not always hold true in physical education contexts. The enabling factors of fitness and body composition were also assessed. Fitness did not appear to influence activity levels, while body composition was negatively associated with physical activity. Welk's model is centred around habitual and long-term physical activity promotion, and in this respect could not be directly applied to this research, as

out of school physical activity was not examined. While the theoretical basis underpinning the model is apparent, this body of research suggests that the framework may require some adjustment when applied specifically to physical activity within physical education lessons.

8.0 Satisfying the aims

The first research aim was to quantify physical activity levels during secondary school physical education lessons. Papers two through to seven reported that activity levels differed markedly between lessons. Furthermore, the data also supported the contention that, on days when students attend physical education, the subject has potential to make a meaningful contribution to their accumulated volume of physical activity. However, this is dependent to a large extent on the type of activity that lessons focus on.

The second research problem was to establish how levels of MVPA differed between discrete activities and groups. Data consistently highlighted how invasion games and fitness activities engaged students in the greatest volumes of MVPA compared to individual and aesthetic activities. Moreover, boys were more active than girls, though as no mixed gender lessons were monitored these differences appeared to be a function of the type of activities that boys and girls typically participated in. Non-significant differences in MVPA between students of differing abilities were reported in paper three. The more highly skilled students were more active than lesser skilled peers. Nonetheless, the expected trend for average abilities to be more active than the lowest ability students was not observed.

The next aim was to investigate factors that determine physical activity during physical education. Study five revealed that among girls lesson enjoyment appeared to diminish as MVPA levels increased. This unexpected result raised the issue of

physical activity engagement *during* physical education, versus physical activity promotion *through* physical education. However, the levels of intrinsic motivation and MVPA reported within the intervention study did not replicate this finding. Thus, further work is required to more fully understand the relationship between MVPA, intrinsic motivation and enjoyment in physical education. Paper six demonstrated that body fat was a significant influence on girls' MVPA during lessons, while cardiorespiratory fitness was not. These findings have implications for physical educators and the way in which they adapt lesson content and teaching strategies to accommodate students with excess adiposity. This is particularly important in girls' physical education as weight gain is prevalent during puberty, and so teachers need to be sensitive to how this might impact on activity levels.

The final aim of the research was to design and apply a teaching intervention to increase physical activity during physical education. The intervention was successful in increasing MVPA during gymnastics lessons. Furthermore, levels of intrinsic motivation and perceived competence remained stable throughout, suggesting that increased activity does not necessarily compromise these psychological constructs. The intervention was based on the inclusion of increased MVPA as a lesson objective. The intervention teacher reported that all lesson objectives were fulfilled, and that the higher activity levels did not negatively affect this. Gymnastics has great potential to contribute to students' musculo-skeletal and skill-related fitness. On the other hand, the aims and characteristics of gymnastics are arguably less suited to the attainment of cardiorespiratory health-enhancing physical activity. On this basis, teachers can increase MVPA in most physical education activities, if they plan and teach with increased activity levels in mind.

9.0 Future work and recommendations for further study

This collection of peer-reviewed publications has demonstrated that physical education has potential to contribute to young people's health-enhancing physical activity. The evidence presented has shown that MVPA may be influenced by pedagogical, psychological and biological factors. Furthermore, modified physical education curricula approaches are capable of improving MVPA during lessons. Future research should develop such intervention strategies and apply them under more stringent circumstances. This could involve implementing them over longer time periods, with students of differing ages and within a range of physical education activities.

Some of the studies would have benefited from larger sample sizes. Future work should be underpinned by researchers developing strong relationships with schools and their local partners, with research playing a key role in providing an evidence base on which to implement changes to practice and policy. Three of the studies in this thesis combined methods of physical activity measurement. If our understanding of physical activity in physical education is to be improved, then future work should continue to combine methods to provide data on the physiological, musculo-skeletal, movement and behavioural dimensions of physical activity. While this can place greater demands on resources, the improved quality of data should be seen as a worthy trade-off. Similarly, it should be recognised that the determinants of physical activity in physical education are multi-dimensional. Integrating psychological self-report instruments alongside qualitative approaches, is recommended to provide a more rounded view of students' experiences and views of how lessons affect their physical activity participation.

The cross-sectional nature of the studies was a potential limiting factor. Longitudinal studies that track activity levels over sustained periods of time may provide more accurate information on patterns of MVPA in physical education. Furthermore, such designs would be better able to demonstrate whether or not interventions were effective over sustained periods, and after any early 'novelty' effects have diminished. Though health-enhancing physical activity was measured using valid, objective instruments, no health parameters were assessed. Future longitudinal interventions that assess MVPA during physical education, as well as other parts of the day should also assess changes in health-related factors such as bone mineral density, adiposity, blood pressure and lipids. Furthermore, such interventions should place greater emphasis on engaging students in VPA, in order to stimulate musculo-skeletal loading and improvements in cardiorespiratory fitness.

Clearly, physical education does not have sufficient time to significantly impact on most young people's activity levels. However, it can complement other school-based opportunities for activity engagement. Furthermore, physical education can instil knowledge, positive attitudes and high levels of perceived competence and intrinsic motivation to promote physically active behaviour outside of school time and in the community. Longitudinal interventions monitoring the psychological, cognitive and behavioural effects of physical education programmes would be better placed to demonstrate the value of curricular physical education as a key vehicle for promoting health-enhancing physical activity in young people.

10.0

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