NAME: CARWYN SIÔN PRICE

UNIVERSITY NUMBER: ST05002356

SCHOOL OF SPORT, PE AND RECREATION

HEALTH RELATED FITNESS AND PHYSICAL ACTIVITY LEVELS OF URBAN AND RURAL BOYS

Contents

List of Tables

List of Figures

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Abstract

The study aimed to investigate the health related fitness level and physical activity behaviour of urban and rural Welsh schoolboys. The sample comprised of 31 urban and 21 rural boys, all aged 11-12 yrs. The health related fitness components tested were body composition (bio-electrical impedance analysis), flexibility (sit and reach), muscular endurance (timed sit ups), muscular strength/power (vertical jump) and cardiorespiratory endurance (multistage fitness test). No significant differences were seen in the height, body mass and fat mass of urban and rural boys. Although no significant differences were found, the rural group were classified as overweight according to body mass index measurements. The vertical jump test showed a significant difference, with urban boys outperforming rural counterparts. Other measures of health related fitness did not display significant differences between both groups. Physical activity behaviour data was obtained through questionnaires. Questions investigated transportation to school, amount of moderate and vigorous activity, sedentary behaviour and sports participation. Rural boys reported to be significantly more active when travelling to school. Although no statistically significant difference was observed in the sedentary measure, rural boys spent more hours watching television and playing video games, and were therefore more sedentary than urban counterparts. Urban boys reported to engage in more vigorous PA than those from the rural area, which was linked with urban boys participating in more sports at a competitive level. The results of the study suggest that urban and rural boys differ in ways which impacts health related fitness and physical activity patterns.

CHAPTER I

INTRODUCTION

1.0 Introduction

Physical fitness and physical activity are often used interchangeably, as highlighted by Thomas *et al.* (2003). Physical activity (PA) is defined by Casperson (1989) as 'any bodily movement produced by the skeletal muscles that results in caloric expenditure' (p. 424). This is a broad definition which encompasses all aspects of PA. PA is seen as behaviour (Freedson and Melanson, 1996) where as physical fitness is referred to as an attribute (Thomas *et al*., 2003). The relationships between PA, physical fitness and health have been documented as being complex (Armstrong and Welsman, 1997). This is supported by Riddoch (1998) in the statement that 'the evidence confirming a positive association between childhood activity and the immediate or future health status of children is suggestive, but weak' (p. 39). But 'obesity can be considered a health compromising condition for children in its own right' (Riddoch, 1998, p. 32). Health and wellness areas of fitness are referred to as health related fitness (HRF). HRF is defined by Warburton *et al*. (2006) as 'the components of physical fitness that are related to health status' (p. 809). The components of HRF commonly recognised are cardiorespiratory endurance, body composition, flexibility and muscular strength/endurance (Pate, 1988).

To assess HRF levels in youth, test batteries can be used. There are various testing batteries used by established testing programs such as the Prudential FITNESSGRAM, YMCA Youth Fitness Test and the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) Physical Best Program (Safrit, 1995). Many of the tests used by the programs are similar in three of the recognised components by Pate (1988), but differ in the assessment of muscular strength/endurance. Cardiorespiratory endurance is measured through the one mile walk/run in the three batteries, with the Prudential FITNESSGRAM also using the multistage fitness test (MSF). Body composition is assessed through

skinfold measures of the triceps and calf in all three tests, with only the Prudential FITNESSGRAM including the calculation of body mass index (BMI). Sit and reach tests are used in all three for measures of flexibility, although protocols differ slightly. The AAHPERD Physical Best Program use pull ups and a modified sit up test to assess muscular strength/endurance, whereas the YMCA Youth Fitness Test use curl ups and a modified pull ups test. Curl ups, 90 degree push ups, pull ups, flexed arm hang and modified pull ups are all options included in the Prudential FITNESSGRAM, but when testing the tester is able to choose which ones to assess the youth in (Safrit, 1995).

The assessment of youth through established tests 'are used with the intent to motivate children to achieve higher levels of fitness and to include optimal levels of physical activity in their present and future lives' (Docherty, 1996, p. 285). With the increased media coverage over recent years on the level of obesity prevalent in youth, HRF testing has become of increased importance in the identification of the HRF state of youth and to encourage positive attitudes and increased understanding about the principles underlying HRF (Harris and Cale, 2006). Recent figures that have been documented on British children state that 'the number of obese children has increased from 9.6% in 1995 to 13.7% in 2003' (www.news.bbc.co.uk). In specifically Welsh adolescents, the health behaviour in school aged children (HBSC) study found that in the year 2000, Wales was ranked fifth overall out of 35 other countries with regards to the percentage of obese 15 year olds. Wales were ranked higher than both Scotland and England with 5.6% and 3% of boys and girls respectively being deemed obese (www.hbsc.org).

In reaction to the published HBSC figures, the Welsh Assembly Government has set a target of '90% of secondary school pupils achieving 60 minutes of physical activity five times a week by 2020' (www.sports-

council-wales.org.uk). In order to achieve the target, the Assembly Government in conjunction with the Sports Council for Wales have set up a school sport scheme named 5×60. Its aim is to offer activities before or after school that targets individuals that currently do not participate or are in danger of losing interest. 5×60 officers are being based in secondary schools to consult with pupils and listen to needs and barriers which prevent them from participating in activity. The 5×60 programme should give the pupils an opportunity to try a range of activities that are not currently available to them. 'The Welsh Assembly Government plans to invest some £7.6 million over the next 3 years and aims for every school in Wales to be involved in the programme by 2009' (www.sports-council-wales.org.uk).

A variety of environmental factors influence the physical activity behaviour of youth (Armstrong and Welsman, 1997). The place of residence has a considerable influence upon the opportunities for PA as found by Loucaides *et al*. (2004). Differences found were that parents of children in rural localities reported more space available in the garden and safer neighbourhoods for their children to be physically active in. Children in urban areas had more exercise equipment available at home and were transported by their parents to places where they could be physically active more often than rural counterparts. The conclusion of their study was that 'intervention programmes to promote physical activity need to consider … geographical location differences in physical activity levels' (p. 138). Some studies have been conducted to investigate possible differences in physical fitness and HRF levels of urban and rural youth (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005). Results so far seem inconclusive to whether urban and rural differences exist. More research is needed in the field.

CHAPTER II

LITERATURE REVIEW

2.0 Literature Review

Research papers were located through the use of online databases (Google Scholar, Ingenta Connect, Sports Discus and Swetswise). The key words and phrases included: fitness, health related fitness, physical activity, urban and rural differences. The key words and phrases were used in combination with the following modifiers: adulthood, youth, children and adolescents. When published reports were obtained, all relevant references contained in the papers were followed up. Papers were excluded from the review for any of the following reasons:

- studies on youths were not on 9-16 year olds;
- if fitness and HRF studies were anything other than field tests;
- or if they were unrelated to the headings in the literature review.

2.1 Physical activity during childhood and adolescence, and its importance to prevent development of disease during adulthood

PA is seen as a modifiable risk factor in the primary and secondary prevention of morbidity or mortality from hypokinetic diseases (Warburton *et al*., 2006). Being physically fit or active has been associated with a 50% reduced risk of death from any hypokinetic disease (Myers *et al*., 2004). One such hypokinetic condition is coronary heart disease (CHD). The risk of it manifesting in adulthood has been closely linked with aerobic fitness and obesity (Katzmarzyk *et al*., 2001; Erikssen *et al*., 2002). Recent studies into CHD risk factors in youth suggest that obesity alone is the determining factor in the development of CHD (Boreham *et al*., 2001; Thomas *et al*., 2007). Both studies (Boreham *et al*., 2001; Thomas *et al*., 2007), on youth ranging from 12 to 15 years old found that the relationship between fatness and CHD was far stronger than between fitness and CHD. Must *et al*. (1992) through their research found that being overweight in adolescence increased the risk of adverse health effects in adulthood. This suggests

that fatness or obesity is of main concern during childhood and adolescence, and as Boreham *et al*. (2001) states 'primary prevention of CHD should therefore concentrate upon preventing or reversing undue weight gain' (p. 273).

Studies into the tracking of obesity from childhood to adulthood have documented mixed findings. Vanhala *et al*. (1998) reported that half of obese children had become obese adults and that childhood obesity increases the risk of metabolic syndrome in adulthood. They also concluded that 'obesity established in childhood may be more harmful than if obesity was established in adulthood' (p. 320). Wright *et al*. (2001) on the other hand reported little tracking of overweight to adulthood. A large proportion of the people aged 50 in the top quarter for body fat, were not overweight as children. Although Wright *et al*. (2001) generally found no link, they did discover that children above the 90th centile at 13 years were twice as likely to be in the top quarter for adult percentage body fat. This therefore may highlight that 13 years is a pivotal age regarding the tracking of obesity through to adulthood and as Riddoch (1998) states 'being overweight during adolescence is indeed a prime target from both prevention and treatment perspectives' (pp. 21-22).

Research into the relationship between youth activity and adult health has been reported as being limited (Malina, 2001). The only research that Malina (2001) reports to have been done is the effect that weight bearing PA has upon bone mineral density in adulthood. It is reported that PA during childhood and adolescence ensures better skeletal health in adulthood. It seems that more studies into the tracking of PA during youth to health in adulthood are needed. Research into the tracking of other aspects of health in adulthood would need to be investigated. Although this seems to be the case Malina (2001) concludes by stating in relation to other PA and fitness pathway research from youth to adulthood, that 'the

trends emphasize the importance of a lifestyle of regular physical activity during childhood and adolescence, which continues into and throughout adulthood, for the health and well being of the individual and the population' (p. 170).

2.2 Physical activity patterns

In order to establish if youth are physically active and gain health benefits, recommendations or guidelines are put forward which outline desired physical activity levels. The recommendations by the Surgeon General (1996) in the American College of Sports Medicine (ACSM) guidelines for exercise testing and prescription were well established standards for adults. The Surgeon General (1996) recommended 30 minutes of light to moderate physical activity on most or all days of the week. Recently the recommendations have changed, and are now 30 minutes a day, five days a week of moderately intense cardiovascular work. Along with vigorously intense cardiovascular work 20 minutes a day, 3 days a week and 8 to 10 strength-training exercises twice a week (ACSM, 2007). But as the ACSM (2006) highlight, children are not miniature adults therefore activity guidelines designed for adults are not applicable. The recommendation that the ACSM (2006) give for youth is

> to accumulate 60 minutes and up to several hours of activity each day of the week. This can be through several bouts each day utilizing a variety of activities. Bouts need not be continuous to be beneficial. In fact, intermittent exercise is the norm for youth. Bouts that include some vigorous bursts of activity, some moderate activity and some brief rest periods are typical, walks to school (moderate activity) that are continuous are appropriate.

There are numerous studies which have been conducted internationally into the PA patterns of youth (Armstrong *et al*., 1990; Riddoch *et al*., 1991; Pate *et al*., 1997; Gavarry *et al*., 1998; Epstein *et al*., 2001). The overall finding seems to be that the activity levels of youth do not reach recommended levels. Harris and Cale (2007) report in their review that half of boys and two thirds of girls do not meet current PA guidelines. The study by Gavarry *et al*. (1998) on French schoolchildren supports the concern raised as it was found that only 32% of teenagers were active. In Wales it has been discovered through the use of a self administered questionnaire that between 1986 and 2000, PA for boys and girls in all age groups increased. Although this was discovered, only 34% of 11-12 year old boys reported to have exercised for at least four hours per week outside school in the year 2000. Sedentary behaviour was indicated by the proportions watching television or playing video games for four or more hours. It was discovered that 30% of 13-14 year old boys had reported that they spent seven or more hours a week, compared with 6% of girls watching television or playing video games (Welsh Assembly Government, 2002). Although the sedentary behaviour measure reports this, most of the literature supports that girls are less active than boys (Armstrong, 1990; Pate *et al*., 1997; Epstein *et al*., 2001; Welsh Assembly Government, 2002). But there are some research papers which have reported no significant sex differences (Riddoch *et al*., 1991; Gavarry *et al*., 1998).

The methods with which measures of PA are obtained on youth vary between studies. As mentioned previously, the Welsh Assembly Government collected data through the use of an indirect self administered questionnaire. Whereas Gavarry *et al*. (1998) used a direct method through heart rate monitoring, to assess the time that 11-16 year old adolescents spent at low, moderate and vigorous PA. The three levels of PA were determined if the percentage of heart rate reserve (%HRR) was below 50% (low), between 50 % and 70% of HRR (moderate) and above 70%

(vigorous). Therefore the field of literature may not be definitive due to the fact that varying methods of assessment are used between studies. This may explain the opposing papers by Riddoch *et al*. (1991) and Gaverry *et al*. (1998). Research may be needed to investigate specifically on one sex to determine their PA behaviour to give meaning to the PA differences that have been found.

2.3 Fitness Testing

As outlined by Harris and Cale (2006), field based measures of fitness are more practical in terms of cost and administration in large scale testing. Many large scale fitness tests involving youth have used field based measurements to assess fitness (Corbin and Pangrazi., 1992; Katzmarzyk *et al*., 1998; Huang and Malina, 2002). Corbin and Pangrazi (1992) conducted a study using tests from the FITNESSGRAM and AAHPERD testing batteries. Both testing batteries are recognised as they use criterion referenced health standards to classify test performance of children. Criterion referenced standards are based not on norms but on research done which sets a minimal level of fitness that indicates a child is in good health (Safrit, 1995). The results of the study indicated that the majority of American youth did meet criterion referenced standards in individual test items but throughout the battery of tests, many did not reach criterion standards.

Other papers have devised their own battery of tests to assess HRF (Katzmarzyk *et al*., 1998; Huang and Malina, 2002). Huang and Malina (2002) used the one mile run (cardiorespiratory endurance), timed sit ups (abdominal strength and endurance), sit and reach (lower back flexibility) and subcutaneous fatness measured through the sum of triceps, subscapular, suprailiac, and medial calf skinfolds. Katzmarzyk *et al*. (1998) used skinfold measures and sit up tests similarly to Huang and Malina

(2002). But they also used tests that can be deemed as laboratory based methods of assessment. For instance muscular strength was determined through voluntary isometric contractions of the left quadriceps group and recorded with a strain gauge. A cycle ergometer test was also used with an ECG chest derivation device to obtain measures of submaximal work capacity.

This therefore demonstrates that previous research papers in the field are sporadic in the use of tests to measure HRF. The differing tests used in studies make it difficult to conclude on the HRF state of the youth because comparisons among papers are difficult to make. Some amount of standardisation in the choice of tests needs to be seen. Little to no reference is made to norms or criterion reference standards for the age groups involved in the testing (Katzmarzyk *et al*., 1998; Huang and Malina, 2002). Therefore future research needs to ensure that their results are interpreted in relation to set norms and criterion reference standards to make the results easier to interpret. Table 1 displays examples of norms, criterion referenced health standards and previous study results in recognised HRF tests for youth (Safrit, 1995).

Table 1. Norms, criterion referenced health norms and study results in HRF tests for 12 year old boys

Authors	BMI (range)	Fat Mass %	MSF Test (no. of shuttles)	Sit Up Test (no. min)	Sit & Reach (inches & cms)	Vertical Jump (cm)
Physical Best Health Fitness Standards. 1989 (Norms)	15 - 22			38	25cm	
NCYFS I. 1987 (Percentile Norms)				38 *(50th Percentile)*	13 inches *(50th Percentile)*	
FITNESSGRAM. 1999 (Health Related Criterion Standards)			32 - 72			
Prudential FITNESSGRAM. 1992 (Health Related Criterion Standards)	16 – 22	10 - 25	29 – 68 *VO2 max (ml/kg/min) 42-52*			
Tsimeas et al. (2005) (Study results)						Urban Boys= 48.6±7.7cm Rural Boys= 46.9cm±7.5cm
President's Council on Physical Fitness (PCFS). 1985 (Percentile Norms)					1 inch (2.5 cm) (50th Percentile)	

2.4 Previous studies into urban and rural differences in health related fitness

Previous studies into urban and rural differences in the HRF of youth are limited. The field of literature nonetheless reports mixed findings. South Australian, Mexican and Greek children (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005 respectively) have been studied in previous research papers. Dollman et al. (2002) and Pena Reyes *et al*. (2003) found that urban and rural environmental differences impact upon fitness and PA patterns. While Tsimeas *et al*. (2005) discovered that the place of residence has no clear impact on physical fitness.

The three studies obtained anthropometric measures of height, weight and BMI. Dollman *et al*. (2002) and Tsimeas *et al*. (2005) found no significant differences between urban and rural (10-11 year old and 12.3 ± 0.42 years old respectively) boys. While Pena Reyes *et al*. (2003) discovered that urban 10-13 year old boys were significantly taller (urban= 137.8 ± 7.9; rural= 135.9 ± 7.8) and had higher body masses (urban= 36.6 ± 10.9 kg; rural= 32.0 ± 6.2 kg), thus giving urban youth a higher BMI (urban= 19.0 ± 3.5 kg/m^2; rural= 17.2 ± 1.8 kg/m^2). Body fat percentages, calculated from skinfolds have also been proven to be higher in urban youth (Tsimeas *et al*., 2005) as has the sum of five skinfolds (Dollman *et al*., 2002). The previous research therefore suggests that anthropometrically, urban boys are larger.

Fitness test results are somewhat mixed within papers, but definitive patterns can be seen in the results of some tests between studies. For instance in running/walking tests, rural boys have been proven to perform better. In a 1.6 km run/walk test, urban boys achieved the distance in a time of 569.0 ± 113.5 s, while rural boys managed it in a time of 524.5 ± 96.1 s (Dollman *et al*., 2002). Pena Reyes *et al*. (2003) reports that in a 12

minute run urban boys ran 153.1 ± 23.7 m/min, while rural boys managed to run at 160.1 ± 21.7 m/min. Another type of test in which a pattern has emerged is in jumping tests. It seems that urban boys can significantly outperform rural boys in such tests. In a standing long jump test, urban boys managed 130.1 ± 18.4 cm, while rural boys fell short at 112.6 ± 21.3 (Pena Reyes *et al*., 2003). Vertical jump measures in the study by Tsimeas *et al*. (2005) showed that urban boys jumped 48.6 ± 7.7 cm, while rural boys managed 46.9 ± 7.5 cm.

Along with anthropometric and fitness measures, Dollman *et al*. (2002) used questionnaires to obtain environmental variable measures. Questionnaires were given to the children to discover any differences in the environment which may affect fitness and anthropometric measures. The results showed that urban boys were more likely to play school sport by 22% over rural counterparts, but that rural children were more likely to be involved in club sport. The reasoning behind this was discussed by Dollman *et al*. (2002) as they state that 'it is feasible that community sport is more firmly "embedded" in rural community life, and that participation by children is less dependant on mediators such as social support and socioeconomic status' (pp. 307-308). The statement can be supported by their results and those reported by Loucaides *et al*. (2004). Urban boys reported a higher level of parent support (by approximately 17%)(Dollman *et al*., 2002), which Loucaides *et al*. (2004) outlines as being due to urban children requiring more parent support in transferring them to places where they can be physically active.

The PA differences between urban and rural children have been linked with seasonal changes (Loucaides *et al*., 2004). The study by Loucaides *et al*. (2004) found that during winter, urban children were more physically active and that in summer the opposite was the case. Pedometers were used in the study to obtain PA measures. Although the pedometer measures

showed seasonal differences in PA, it was found that rural children spent more time outside in both winter and summer. Questionnaires were given to parents to obtain measures of environmental variables. The results of the questionnaire suggested that rural children had more garden space, space in the neighbourhood and safety in the neighbourhood. These results support the statement made by Dollman *et al*. (2002) in that the 'abundance of space in rural settings is likely to provide a larger play range within which children can move with relative freedom' (p. 310).
This as a result may explain why rural children were found to be more physically active during the summer.

It has been discovered that urban children spend more time playing video games during both winter and summer (Loucaides *et al*., 2004). Although Loucaides *et al*. (2004) report this, the urban and rural differences in television watching and video game play times are not great (Winter:- Urban= 2.3 ± 1.0 hours; rural= 2.2 ± 1.0 hours), thus questioning the reliability of their conclusion. Pate *et al*. (1997) in their study on rural youth found that those watching television or playing video games for 3 or more hours after school were 2.9 and 2.3 times more likely to be low active. In the discussion by Pate *et al*. (1997) they highlight the mixed findings of previous research papers when relating television watching and video game play to PA. But their conclusion and suggestion (Pate *et al*., 1997) is that parents should limit the number of hours children watch television.

2.5 Gaps and possible flaws in the field of literature

Due to the limited amount of studies conducted in the specific field, it makes evaluating the effect that the area of residence has upon HRF of children difficult. No reliable conclusion can be derived from the available research at present due to the mixed findings (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005). Only the three papers

mentioned, have directly assessed the fitness levels of children. The other papers of relevance have obtained PA measures of both urban and rural children (Loucaides *et al*., 2004) and correlates of PA behaviour in only rural children (Pate *et al*., 1997).

The definition of urban and rural areas is inconsistent among papers. Dollman *et al*. (2002) and Tsimeas *et al*. (2005) define the area of residence as cut off population sizes. Different cut off points were used in both studies. Populations greater than 20,000 persons was defined as urban by Dollman *et al*. (2002), while Tsimeas *et al*. (2005) defined urban as >10,000. Rural measures were less than 5,000 in the study by Dollman *et al*. (2002) and <10,000 in the one by Tsimeas *et al*. (2005). The other two papers (Pate *et al*., 1997; Loucaides *et al*., 2004) do not give a clear definition of how urban and rural areas were determined. With residing areas being defined differently from study to study it distorts what is urban and what is rural. There needs to be a standardised method of identifying areas to make it possible to compare results from various studies without there being discrepancies.

The sample sizes used in the studies vary but are relatively small overall, and as a result may not be a true reflection of the general population. The largest amount of subjects used was in the study by Pena Reyes *et al*. (2003), with a total of 708 participants and the least being 256 (Loucaides *et al*., 2004). Dollman *et al.* (2002) used a cluster sampling procedure which resulted in an uneven distribution of participants in various tests. It makes the data retrieved less convincing as various subjects were used in the tests. This may have caused the results to become distorted due to the effect of changing participants during the study. Research papers with larger sample sizes and the same participants throughout study protocols are needed to obtain more credible evidence which reflects the state of the general population.

As mentioned previously, the paper by Dollman *et al*. (2002) included a questionnaire to investigate environmental influences on PA behaviour. This makes the paper more insightful because comparisons and reasoning's are made when referring to the fitness test results. Tsimeas *et al*. (2005) do not include such a measure in their paper which seems to limit their discussion. Therefore future papers should include data on environmental variables and PA behaviour to strengthen the research.

The field tests used in studies vary, which makes comparing and contrasting results difficult due to the differing protocols used. For instance the three papers (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005) which have used field tests to obtain fitness measures have all used different tests. Of the three papers, only Pena Reyes *et al*. (2003) make reference to the use of HRF tests in their study, which include grip strength, sit and reach, timed sit ups and a 12 minute distance run. Although Dollman *et al*. (2002) and Tsimeas *et al*. (2005) report on the physical fitness of urban and rural children, they do not refer to HRF. The study designs suggest that the papers assess HRF due to the anthropometric and field tests which are included, such as handgrip (Dollman et *al*., 2002; Tsimeas *et al*., 2005), sit and reach (Tsimeas *et al*., 2005), vertical jump (Tsimeas *et al*., 2005) and the 1.6 km run/walk (Dollman *et al*., 2002). Therefore some amount of standardisation is needed in the choice of tests, to allow HRF comparisons to be made more easily between research papers.

2.6 Conclusion

More research in the field is needed to investigate the effect that urban and rural environmental differences have upon the HRF levels and PA of youth. Available research papers are limited, and as a result little is known with regards to the effect that urban and rural living has upon HRF and PA levels of children. Due to the sex differences in PA levels that have been

discovered in previous research, there may be a need to investigate more specifically on the PA behaviour of one of them. Studies at present have been conducted on Cypriot (Loucaides *et al*., 2004), Australian (Dollman *et al*., 2002), Mexican (Pena Reyes *et al*., 2003), Greek (Tsimeas *et al*., 2005) and American children (Pate *et al*., 1997). There are no apparent studies that have been conducted on British and specifically Welsh children. Harris and Cale (2007) have highlighted in their review that

> no study on Welsh children should focus solely on monitoring fitness as this would be inappropriate and misguided. However, a broader 'lifestyle orientated' research project prioritizing the promotion and monitoring of physical activity levels was considered desirable (p. 165).

2.7 Aim of the Study

The aim of this study was therefore to investigate the HRF level and PA behaviour of urban and rural Welsh schoolboys.

2.8 Research and Null Hypotheses

The research hypothesis was that there would be no apparent differences in the HRF and PA of urban and rural boys. The null hypotheses for the HRF tests were:

Ho 1 – There will be no significant differences in the body composition of urban and rural boys.

Ho 3 – There will be no significant difference in the flexibility of urban and rural boys.

Ho 4 – There will be no significant difference in muscular strength/endurance between urban and rural boys.

Ho 5 – There will be no significant difference in the cardiorespiratory endurance of urban and rural boys.

The null hypotheses for the PA behaviour questionnaire were:

Ho 1 – There will be significant differences in transportation to and from school, with more urban boys actively commuting.

Ho 2 – There will be no significant differences in the amount of vigorous and moderate activity that urban and rural boys engage in.

Ho 3 – There will be no significant difference in the sedentary time of urban and rural boys.

Ho 3 – There will be significant differences in the amount of recreational and competitive sports and activities that urban and rural boys participate in, with urban boys reporting greater participation and competitive rates.

(The significance value was set at the 0.05 level)

CHAPTER III

METHODS

3.0 Methods

3.1 Participants

Boys from two Welsh Secondary schools volunteered to participate in this study. One school was within an urban area, defined as having >10,000 inhabitants and was situated within the urbanised Cardiff area and the second school was within a rural area, defined as <10,000 inhabitants in a highly agricultural region in Mid Wales (31 urban and 21 rural). The participants were year 7 pupils at rural and urban schools, aged between 11 and 12 years old. An explanation of the study was given to both headmasters. Consent forms and explanation letters outlining the content of the study were sent to the parents and guardians of all participants. Consent forms were filled in and signed by parents or guardians of all the participants. The whole testing protocol was undertaken at the respective schools. The protocol for the study was approved by the university's ethics committee.

3.2 Procedure

Prior to the anthropometric assessments and field tests, the PA behaviour questionnaire was answered by each participant, as seen in Appendix A. The Modifiable Activity Questionnaire for Adolescents (Appendix B), originally developed by Aaron et al. (1995) was used but adapted with questions from the Sports Council Wales Youth Questionnaire (Appendix B). The Modifiable Activity Youth Questionnaire did not include questions on transportation to school. Therefore questions 1 to 3 were included from the Sports Council Wales Youth Questionnaire. The questionnaire was answered under the supervision of the PE teachers and principal researcher. Pupils were separated when answering the questionnaire to avoid copying the answers of peers.

After answering the questionnaire, pupils in pairs completed the anthropometric assessment, sit and reach, sit up test and vertical jump, which were set up as circuit stations. The sit and reach, sit up test and vertical jump stations had 6th form pupils from the schools to ensure that the correct procedure was used in each test, and that the correct results were recorded by the pupils. Anthropometric assessments were done by the principal researcher. The multistage fitness test (MSF) was conducted after the circuit tests. All tests were completed in the school gyms.

3.3 Anthropometric Assessment

Height was measured to the nearest millimetre using a portable stadiometer (Seca Ltd, Birmingham, United Kingdom). Weight measurements were taken to the nearest 0.1 kg using Seca digital scales. Body composition measurements were taken through bio-electrical impedance (BIA) (Bodystat 1500, Isle of Man, British Isles). The anthropometric variables were inputted into the BIA device for calculation. Participants were asked to remove their right shoe and sock and lie in a supine position on the floor with no parts of their body touching one another. Electrodes and leads were attached to the appropriate sites as outlined in the Bodystat 1500 users' guide. Measurements recorded from the device included fat mass percentage, lean mass percentage and the body mass index (BMI) calculation. A previous study using bio-electrical impedance has reported a reliability coefficient of .96 in males aged 14.9 ± 1.7 years (Unick et al. 2006).

3.4 Field Tests

3.4.1 Sit & Reach (Flexibility)

The sit and reach test was used to measure lower back and hamstring flexibility (Docherty, 1996). Pupils sat on the floor with bare feet placed vertically against the end of a bench measuring 30 cm in height with knees and legs straight. Pupils stretched forward along the top of the bench four times, hands on top of each other with straight arms and palms facing downwards. On the fourth stretch, the pupils reached as far as possible and held it for a second, for a measurement to be taken with a tape measure. Recorded measurements were in centimetres. The distance between tips of fingers and toes were taken. If pupil was able to stretch past their toes, then a positive measurement was taken. If the pupil was unable to reach their toes, a negative measurement was taken and if they were able to touch their toes a zero value was given. The reliability of the test has been documented as being up to .94, dependent on following a consistent procedure in each test (Tritschler, 2000). Therefore the same testing procedure was followed with each subject.

3.4.2 Sit Up Test (Muscular Endurance)

The aim of the sit up test was to measure the strength and endurance of abdominal muscles (Safrit, 1995). On an exercise mat, pupils performed as many sit ups as possible in 60 seconds measured with a stopwatch. Pupils were paired up in order to have someone to hold ankles or feet on the floor. The participants being tested started from a lying position on their back with knees bent. Sit ups were performed with arms crossed on the chest and were counted if the forearms touched the thighs. Scoring was the number of correctly performed sit ups within the time limit. The

reliability of the test has been reported as being between .68 and .94 dependent on consistency of administration (Safrit, 1995).

3.4.3 Vertical Jump (Muscular Strength/Power)

The vertical jump was used to assess the explosive strength of the extensor muscles of the thigh, leg and foot (Docherty, 1996). The test was conducted through the use of jump mats (Takei Scientific Instruments, Japan). Prior to each jump, the line between the mat and the belt around the waist was winded tight to ensure tension. A short familiarisation period was allowed before testing. Pupils performed the jumps with hands held behind their backs. The participants performed three vertical jumps, with the highest jump being recorded. Jump height was displayed on the digital display and was recorded in centimetres. This test has been found to be highly valid and reliable in men, but unknown in children. The test has a concurrent validity of .989 with the vertical jump (horse power) for college men and a test-retest reliability of .977 (Tritschler, 2000).

3.4.4 MSF Test (Cardiorespiratory Fitness)

The MSF Test was used as a measure of cardiorespiratory fitness (Safrit, 1995). Pupils performed the test over a length measuring 20 m, which was marked out with cones. The participants performed shuttles of the 20 m length, back and forth, in synchrony with the timed and recorded beeps (CD used). Pupils were required to touch the line created with the cones with their foot, and wait for the timed beep before performing the next shuttle if they were early arriving at the line. They were encouraged to pace themselves in relation to the beeps. The speed began at 8.5 km/hr and increased 0.5 km/hr at each successive level. They continued running back and forth until they could no longer maintain the pace. When the pupils were unable to reach the lines in time for three successive beeps in a level,

they were withdrawn from the testing. The test is reasonably high in validity with .52 to .93, compared with a VO_2 max stress test on a treadmill. The reliability coefficient for the test range from .89 to .98 (Safrit, 1995).

3.5 Statistical Analysis

Mean and standard deviation calculations were made on all anthropometric and field test results. The independent t test was used to assess urban and rural differences anthropometrically and in the field tests. Nonparametric testing through the likelihood ratio was used to identify differences in the answers reported by urban and rural boys in the PA behaviour questionnaire. The significance level was set at $p < 0.05$ for both tests. Independent t tests and likelihood ratios were calculated using the SPSS 12.0 software package.

CHAPTER IV

RESULTS

4.0 Results

4.1 Anthropometric Assessments

Mean anthropometric values are all higher for boys living in rural localities compared to those in urban areas, as demonstrated in Table 2. Although the mean values are greater, no significant differences were found in height, body mass, BMI and fat mass ($p > 0.05$).

Table 2. Anthropometric measurements of urban and rural Welsh boys

	Urban	Rural
Height (cm)	147.8 ±8.5	148.7 ±7.5
Body mass (kg)	42.2 ±10.1	44.9 ±12.4
BMI (kg/m²)	19.3 ±3.4	20.1 ±4.0
Fat Mass (%)	23.8 ±11.9	24.7 ±7.5

The BMI and fat mass values of both groups of boys are towards the upper end of the criterion referenced health standard range (15–22 kg/m² and 10-25 % respectively) (Physical Best Health Fitness Standards, 1989; Prudential FITNESSGRAM, 1992).

4.2 Field Tests

Results from the field tests are given in Table 3. Both urban and rural boys were unable to attain the norms in the sit and reach, and sit up tests. In the sit and reach, urban and rural boys were also unable to reach distances set by boys of the same age in a previous study (Tsimeas et al., 2005). In the MSF test, the criterion reference health standard (FITNESSGRAM, 1999), was achieved. In the vertical jump test, both populations were unable to reach the heights achieved by boys of the same age in a previous study (Tsimeas et al., 2005).

Table 3. Anthropometric and fitness test results for urban and rural boys with norm values, criterion reference health standards and previous study results where applicable

	Urban	Rural	Norm Values	Criterion Reference Value	Previous Studies
BMI (kg/m^2)	19.3 ±3.4	20.1 ±4.0	15-22	16-22	Urban Boys: 21.0 ±3.4 Rural Boys: 20.5 ±3.4 (Tsimeas et al., 2005)
Fat Mass (%)	23.8 ±11.9	24.7 ±7.5	n/a	10-25	Urban Boys: 21.0 ±7.8 Rural Boys: 19.4 ±7.9 (Tsimeas et al., 2005)
MSF (level+shuttle)	7.0 ±1.6	7.4 ±1.9	n/a	32-72 (~level 5-9)	n/a
Sit and Reach (cm)	-0.9 ±6.2	-1.8 ±4.9	+2.5	n/a	Urban Boys: 14.3 ±6.1 Rural Boys: 14.5 ±6.0 (Tsimeas et al., 2005)
Sit ups (in 60 s)	31.0 ±7.7	33.0 ±6.1	38	n/a	n/a
Vertical Jump (cm)	38.5 ±5.7*	33.4 ±5.5	n/a	n/a	Urban Boys: 48.6 ±7.7 Rural Boys: 46.9 ±7.5 (Tsimeas et al., 2005)

* $p < 0.005$

The MSF test, sit and reach and sit up tests were not significantly different between urban and rural boys ($p > 0.05$). A significant difference was however seen is in the vertical jump, $t(50) = 3.341$, $p<0.05$ ($p= 0.002$).

4.3 PA Behaviour Questionnaire Results

Questions 1-3 dealt with transport to school, of the rural boys, 47% reported walking to school compared with 13% of urban boys (question 1). Within this active transport group, 43% of the rural boys reported that their journey to school included more than 10 minutes of walking, versus 12% of the urban boys (question 3). No obvious percentage differences could be seen in the total reported time that urban and rural boys took to travel to school (question 2). Likelihood ratio analysis revealed that there were significant differences between the populations in terms of walking to school and the duration of this walk ($p < 0.05$).

The next section of the questionnaire (questions 4 and 5) dealt with participation in vigorous and moderate activities. Although more urban boys reported that they engaged in 6 or more days of vigorous activity (by approximately 17%), this was not significantly higher than the amounts reported by the rural population. No significant differences were found in terms of reported amount of moderate exercise performed over the last 14 days. It must be noted however that 6% of urban boys reported that they did no moderate exercise, whilst all rural boys reported that they had engaged in moderate exercise on at least 1 day in the past two weeks.

Question 6 investigated the hours of sedentary activity in terms of hours watching television and playing video games. Again no significant differences were found between the groups. The hours that urban and rural boys reported spending on ‘screen’ time is shown in Figure 1.

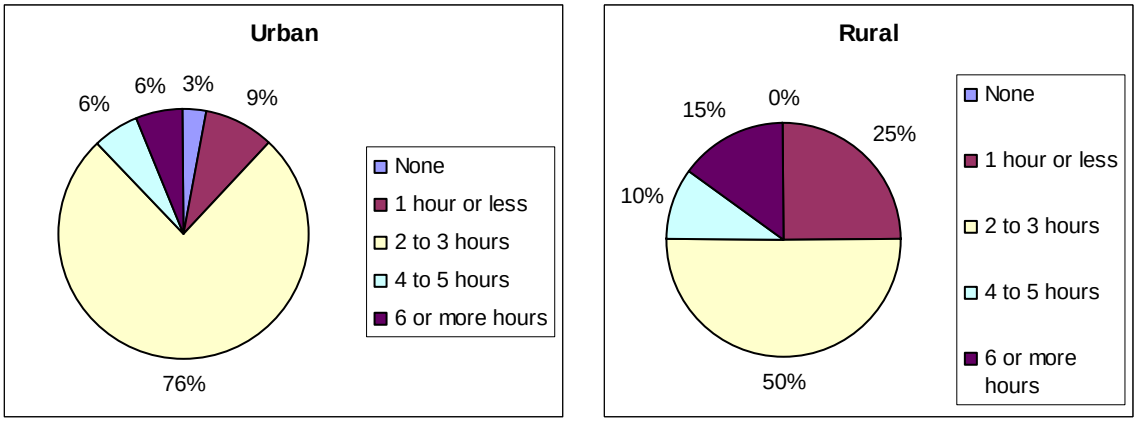

Figure 1. Reported amount of hours a day spent watching television and playing video games.

Table 4. Participation levels in various sports/activities as percentages.

Sport/Activity	Urban (%)	Rural (%)
Athletics	3	1
Badminton	1	2
Baseball	3	1
Basketball	1	1
Circuit Training	2	1
Cricket	3	5
Cross Country Running	5	1
Cycling/Mountain Biking	7	6
Dance	0	2
Fitness Classes	3	4
Football	11	15
Golf	6	4
Gymnastics	3	1
Hockey	0	0
Outdoor Pursuits	3	1
Martial Arts	4	0
Rugby	11	14
Swimming	11	10
Street Sports	3	1
Squash	1	7
Table Tennis	5	7
Tennis	7	7
Trampolining	5	6
Volleyball	0	0
Other	1	1

Question 7 investigated the participation of the boys in different types of sports. Table 4 shows participation levels for each sport.

The last section of the questionnaire dealt with participation in competitive sports and activities. Twice as many rural boys reported not to have competed in a sport or activity over the past year (urban= 12%; rural= 24%). More boys from the urban area reported to have competed in 2 or more competitive sports or activities (by approximately 17%).

CHAPTER V

DISCUSSION

5.0 Discussion

5.1 Anthropometry

The anthropometric measures obtained on Welsh boys are unlike previously gathered data on urban and rural children. Previous research on Australian (Dollman *et al*., 2002), Mexican (Pena Reyes *et al*., 2003), and Greek (Tsimeas *et al*., 2005) children reported that urban boys had higher anthropometric measures. Pena Reyes *et al*. (2003) documented that the urban children were significantly taller (urban= 137.8 ± 7.9 cm; rural= 135.9 ± 7.8 cm) and heavier (urban= 36.6 ± 10.9 kg; rural= 32.0 ± 6.2 kg) than rural counterparts. The BMI and fat mass percentage has also been found to be higher in urban boys (Tsimeas *et al*., 2005).

The BMI measurements obtained in the study are similar to those obtained in a previous paper on boys aged 12.3 ± 0.42 years (Tsimeas *et al*., 2005)(Table 3). Both urban and rural boys are within the criterion reference health standard set for the Prudential FITNESSGRAM (1992) (Table 3). But both areas are towards the upper end of the standard, close to being out of the healthy fitness zone. According to the UK BMI cut off points on overweight and obesity presented in the paper by Chinn and Rona (2002), the Welsh rural boys used in the study are classed as overweight (20.1 kg/m^2).

The use of BMI is recognised as being prone to errors when testing the general population. In children it is magnified due to the changes in muscle and bone weights that accompany growth (Tritschler, 2000). Nevertheless in epidemiological studies it is widely used (Martin and Ward, 1996). McCarthy *et al*. (2003) discovered that in 11-16 year old British boys between 1977 and 1997, the amount deemed overweight through BMI had increased from 8% to 21% respectively. Obesity levels had risen from 3%

in 1977 to 10% by 1997. Waist circumference measurements were also used in their study, which measures central fat accumulation. A large waist circumference being linked to increased risk of metabolic complications. It was discovered that more boys were deemed overweight or obese using this method. Their conclusion was that BMI underestimated the prevalence of obesity, as a result questioning its use. Therefore the use of BMI as a measure in this study and others may be irrelevant, but it gives easily comparable data between studies.

Fat mass percentage measures were obtained through two skinfolds in the study by Tsimeas *et al*. (2005). This is unlike the method used in the present study which involved the use of bioelectrical impedance analysis (BIA). In a previous study using adolescents aged 14.9 ± 1.7 years, it was found that BIA was significantly correlated ($r= 0.96$, $p< 0.001$) with hydrostatic weighing in determining fat free mass in boys (Unick *et al*., 2006). Although the method has been found to be valid and reliable by Unick *et al*. (2006), the data that was collected in this study was inconsistent and cannot be accepted as reliable measures of fat mass percentage. As outlined by Tritschler (2000), the accuracy of the analysis is dependent upon standard measurement procedures. In this case measurements may have been affected due to pupils not being hydrated adequately, they may have eaten or drunk within 4 hours of the test or exercised during the preceding 12 hours. More stringent pre testing controls would need to be put in place to use BIA, which as a result may be a flaw in its use to field test school pupils.

4.2 Field Tests

The data collected in two of the fitness tests rise suspicion about the health status of the boys from both areas in two of the HRF components. Both urban and rural boys were unable to reach normative values set at the 50th

percentile for the sit up (muscular endurance) and sit and reach (flexibility) tests (Table 1). The sit and reach test results are comparable to those obtained in the study by Tsimeas *et al*. (2005), as the same test procedure was used. There is a substantial difference in the measurements obtained (Table 3), which arises questions regarding the flexibility of the spine and posterior leg muscles of adolescents used in this study. The choice of sit and reach protocol does not allow comparisons to be made with criterion reference health standards set by testing programs such as the Prudential FITNESSGRAM (1992). There is also no criterion reference health standard for the sit up test. Therefore it is difficult to definitively state that the flexibility and muscular endurance measures obtained in this study are unhealthy. Testing using criterion reference health standard procedures would be needed to enable such a statement to be made.

One of the main aims of the study was to determine if the HRF of boys differed between urban and rural areas. The present study advocates that the place of residence has no clear impact upon HRF. No significant differences were found between urban and rural boys in the majority of the tests. Only the vertical jump test displayed significant differences between the boys in both areas. Previous studies have documented similar findings in jumping tests (Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005). The possible reason given by Pena Reyes *et al*. (2003) for the observed difference was that urban children appeared more familiar with several fitness tests in their study. This cannot be true in this study as familiarity was checked prior to testing, with neither urban nor rural boys having any previous knowledge of the tests. A more possible reason for the difference seen in this study may be attributed to the reasoning given by Tsimeas *et al*. (2005). Tsimeas *et al*. (2005) confirmed that body fatness has a negative influence on performance in running and jumping tests. The body mass, BMI and fat mass, although not significant were higher in rural boys. Therefore the additional weight and body fatness in rural children may

have influenced their ability in the vertical jump test, thus giving a significant difference. Another possible reason can be derived from the PA behaviour questionnaire. Hoffman et al. (2005) proved that children aged 11.2 ± 0.3 years were able to perform significantly better in the vertical jump if they participated in three or more recreational sports. This could closely relate to the findings in this study as urban boys reported to have competed in more sports/activities in the past year.

Although additional weight and body fatness may be a possible reason for the differences observed in the vertical jump, it cannot be applied to the MSF test. The MSF test results show that rural boys outperformed boys from the urban area. Therefore the statement made by Tsimeas *et al*. (2005) in relation to body fatness negatively influencing performance in running tests can be dismissed due to the data retrieved in this study. The paper by Thomas *et al*. (2007) into the relationship between fitness, fatness and coronary heart disease risk included results on 12-13 year old Welsh children in a MSF test. The children used in their study were a school year older, but the result obtained on boys was lower (57 ± 21 ~ just under level 7) than which was achieved by both urban (level 7.0 ± 1.6) and rural boys (level 7.4 ± 1.9) in this study. The criterion reference health standard of between 32 and 72 shuttles (~level 5-9) set by FITNESSGRAM (1999) was achieved by both urban and rural boys. Although this is the case, secular changes in the performance of youth at the MSF test have been documented (Reed *et al*., 2006). The results of a study by Reed *et al*. (2006) show that the VO_2 max of 9-11 year old Canadian boys and girls have dropped (13.7% and 8.5% respectively) over a 23 year period between 1981 and 2004. This therefore suggests that the performance of youth on aerobic fitness tests is declining.

4.3 Physical Activity Behaviour

Tomkinson *et al*. (2003) highlight that the decreases in running performance in tests may be mostly attributed to decreased physical activity. Decreases in PA have been proven to be strongly associated with television watching time (Pate *et al*., 1997). Therefore reported television watching and video game playing time was used as a sedentary measure in this study. Pate *et al*. (1997) highlighted that 'students who watched television or played video games for 3 or more hours in the after school period were 2.9 and 2.3 times more likely to be low active than those who watched less than this amount' (p. 245). The Welsh Assembly Government (2002) has obtained data on reported television watching and computer game play from the Health Behaviour in School-aged children (HBSC) study 1986-2000. Their findings in the year 2000 were that 31% of 11-12 year old boys spent 4 or more hours a day watching television. Computer game play was reported separately with 22% of 11-12 year old boys stating they spent 4 or more hours playing. The data retrieved for this study has percentages for both urban and rural boys which are lower than the national average obtained in 2000 for reported television watching. Although this is the case, an obvious difference was found between urban and rural boys' television watching. The greater amount of hours spent watching television was seen in boys living in the rural area. This is unlike previous research which has documented that urban youth spend more hours watching television (Loucaides *et al*., 2004). Nevertheless the findings of this study may therefore suggest that rural boys are more sedentary than urban counterparts. It may also explain why rural boys attained higher BMI and fat mass measures. But more direct methods of assessing PA levels would be needed to come to a more definitive answer.

The reported amount of moderate and vigorous PA coincides with the findings from the sedentary question, in that urban boys reported more days with PA. The findings for the Welsh Assembly Government (2002) noted that 65% of 11-12 year old boys reported to have exercised on at least four occasions per week outside school. This percentage exceeds the reported amount of moderate (urban= 16%; rural= 15%) or vigorous (urban= 9%; rural= 10%) activity that both urban and rural boys reported in this study. Although the study results by the Welsh Assembly Government (2002) do not distinguish the intensity of exercise in their results, it does raise questions regarding the amount of PA that both residing areas complete during the week. Again more direct methods of assessment would be needed to clearly distinguish if PA levels are low.

In the study by Loucaides *et al*. (2004), pedometers were used to assess PA levels. Their findings were that a number of 11-12 year old Greek-Cypriot children were not attaining the expected steps per day of 14,000. In the winter, 46% of urban children and 33% of rural children were attaining the expected step count. In the summer, 42% of urban and 69% of rural children were attaining the step count. This shows that seasonal differences exist in the amount of PA that urban and rural children perform. Seasonal differences could be used to give meaning to the results obtained in this study, as urban boys reported to have done more vigorous activity over two weeks of the winter months. The pedometer data collected by Loucaides *et al*. (2004) does not distinguish the intensity of PA. Regardless of this, the reason they give for the differences observed in winter was due to sports club attendance. Sports club attendance was related to parents in urban areas transporting children to places to be physically active more frequently than rural parents. This can also be true in relation to the competitive sport/activity participation levels discovered within this study, as urban boys reported to participate and compete in a wider range of sports and activities.

The wider range of sports participation seen with urban boys can be attributed to the variety of sports clubs that are available in urbanised areas. Rural boys may only have limited clubs available; therefore there could be less opportunity to join a variety of sports clubs. This can be seen in the results, as larger percentages of rural boys reported to participate in team games, such as rugby and football. Individual sports such as martial arts have higher participation rates in the urban group, as these clubs are available to them. This suggestion can be supported by Loucaides *et al.* (2004) in their statement that 'in villages there is usually a single sports club, whereas in towns a plethora of sports clubs are available offering varied activities. Thus children in towns are more likely to participate in a sports club of their choice' (p. 145).

Organised sports participation by children 11.2 ± 0.3 years has been proven to affect physical fitness. Higher results in fitness tests have been seen in children that participate in three or more recreational sports (Hoffman *et al*., 2005). This study found that more urban boys participated in three or more sports competitively (urban= 39%; rural= 29%). Although this was reported, only the vertical jump test saw significantly better results in favour of urban boys. The urban and rural participation differences were also statistically insignificant, which may therefore explain the lack of differences seen in the other HRF tests.

Active commuting has been overlooked as a measure of PA in surveys (Locke *et al*., 2001). It is seen by Locke *et al*. (2001) as a 'potential source of continuous moderate activity' (p. 309). The ACSM (2006) state that youth should accumulate a minimum of 60 minutes of PA a day through bouts of moderate and vigorous activity. Walks to school are also recognised as moderate activity by the ACSM (2006). The PA behaviour questionnaire examined if there were urban and rural differences in the

method of transportation to school. The results identified that significantly more rural boys were physically active when commuting to school. This is against what was hypothesised prior to testing as it was believed that more of the rural boys would require transportation through busses or cars. It emerged that the majority of the rural boys lived in the town where the school was situated. This explains the significant differences seen in questions 1 and 3 as they were within walking distance of the school. The reason why active transportation levels were not of a higher level in the urban locality may be due to the fact that the school was one of two Welsh secondary schools in Cardiff. The demand for education through the Welsh language has increased in the Cardiff area over recent years, and therefore the boys may have been commuted by motorised vehicles from various areas of the city.

5.4 Relevance of the Study

The study enabled insights to be made into the influence that urban and rural living has upon both the HRF and PA behaviour of boys in Wales. Of previous papers, only one (Dollman *et al*., 2002) has investigated by analysing the interrelationship between HRF and environmental influences. Dollman *et al*. (2002) concluded their study by stating that it is 'inappropriate to generalize about the impact of rural and urban upbringings on the health related fitness of children' (p. 310). The same can be said through the findings of this study, as the preconceived notion that rural children are more physically active was not discovered. Therefore the study is made all the more relevant as there is now a greater need to identify and fully understand the ways with which youths are induced to be physically active in various environments. The study should highlight the need for more research into the field to discover what influences PA in various areas to enable improvements to be made in the HRF of youths.

CHAPTER VI

CONCLUSION

6.0 Conclusion

The results of the study demonstrate that no significant differences exist between urban and rural Welsh boys in all but one of the HRF components. The vertical jump results identified that urban boys were significantly stronger and more powerful than rural counterparts. Although no significant differences were observed in the other measures of HRF, some noteworthy mean differences were seen. The main one being that rural boys were anthropometrically bigger than those from urban localities. Height, body mass, BMI and fat mass measures were all higher for rural boys. It emerged that the BMI measurements for rural boys were deemed as overweight according to the UK BMI cut off points. The urban group were also not far from being classed as overweight. The BMI measures have therefore raised concerns about the body composition and the possible associated health risks posed to boys involved in the study. Another cause for concern was the results obtained for flexibility and muscular endurance. Neither group was able to reach normative values set at the 50^{th} percentile for the sit and reach (flexibility) and sit up test (muscular endurance). Although the results were not comparable to set HRF measures, it does add to the speculation that the level of HRF in youth is generally low.

PA behaviour differences were not statistically significant in response to six of the eight questions. Two questions which displayed significant differences between the two groups were associated with transport to school. It was found that rural boys were more physically active when travelling to and from school. This goes against what was hypothesised, as it was believed that more rural boys would require transport through cars and busses. But it emerged that the majority of the boys involved in the study lived in the town where the school was situated, and as a result were able to walk to school.

It was also hypothesised that there would be no significant difference in the sedentary measure of hours watching television and playing video games. Although no statistically significant difference was observed, the measures seemed to suggest that rural boys spent more hours on ‘screen’, and were therefore more sedentary than urban counterparts. This goes against the pre conceived notion that rural children should generally be more physically active. But it was found that the sedentary measure may have been linked with the availability of sports clubs and the time of year. The data was collected during the winter, which has previously been proven to reduce the level of PA that rural children complete. This was linked to the belief that the parents of urban children more frequently transport their children to places where they can be physically active. Urban boys reported to compete in more sports in this study which supports the belief.

The urban boys reported to engage in more vigorous PA than those from the rural area. This may again link to the fact that the urban boys are able, and do participate in more sports at a competitive level. Due to the time of year and lack of sports clubs available locally, it may explain why rural youth do not engage in more vigorous PA. No definitive differences were however seen in the amount of moderate PA that both groups engaged in. The results of the study therefore suggest that urban and rural boys differ in ways which impacts health related fitness and physical activity patterns.

6.1 Limitations

As previously mentioned, the fat mass measures obtained cannot be interpreted as reliable results. The data is displayed in Appendix C. Although previous studies have proven that the use of BIA is valid and reliable in youths (Unick *et al*. 2006), unless pre testing procedures are controlled future field testing should avoid its use. Recognised testing batteries with criterion reference health standards should have been used

to enable a clearer discussion about the HRF levels of the pupils. Studies using standardised testing batteries would enable easy comparisons to be made between youths in various areas and countries.
A delimitation of the study was the assessment of boys alone. Future research would need to investigate the effect that the area of residence has upon both sexes to be in accordance with previously published papers (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005).

Another delimitation was that the maturation level of the participants was not assessed. Growth and maturation has a significant influence on the HRF of children (Katzmarzyk *et al*., 1998). Results may have been influenced by the effects of growth and puberty.

The lack of urban and rural participants may mean that the results obtained are not a true reflection of the population as a whole. Samples of youth from different geographical regions of the country would have enabled stronger conclusions to be drawn.

The questionnaire should not originally have been set using categorical options. It was developed using questions from two proven valid and reliable questionnaires which had used categorical answers. Nonetheless the lack of answered questionnaires meant that the frequency of 5 in the likelihood ratio analysis was not met for some categories. The assumption of a significant difference may therefore have been met in some instances. More answered questionnaires would have enabled the frequency to be met in more of the categorical answers.

6.2 Recommendations for Future Research

Published papers in the related field (Dollman *et al*., 2002; Pena Reyes *et al*., 2003; Tsimeas *et al*., 2005) have also not assessed the maturational status of their participants. Future studies in the specific field should assess the maturation level of participants to ensure that participants are grouped as pre pubescent and post pubescent. This would ensure that a fluctuation in the data retrieved on a cohort is due to HRF levels and not the effects of puberty.

Research on urban and rural differences should gather data in numerous areas of the country to have a true representation of the general population and not specific to those areas alone. A follow up study could identify the effectiveness of the 5×60 scheme in adapting PA behaviour and HRF levels in Welsh youth.

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APPENDICIES

APPENDIX A

PA Behaviour Questionnaire

Name ……. Date of birth …….
School ……..

Instructions: Tick the box which applies to you and where appropriate give further details in the space provided.

1) **On a normal day how do you get to school?**

Walk	
By Car	
By Bus	
Cycle	

Other		Specify:

On average how long does it take to travel from your home to school? (Please tick one box only)

Less than 5 minutes		6 to 9 minutes		10 to 15 minutes	
16 to 19 minutes		20 to 24 minutes		25 to 29 minutes	
30 minutes or more					

2) **Does the journey to school usually include more than 10 minutes of walking?**

Yes		No	

3) **How many times in the past 14 days have you done at least 20 minutes of exercise hard enough to make you breathe heavily and make your heart beat fast outside PE lessons? (Hard exercise includes, for example, playing football or jogging)**

None	
1 to 2 days	
3 to 5 days	
6 to 8 days	
9 or more days	

4) **How many times in the past 14 days have you done at least 20 minutes of light exercise that was not hard enough to make you breathe heavily and make your heart beat fast? (Light exercise includes walking)**

None	
1 to 2 days	
3 to 5 days	
6 to 8 days	
9 or more days	

5) **During a normal week how many hours a day do you watch television and DVD's, or play computer or video games before or after school?**

None	
1 hour or less	
2 to 3 hours	
4 to 5 hours	
6 or more hours	

6) **Which, if any, of the activities listed have you done on ten or more separate days with a club or a group that is not run by your school over the last year?**

Athletics		Badminton		Baseball/Rounders/softball	
Basketball		Circuit training		Cricket	
Cross country running		Cycling/Mountain biking		Dance	
Fitness classes (e.g aerobics)		Football		Golf	
Gymnastics		Hockey		Outdoor pursuits	
Martial arts (e.g karate)		Rugby		Swimming	
Street sports (e.g skateboarding		Squash		Table tennis	
Tennis		Trampolining		Volleyball	

Other		Specify:

7) **During the past year, how many team or individual sports or activities did you participate in on a competitive level, such as local club game or competition?**

None	
1 activity	
2 activities	
3 activities	
4 or more activities	

What activities did you compete in?

Annwyl Rhiant/Gwarcheidwad,

'Rwyf yn fyfyriwr lefel 3 israddedig yn Ysgol Chwaraeon Caerdydd, Athronfa Prifysgol Cymru, Caerdydd (UWIC). 'Rwyf yn gwneud ymchwil ar gyfer fy nhraethawd hir (dissertation) i ffitrwydd yn ymwneud ac iechyd a lefelau gweithgaredd corfforol bechgyn blwyddyn 7 mewn ardaloedd dinesig a gwledig. Er mwyn cwblhau'r ymchwil 'rwyf yn gofyn caniatad ganddoch i'ch plentyn gymryd rhan yn yr arolwg.

Mae'r ymchwil yn edrych i ddarganfod os oes gwahaniaethau yn bodoli rhwng plant dinesig a gwledig o ran eu lefelau ffitrwydd yn ymwneud ac iechyd ac ymddygiad gweithgaredd corfforol. Yn yr ymchwil bydd gofyn i'r plentyn gwblhau profion ffitrwydd ynghyd â holiadur ar ei ymddygiad gweithgaredd corfforol. Bydd y profion yn cael eu cynnal yn ystod gwersi chwaraeon o dan arolwg yr athro chwaraeon. Gall yr ymchwil brofi'n fuddiol gan nad oes llenyddiaeth eang ar y pwnc penodol, ynghyd ac adnabod os ydy gwahaniaethau yn yr ardaloedd byw yn annog gwahaniaethau mewn ffitrwydd yn ymwneud ac iechyd. Mae'r lefelau risg yn isel, ac mae'r profion yn rhai sydd yn cael eu gweld yn aml mewn ysgolion. Mae cymryd rhan yn yr ymchwil yn hollol wirfoddol, felly gall y plentyn dynnu allan o'r ymchwill ar unrhyw bryd.

Ni ddatgelir enw eich plentyn a bydd unrhyw wybodaeth yn cael ei gadw'n gyfrinachol. Yn ystod yr ymchwill bydd y data yn cael ei gadw'n gyfrinachol gan yr ymchwilydd a bydd mynediad i'r data yn cael ei gyfyngu i'r arolygydd traethawd hir (dissertation supervisor) yn unig.

Darllenwch a llofnodwch y bonyn isod os ydech am ganiatau i'ch plentyn gymryd rhan yn yr ymchwiliad. Atodaf holiadur cyflwr iechyd ar gyfer gweithgareddau corfforol i chi i'w gwblhau.

Diolch yn fawr,

Carwyn Price

……
…

'Rwyf wedi darllen a deallt y gwahoddiad i gymryd rhan yn yr ymchwiliad. 'Rwyf fi a fy mhlentyn yn cydnabod bod cymryd rhan yn wirfoddol a gellir tynnu allan ar unrhyw bryd. 'Rwyf i a fy mhlentyn yn ymwybodol bod y wybodaeth yn gyfrinachol a rhoddaf ganiatad i fy mab gymryd rhan yn yr ymchwiliad.

Enw eich mab ……..

Llofnod- *Dyddiad-*

Cyncoed Campus Cyncoed Road Cardiff CF23 6XD UK
Tel: 029 2041 6591 Fax: 029 2041 6768
web: www.uwic.ac.uk

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Campws Cyncoed Heol Cyncoed Caerdydd CF23 6XD DU
Ffôn: 029 2041 6591 Ffacs: 029 2041 6768
gwe: www.uwic.co.uk

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SCHOOL OF SPORT, P.E. AND RECREATION
YSGOL CHWARAEON, Y.C. AC ADLONIANT

Dear Parent/Guardian

I am a Level 3 undergraduate student in the Cardiff School of Sport, at the University of Wales Institute Cardiff. My dissertation investigates the health related fitness and activity levels of urban and rural year 7 schoolboys, and wonder if it would be possible for your child to participate in the study.

The research aims to discover whether urban and rural differences exist in health related fitness and compare the possible reasons for this through their physical activity behaviour. As a subject the child will be asked to complete a series of health related fitness field tests and a short physical activity behaviour questionnaire. The tests will be conducted within the regular PE lesson under the supervision of the PE teacher. The research might prove beneficial since there is limited literature related to the subject and it would recognise if environmental differences affect health related fitness of children. There are minimal risks involved in participation seeing as the tests are basic field tests often used in school settings. Participation is entirely voluntary. Therefore the child may withdraw at any stage of the research process.

Confidentiality will be upheld as far as is humanly possible. The child's name will not appear in the final dissertation and the features cited will only be those relevant to the research. During the research process, the data will be kept by the researcher. Access will be restricted to the researcher and dissertation supervisor.

If you are willing for your child to participate please sign the consent slip below. I enclose a Physical Activity Readiness questionnaire for you to complete.

Thank you.

Carwyn Price

……

I have read and understood the request for my child to be a participant in the above research. My child and I understand the risks involved. My child and I understand that participation is voluntary, and that withdrawal is possible at any time. My child and I understand the measures that will be taken to uphold confidentiality. I agree that my child can participate.

Name of child ……..

Signature- *Date-*

Cyncoed Campus Cyncoed Road Cardiff CF23 6XD UK
Tel: 029 2041 6591 Fax: 029 2041 6768
web: www.uwic.ac.uk

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Ffôn: 029 2041 6591 Ffacs: 029 2041 6768
gwe: www.uwic.co.uk

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APPENDIX B

APPENDIX C

Rural HRF Testing Results

Subject	BMI (kg/m^2)	Fat Mass (%)	VJ (cm)	Sit and Reach (cm)	Sit up (no. in 60s)	MSF (Level & Shuttle)
1	16.3	25.1	28	-6	37	8.6
2	19.8	23.1	30	2.5	38	8.6
3	16.1	47.1	39	2	28	10.7
4	25.8	21.9	25	-5	21	5.3
5	20.9	20.4	30	9	33	7.4
6	18.6	25.8	29	-7	36	8.4
7	22.4	19.8	32	-5	34	7.3
8	19.7	19.9	30	1	33	8.6
9	20.8	22	37	2	33	9.8
10	17	29.5	34	-4	28	8.6
11	21.3	18.4	40	-8	40	5.1
12	17	21.3	33	0	31	6.8
13	22.2	14.6	31	1	38	6.4
14	16.1	36.3	40	0	37	10.5
15	18.6	31	29	-4	36	6
16	17.1	29.7	37	1	27	8
17	32.5	25.7	42	-4	28	4.2
18	16.4	23.2	46	3	44	8
19	23.2	18.3	30	-12	27	4.3
20	16.4	29.1	33	2	41	8
21	23.5	15.5	27	-7	22	5

Rural Anthropometric Testing Results

Subject	Height (cm)	Weight (kg)	Fat Mass (%)	BMI (kg/m^2)
1	154	38.6	25.1	16.3
2	151	45.1	23.1	19.8
3	134	28.9	47.1	16.1
4	155	62	21.9	25.8
5	155	50.1	20.4	20.9
6	145.6	39.1	25.8	18.6
7	144.5	46.5	19.8	22.4
8	149.8	43.7	19.9	19.7
9	142.2	41.9	22	20.8
10	144.5	35.2	29.5	17
11	153	51.2	18.4	21.3
12	144	35.2	21.3	17
13	156	54	14.6	22.2
14	138	30.6	36.3	16.1
15	135	33.9	31	18.6
16	145	36	29.7	17.1
17	157	80	25.7	32.5
18	153	38.3	23.2	16.4
19	151	52.9	18.3	23.2
20	152	37.8	29.1	16.4
21	163	62.5	15.5	23.5

Urban HRF Testing Results

Subject	BMI (kg/m^2)	Fat Mass (%)	VJ (cm)	Sit and Reach (cm)	Sit up (no. in 60s)	MSF (Level & Shuttle)
1	15	46	41	-2	41	9.5
2	15.2	42.2	41	1	39	8.7
3	24.7	15.2	39	5	21	4.4
4	18.5	15.3	39	9	38	7.6
5	20.9	20.4	44	-5	36	8
6	16.5	38.1	37	-3	21	6.7
7	17.7	25.3	49	3	41	-
8	21.7	19.9	31	-10	42	6.2
9	21.4	10.7	33	2	42	4.9
10	21.8	2.9	31	-7	34	7.7
11	27.2	19.3	42	6	34	6.3
12	15.3	59.6	25	-13	42	5.2
13	23.8	19.9	38	0	37	5.4
14	15.7	28.8	39	5	23	6.9
15	16.1	34.6	38	-5	34	6.6
16	20.6	27.3	43	3	34	6.4
17	14.5	37	46	-10	26	8.11
18	18.5	23.1	39	4	27	8
19	21	21.6	41	-16	22	6.3
20	18.3	18.7	44	7	38	8.4
21	17.1	9.2	50	-5	33	6.7
22	17.4	16.7	39	2	32	6.9
23	26.6	22.9	27	4	20	4.8
24	18.2	23.8	33	7	34	6.1
25	21.4	20.8	34	-1	22	4.2
26	19.5	14.3	44	-1	26	8.9
27	20.4	26	41	-5	30	8.9
28	16.4	31.2	41	-5	28	10.5
29	17.3	18.2	43	1	30	8.11
30	16.1	12.9	42	3	33	8.8
31	21.9	18.8	31	1	12	6.2

Urban Anthropometric Testing Results

Subject	Height (cm)	Weight (kg)	Fat Mass (%)	Lean Mass (%)	BMI (kg/m²)
1	138.1	28.5	46	54	15
2	145.8	32.2	42.2	57.8	15.2
3	148	54.1	15.2	84.8	24.7
4	153.8	43.2	15.3	84.7	18.5
5	163	55.5	20.4	79.6	20.9
6	138	31.5	38.1	61.9	16.5
7	141.5	35.2	25.3	74.7	17.7
8	152.2	50.2	19.9	80.1	21.7
9	162.6	56.1	10.7	89.3	21.4
10	144.5	45.3	2.9	97.1	21.8
11	157.5	67	19.3	80.7	27.2
12	132.5	26.7	59.6	40.4	15.3
13	140.2	46.7	19.9	80.1	23.8
14	147.7	34	28.8	71.2	15.7
15	145.4	33.8	34.6	65.4	16.1
16	138	39.2	27.3	72.7	20.6
17	150.4	32.7	37	63	14.5
18	140.4	36.3	23.1	76.9	18.5
19	144.2	43.6	21.6	78.4	21
20	146.6	39	18.7	81.3	18.3
21	155	41.2	9.2	90.8	17.1
22	154.5	41.2	16.7	83.3	17.4
23	157	65.5	22.9	77.1	26.6
24	144.2	37.8	23.8	76.2	18.2
25	143.7	43.8	20.8	79.2	21.4
26	163.6	51.8	14.3	85.7	19.5
27	133.7	36.1	26	74	20.4
28	141.7	32.7	31.2	68.8	16.4
29	146.6	36.9	18.2	81.8	17.3
30	158.4	40.2	12.9	87.1	16.1
31	152.6	50.5	18.8	81.2	21.9

APPENDIX D

PA Behaviour Answers

The number of answers received in each category for the eight questions.

Question 1

	Urban	Rural
Walk	4	10
By Car	3	1
By Bus	24	10
Cycle	1	0
Other	0	0

Question 2

	Urban	Rural
Less than 5 minutes	0	1
6 to 9 minutes	7	5
10 to 15 minutes	13	9
16 to 19 minutes	3	2
20 to 24 minutes	7	2
25 to 29 minutes	2	1
30 minutes or more	1	1

Question 3

	Urban	Rural
Yes	4	9
No	29	12

Question 4

	Urban	Rural
None	2	1
1 to 2 days	8	5
3 to 5 days	9	10
6 to 8 days	10	3
9 or more days	3	2

Question 5

	Urban	Rural
None	2	0
1 to 2 days	8	7
3 to 5 days	9	6
6 to 8 days	8	4
9 or more days	5	3

Question 6

	Urban	Rural
None	1	0
1 hour or less	3	5
2 to 3 hours	25	10
4 to 5 hours	2	2
6 or more hours	2	3

Question 7

	Urban	Rural
Athletics	5	1
Badminton	2	2
Baseball	5	1
Basketball	2	1
Circuit Training	3	1
Cricket	5	4
Cross Country Running	7	1
Cycling/Mountain Biking	10	5
Dance	0	2
Fitness Classes	5	3
Football	16	13
Golf	9	3
Gymnastics	4	1
Hockey	0	0
Outdoor Pursuits	4	1
Martial Arts	6	0
Rugby	16	12
Swimming	17	8
Street Sports	4	1
Squash	2	6
Table Tennis	7	6
Tennis	11	6
Trampolining	7	5
Volleyball	0	0
Other	2	1

Question 8

	Urban	Rural
None	4	5
1 activity	9	7
2 activities	7	3
3 activities	8	2
4 or more activities	5	4