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PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND MENTAL HEALTH IN YOUNG PEOPLE

By

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Doctoral Thesis

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More research is needed in physical activity and sedentary behaviour and their associations with mental health in young people. Study 1 examined the effect size for the association between sedentary behaviour and mental health in young people aged 5-18 years of age, using a meta-analysis. Results from 37 independent studies (n=373, 512) showed a small but significant effect size (\(r=-0.30, \text{ 95\% CI}= -0.20, -0.45, p<0.001\)), indicating that sedentary behaviour is associated with mental health problems in young people. Study 2 examined the association between sedentary behaviour and mental health in African young people. Participants were 296 adolescents (150 males, 146 females) aged 13 to 18 years (mean=14.85 years) living in Ghana. Participants’ physical activity levels were assessed using the Physical Activity Questionnaire for Older Adolescents (PAQ-A) and sedentary behaviour, using the Adolescents Sedentary Activity Questionnaire. Depression was assessed using the Children Depression Inventory and aspects of self-esteem were measured with the Physical Self-worth test and body image silhouette test. There was a significant negative correlation between physical activity and mental health [depression (\(r= -0.78, p<0.001\)); physical self-worth (\(r=0.71, p<0.001\)); body dissatisfaction (\(r= -0.76, p<0.001\))]. Moreover, sedentary behaviour was significantly associated with higher depression (\(r=0.68, p<0.001\)). Affluence was a significant contributing factor of sedentary behaviour in African young people [\(t\ (294)= -7.30, p<0.001\).]
Moreover, Study 3 examined the impact of physical activity on cognitive functioning in African young people. An experimental design was used with 60 adolescents (27 males, 33 females) aged 13 to 18 years (mean=14.83 years) living in Ghana. Participants’ physical activity and health were assessed both at baseline and at the end of the intervention. Physical activity levels were measured using the PAQ-A and by pedometer; cognitive functioning was assessed with the Raven’s Progressive Matrices test, with additional psychological variables of physical self-worth being measured with a subscale of the Physical Self Perception Profile, and body dissatisfaction using the body image silhouette test. The participants in the experimental group participated in aerobic physical activities, twice a week for 6 weeks. Results from the study showed that participants in the experimental school scored significantly higher on cognitive functioning \(F (1,56)=34.77, p<0.001\); and self-esteem than those in the control group. From this current research the new finding seems to be associated with affluent behaviour being a significant contributing factor of sedentary behaviour in African youth, whereas other findings in the Western culture show that the weather is one of the contributing factors for sedentary behaviour in young people.
I dedicate this work to Almighty God for his strength and guidance

and to Professor S.A. Danquah, who has been my mentor
I acknowledge the Commonwealth Scholarship Commission for their sponsorship of my studies in Loughborough University and full support of the research in this thesis. I really appreciate this opportunity.

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CHAPTER 1
INTRODUCTION

1.1 Overview

In order to understand the behavioural constructs of physical activity and sedentary behaviour in relation to health, it is essential to know why individual’s behaviour became important in healthcare. Therefore Chapter 1 provides the background information on health behaviours and well-being. It also presents trends of participation in health behaviours among young people.

1.2 The Background to Illness Prevention

*Why people are responsible for their well-being*

During the European Middle Ages, 7th-11th century, many diseases that caused suffering and loss of lives were attributed to spiritual factors. The 19th century, however, saw the establishment of ideas underlying modern medicine such as the *biomedical model* (Bernard and Krupat, 1994). Darwin’s evolution theory, which also described man as a biological being, published in 1856 may have influenced the biomedical model because it encouraged man to be studied in the same way as the species of the natural world (Ogden, 2007). The *biomedical model* was based on the philosophical view that the mind and the body are separate. According to
the model, diseases were caused by pathogens, imbalances in body chemicals and genetic predisposition, which were beyond human control. This model did not consider the psychosocial factors including the role of behaviour in the development of illness. Individuals therefore, were not seen as responsible for their illness and treatment was seen as mainly being the responsibility of the medical profession (Bernard and Krupat, 1994; Ogden, 2007).

Despite the success of the biomedical model in developing successful medication for treating disease, it could not completely address the changing pattern of illness and was found to be increasingly costly (Bernard and Krupat, 1994). Around 1950, the occurrence of contagious diseases such as influenza, pneumonia, tuberculosis, typhoid fever, etc., reduced dramatically and the leading causes of illness were lifestyle diseases such as cardiovascular diseases (U.S. Department of Health and Human Services [USDHHS], 1992). The increase in noncontagious diseases beginning from the 20th century has been largely due to people living longer and engaging in unhealthy behaviours including low levels of physical activity, inappropriate eating habits and substance abuse (Bernard and Krupat, 1994; Brannon and Feist, 2010). The other challenge to the biomedical model, the dramatically escalating costs of health care, resulted from the high cost of the advances in technology needed to treat lifestyle diseases (Brannon and Feist, 2010).
Due to the limitations of the biomedical model, an alternative approach, the *biopsychosocial model* (Engel (1977, 1980) was developed. This holistic model is based on the philosophical view that the mind and the body are connected. The *biopsychosocial model* stated that illness could be caused by a number of factors including biological processes (e.g., genetic factors), pathogens, and also psychosocial factors, including individual’s personality and behaviour. Unlike the biomedical model, this new model also considers the social, psychological, and even spiritual aspects of a person in order to explain health and treat illness (Bernard and Krupat, 1994).

Whilst the biomedical model led to the development of medication and new surgical procedures that reduced complications and saved lives, the biopsychosocial model places an emphasis on also considering the prevention of illness through behavioural and lifestyle changes (Bernard and Krupat, 1994; Ogden, 2007). Therefore, the biomedical model prevents premature death and takes an individual to the midpoint of healthiness, whereas the biopsychosocial model takes the individual to the highest part of the health ladder in order to achieve optimum health (see Figure 1.1).
Using the biopsychosocial model to explain health and illness, the healthcare system now considers individual’s behaviour when addressing health. Physician John Knowles (1977), for example, stated that "Over 99 percent of us are born healthy and made sick as a result of personal misbehaviour and environmental conditions. The solution to the problem of ill health in modern American society involves individual responsibility, in the first instance, and social responsibility through public legislative and private voluntary efforts, in the second instance (p.58)” (Bennett, 2000).
1.3 Health Behaviours of Physical Activity and Sedentary Lifestyle

Around the 5th century, some scientists such as Claudius Galenus (Galen) identified that contraction is the main activity of the body muscles. Hippocrates, for example, found that physical activity was necessary in the intervention of health problems. Thorough scientific investigations into physical activity and health, however, started after the 20th century (Bouchard, Blair, and Haskell, 2012). Currently, it has been established that regular participation in physical activity and also reduced sedentary behaviours are lifestyles which people could adopt to enhance their health (Chief Medical Officers, 2011). However, research shows that people are no longer doing sufficient physical activity (Hallal et al., 2012).

1.4 The Trend of Physical Activity

In previous generations people engaged in lots of physical activity. They walked long distances to work, to visit friends and go to different places. People were mainly engaging in primary occupations such as agriculture, mining, animal farming, textile making and fishing. As there were limited machines available, their work was typically manual. The use of mainly manpower in working resulted to adequate level of physical activity among the population (e.g., Brownson, Boehmer, and Luke, 2005; Hallal et al., 2012). Adolescents in particular assisted their parents in their jobs especially after school hours, therefore making teenagers more active including during leisure time (e.g., Kelty, Giles-Corti, and Zubrick, 2008).
At the present time, technological advancement, including the manufacture of machines and faster modes of transport, has contributed to less participation in physical activities (Hallal et al., 2012; Popkin, 1999). This technological advancement started mainly from Western cultures and it has extended to almost every part of the world (Pratt et al., 2012). Moreover, people have moved from towns to urban areas and cities. This relocation has caused cities to become densely populated. In most countries, cities are overcrowded with people, and have few natural resources. This lack of space has made people unable to do activities such as gardening, animal rearing and other low intensity activities which could contribute to overall physical activity levels.

Furthermore, due to urbanisation there has been the development of industries where people are recruited to work other than working for themselves (e.g., Hallal et al., 2012). Therefore, the nature of most jobs in cities has been transformed from direct agriculture to different industries. Most industries require that workers report to work early in the morning at a specified time. Therefore, workers who no longer work for themselves and have to arrive early for their job are compelled to travel by vehicles, due to inconvenience such as sweating and also delays associated with active transportation. Currently, it has been reported that participation in physical activity has reduced dramatically among both adults and young people compared to previous times (e.g., WHO, 2011)
(Figure 1.2). Even in situations where there are no significant barriers to physical activities, people still remain less active (Hallal et al., 2012).

![Figure 1.2. Physical inactivity in age groups in some continents (WHO, 2011)](image)

1.5 **Current Physical Activity Levels and Sedentary Behaviours Among Young People**

Young people are expected to be the most active people in society, when compared to adults, because of the increasing strength which is gained during youth (McArdle, Katch, and Katch, 2007). Research, however, shows that physical activity starts decreasing as children grow and significantly at the beginning of the adolescent age (e.g., Kimm et al., 2002; Riddoch et al., 2004; Thompson et al., 2009). Regarding sedentary
behaviour, industrialisation and increases in technology have led to the development of entertainment devices, including mobile phones, computers and the internet (e.g., Pratt et al., 2012). Generally, adolescents have become attracted to playing computer games, chatting with friends on the phone, watching movies, viewing online and shopping on the internet (e.g., Appel, 2012; Park and Kim, 2008). Participation in these activities, especially in leisure time, have made them highly sedentary (Aydin and Sari, 2011; Strasburger, 2004; Hallal et al., 2012).

1.6 Psychological Health Among Young People

Young people desire to have good cognitive functioning because academic learning constitutes the major cognitive activity in their daily lives. Moreover, success in academic or vocational training is important for living in the modern society. Poor academic performance therefore may generate health problems among school students (e.g., Siegler, DeLoache, and Eisenberg, 2011). A number of mental health problems among students are linked with poor academic performance rather than family problems (Bernard, 2009; Emerson, Einfeld, and Stancliffe, 2010; McCarty et al., 2008). Recently, the consequences of emotional symptoms among the youth as well as the occurrence of disturbing incidents in some academic institutions has prompted school authorities to consider their students’ mental well-being in addition to their education (Gledhill and Hodes, 2008; Voelker, 2007).
Depression is the main mental health problem affecting adolescents (WHO, 2011; National Alliance on Mental Illness [NAMI], 2013). Epidemiological studies indicate that 20% of young people suffer depression every year (WHO, 2011). However, more recently, it has been found that the rate of depression has increased to 28% among adolescents (NAMI, 2013), which is very worrying. Adolescents who suffer severe depression may develop cognitive distortions which could lead to suicidal ideations (Comer, 2007; Gledhill and Hodes, 2008). In addition, there are significant reported cases of adolescents with self-esteem problems and anxiety disorders (Dalgard, Gieler, Holm, Bjertness, and Hauser, 2008; Van den Berg, Mond, Eisenberg, Ackard, and Neumark-Sztainer, 2010). Chronic low self-esteem and anxiety conditions interfere with students’ cognitive functioning and well-being (e.g., Courtney, Gamboz, and Johnson, 2008; Kim and Kim, 2009; Saadat, Ghasemzadeh, and Soleimani, 2012).

1.7 Mental Health Problems in Ghanaian Adolescents

A study conducted in Africa found that about 30% of young people experience psychological difficulties, including depression, anxiety and stress conditions (Abd Elhamid, Howe, and Reading, 2009). In Ghana, for example, one of the main precipitating factors of depression, anxiety and stress-related problems among adolescents is the increasing demand for better academic performance. Before Ghana’s independence, which was in 1957, the majority of Ghanaians did not know the importance of higher education. Higher education was found mainly among the elites in society.
However, after independence and Western influence, the majority of Ghanaians have become sensitized to the need for higher education. The first president of Ghana, Dr Kwame Nkrumah, in one of his public speeches stated that “Seek ye the kingdom of education and everything shall be added” (Haizel, 1991; p.55). Since then, coupled with Western influence, higher education has become a priority for future advancement.

Currently, Ghanaian parents expect their children to enter colleges and universities in order to succeed in life. Therefore young people experiencing learning difficulties, especially adolescent students, experience frustration as a result of their own aspiration to perform well in school and also the parents’ pressure for them to obtain higher education. In Ghana, students with poor academic performance manifest emotional problems and behaviours such as depression, anxiety, substance abuse and early sexual relationships (Progressive Life Center, 2010). It appears that mental health problems in recent Ghanaian adolescents may be associated with high academic demands, parental relationships (e.g., PLC, 2011), societal pressures and possibly the increasing trend of less participation in physical activities among African young people (e.g., WHO, 2011).
The Situation of Mental Health Treatment in Ghana

In Ghana, there are mental health clinics and school counselling centres where young people can seek help for psychological problems. However, few Ghanaian parents seek mental health treatment for their children suffering psychological problems (Danquah and Asare, 2008). Similar to the situation in Western cultures, most young people do not have knowledge about mental health problems and therefore do not report psychological problems such as low mood and negative thoughts to their parents (Langeveld, Israel, and Thomsen, 2010). Parents in Ghana generally detect mental health problems in their children when the symptoms become quite severe and manifested in the children’s behaviours (PLC, 2010).

More importantly because of the strong belief system in Ghana, most parents resort to spiritual treatment for mental health treatment for their children. Children with poor academic performance and mental health problems may not receive initial appropriate intervention, which sometimes increase the symptoms before they are finally referred for psychological intervention (Danquah and Asare, 2008; Osei, 2001). Also, students suffering from mental health problems may not consult the school counselling centres because, in some schools, the counsellors are academic staff and students become concerned that the history they provide about their psychological problems may be reported to their teachers (PLC, 2010).
Physical Activity Participation in Ghana

There is no thorough study about the situation of physical activity participation in African cultures (e.g., Hallal et al., 2012). However, reports from WHO (2010) indicate that physical activity participation among adults and young people has decreased in African countries, which is becoming similar to the situation in other countries. People living in African cultures used to have higher levels of physical activities compared to other countries due to the less development in technology in African countries (WHO, 2010). It has been found that many African countries are now going through rapid technological development and increasing urbanisation. Currently, there is increasing information and communication technologies in African countries. There is also easy accessibility of motorised transport and a significant number of people in Africa have their own private cars (Hallal et al., 2012).

In Africa, and specifically Ghana, it appears that the increased affluence of society has contributed to reduced physical activity levels and also increased sedentary behaviour among adolescents. Previously, Ghanaian children and adolescents walked to school (e.g., Arthur, 2003). However, presently, young people from middle to upper class families are driven to school by their parents in their private cars and picked up from school in cars. Adolescents are laughing at their peers who walk to school. Therefore, the majority of adolescents whose parents do not own vehicles
prefer to use public transport, including buses and taxis. Studies (e.g., Hallal et al., 2012; WHO, 2010) have indicated that participation in regular physical activities has declined among adolescents in the African culture.

1.8 Physical Activity, Sedentary Behaviour and Mental Health

Low levels of physical activity and sedentary behaviour have been linked with mental health problems. Mental health problems in young people increase health cost (Chief Medical Officers, 2011; Tremblay et al., 2011). Besides, not all the cases of mental health problems among young people could be reported for treatment (e.g., Reavley and Jorm, 2010). Some young people who suffer depression, body dissatisfaction, anxiety and stress may eventually resort to wrong conducts such as substance abuse and sexual behaviours for coping with emotional distress (e.g., Burnett-Zeigler et al., 2012; NAMI, 2013). Moreover, it has been indicated that some adolescents suffering from moderate to severe depression may not have clear minds to benefit from psychotherapy in that depression blocks clear thinking (e.g., Comer, 2007; Haw, James, and Gralton, 2011). Other behavioural interventions are necessary to improve mental state in order to make people understand and benefit from cognitive therapy techniques (e.g., Freeman and Dattilio, 1992). Therefore, it is worth researching physical activity and sedentary behaviours if they could be used as
interventions to prevent or cope with mental health problems among young people (e.g., Garber, 2006; Reavley and Jorm, 2010).

1.9 Statement of the Problem

It has been found that mental health problems in adolescents have increased from 5% (e.g., Costello, Egger, and Angold, 2005) to 20% (NAMI, 2013; WHO, 2011) since 2005, despite not all cases of psychological difficulties being reported for treatment (Reavley and Jorm, 2010). In Africa, mental health problems are increasing among young people (Abd Elhamid et al., 2009). However, few research studies have examined the precipitating factors of mental health problems in African young people though this has already been done in other cultures (Bauman et al., 2012). Currently, studies have found that higher levels of physical activity and less sedentary behaviours are protective lifestyles for mental health problems in young people (Ahn and Fedewa, 2011; Taras, 2005; Tremblay et al., 2011). Notably, physical activity levels have reduced among adolescents in Africa (e.g., WHO, 2010). However, the impact of physical activity on adolescents’ health has not yet been established in the African culture (e.g., Hallal et al., 2012). This is a research gap which the present thesis addressed.

Moreover, higher academic performance is a priority among African students (PLC, 2010). A link has been found between physical activity and
cognitive skills such as improved concentration (e.g., Biddle and Asare, 2011; Tomporowski, Lambourne, and Okumura, 2011). There is no conclusive evidence, however, for the impact of physical activity on young people’s executive functioning (e.g., Best, 2010; Tomporowski et al., 2008). Again this is an area which the present research addressed because poor academic performance could precipitate psychological difficulties in students (Emerson et al., 2010). More importantly, screen-based sedentary behaviour is new in Africa (e.g., Pratt et al., 2012). However, the impact of sedentary behaviour in African young people has not yet been studied. This is a new research area which the present research in this thesis also addressed.

1.10 Research Objectives

Five main objectives were developed in order to address the research issues of the thesis. The main objectives of the research were:

1) To examine the association between physical activity and cognitive functioning among African youth, aged 13-18 years;

2) To examine the association between physical activity and mental health among African youth;

3) To determine the prevalence of sedentary behaviour and a possible contributing factor of sedentary behaviour among the youth in the African culture;
4) To examine the association between sedentary behaviour and mental health among African youth;

5) To determine the effect size for the association between sedentary behaviour and mental health in young people, aged 6 to 18 years.
CHAPTER 2
LITERATURE AND SYSTEMATIC REVIEWS

2.1 Overview

This chapter provides the theory, literature and systematic reviews of physical activity, sedentary behaviour and health outcomes. Chapter 2 will enable readers to understand the health issues in young people and the terminologies used in this thesis. It consists of three parts:

- Part I explains the constructs of physical activity and sedentary behaviour. It also provides a description of common health problems among youth. The latter section of this part provides the theories of physical activity and mental health.

- Part II reviews available studies on physical activity and well-being among young people. It also covers a literature review of sedentary behaviour and mental health in young people.

- Part III presents a systematic review (a review of reviews) of physical activity and well-being in young people. The latter section of this part provides the justification for researching physical activity, sedentary behaviour and health in African youth.
The review of reviews presented in Chapter 2 (Part III) has been published (Appendix 1). The citation is:


Link: http://bjsm.bmj.com/cgi/alerts/etoc
PART 1:

DEFINITION OF PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND HEALTH

2.2 Introduction

This section clarifies physical activity, sedentary behaviour and associated terminologies. It also provides the theories underlying physical activity and cognitive functioning and mental health.

2.3 Definition of Physical Activity

Physical activity is any bodily movement produced by the muscles which leads to energy expenditure (Caspersen, Powell, and Christenson, 1985). It comprises exercise and sports. Exercise is structured and done regularly whereas sports involve competition with rules (Bouchard et al., 2012; Caspersen et al., 1985). Participation in physical activity provides physical fitness, i.e. bodily attributes that increase the capacity to do physical activities (Caspersen et al., 1985). Therefore, it is suggested that physical fitness is the underlying factor for the benefits of physical activity on health (e.g., Etnier, Nowell, Landers, and Sibley, 2006; McArdle et al., 2007). This is plausible because physical fitness may extend to strengthen the immune system which could protect people from the risk factors of some illnesses (e.g., Haskell, 1994).
There are different intensities of physical activity which indicates the physiological effort, including the amount of oxygen used to carry out an activity (McArdle et al., 2007). The intensity of physical activity is usually estimated with metabolic equivalents (METs). One MET, which represents resting energy expenditure, is equivalent to 3.5 ml/kg/min with respect to oxygen use (Ainsworth et al., 2000). Light intensity physical activity (<3 METs) includes activities such as washing, bathing, dressing, gardening, etc. Moderate intensity physical activities (3-6 METs) are activities which make you breathe hard such as brisk walking, biking, swimming and skipping. Vigorous intensity physical activities (>6 METs) include jogging, running, basketball, football etc. (Welk, 2002).

According to physical activity researchers, at least moderate intensity physical activities provide significant health benefits. Vigorous physical activities, which are more strenuous and make a person feel like being out of breath, are associated with greater benefits (McArdle et al., 2007). Light intensity physical activities like standing, little movements or slow walking are helpful than being entirely inactive (Bouchard et al., 2012). Previously, doctors used to recommend bed rest for people suffering chronic conditions. Being entirely inactive for most times can be dangerous for health because the main purpose of the human body is to move (e.g., Bouchard et al., 2012). The dose of physical activity, i.e. frequency and duration of activity, is also important when considering the benefits of physical activity. Therefore, the physical activity guidelines
recommend that people accumulate 10,000 steps a day which is equivalent to one hour moderate to vigorous physical activity (Chief Medical Officers, 2011). Physical activity is usually used for interventions. Physical activity interventions can be acute or chronic. A number of studies investigating physical activity and health have used chronic physical activity (Bouchard et al., 2012).

**Acute physical activity** is a physical activity intervention which involves participation in a single session of physical activity (Bouchard et al., 2012)

**Chronic physical activity** is a physical activity intervention which involves participation in multiple sessions of physical activity (Bouchard et al., 2012).

The American College of Sports Medicine (2000) has identified three types of physical activity which are cardiorespiratory (aerobic), muscular strength (e.g., weight lifting) and flexibility exercises such as gymnastics. Aerobic physical activity, however, has been associated with wider health benefits than other types of physical activities (Bouchard et al., 2012; McArdle et al., 2007). Aerobic physical activity involves the use of the large muscles and is continuously maintained. It includes walking, jogging, running, swimming, cycling, rope skipping, basketball, volleyball, aerobic dancing, etc. These activities generally require greater oxygen consumption, therefore it improves the body’s capacity to use oxygen (Canadian Society for Exercise Physiology, 2012).
2.4 Physical Activity Prescriptions for Young People

The physical activity guidelines for adults have been applied to young people because it was assumed that children and adolescents also need greater physical activity. The current physical activity guidelines for young people state that children and adolescents should do at least 60 minutes of moderate to vigorous intensity physical activity each day. This amount of physical activity can be done at a particular period or could be done across the day. It is also recommended that people accumulate 10,000 steps a day (Chief Medical Officers, 2011).

2.4.1 Restrictions to Physical Activity

Physical activity is beneficial to young people (Chief Medical Officers, 2011). Research studies, however, show that moderate to vigorous physical activities require more physiological effort (Bouchard et al., 2012; McArdle et al., 2007). Based on this finding and other studies (e.g., Spurr and Reina, 1988; Spurr, Reina, and Barac-Nieto, 1986; Spurr, Reina, Dahners, and Barac-Nieto, 1983), it has been suggested that malnourished children have reduced capacity for physical activity. Spurr and Reina (1988), for example, found that slightly undernourished schoolchildren were unable to perform physical activity for a long duration in the morning. However, after giving them an afternoon meal, these children performed physical activity similarly to those children who were well-nourished. Moreover, the American College of Sports Medicine (2010)
recommends that young people with medical conditions like asthma, digestive problems and other chronic diseases are required to do physical activities under strict supervision. Malnutrition and diseases may limit the capacity to do higher intensity physical activities (ACSM, 2010).

2.4.2 Physical Education in Schools

School physical activities could help young people to meet the daily physical activity recommendations (Cale and Harris, 2005). Many schools, however, are not conducting physical education though it appears on the school curriculum (Pühse and Gerber, 2005).

Physical Education in Ghana

The government of Ghana accepts the UNESCO policy that physical education should be part of the school curriculum. Physical education is taught in elementary, and high schools. The course, however, is not taught effectively as it should be (Curriculum Research and Development Division, 2001; Pühse and Gerber, 2005). Private schools, owned by individuals, mainly focus on the provision of equipment and facilities for teaching subjects like mathematics and science because in Ghana, the quality of a school is judged by the students’ performance in academic curricular subjects during the national examination. The main reason for the ineffective teaching of physical education in Africa seems to be the lack of experts to teach the course (e.g., Pühse and Gerber, 2005). Particularly, physical education is a course which involves two aspects:
theory (education) and practical (learning physical activity skills). Teachers handling physical education are supposed to educate students about the importance of maintaining a healthy lifestyle at their age into adulthood and also take students to the field to do actual physical activities (Pühse and Gerber, 2005). However, in most schools, the usual teachers who know how to play certain games are assigned to teach physical education in order to avoid extra cost of recruiting a physical education teacher. Therefore, students are not exposed to the educational aspects of physical education (Aboagye, 2003; Pühse and Gerber, 2005).

Even, in the public schools, where the government provides some funds to support the teaching of physical education, it has been found that there are difficulties in getting specialist physical education teachers to teach the course (Pühse and Gerber, 2005). As a result, students do not understand the importance of the course and therefore do not participate in physical education. On the other hand, the less participation in physical education in Western cultures is more associated with limited school time and the value placed on physical education than lack of experts to teach the course (Sibley and Etnier, 2003). Generally schools are faced with time challenges; therefore courses which are ranked as less importance are prioritised to the bottom when allocating time for courses. To date, many school authorities do not recognise the importance of physical education for students. It is portrayed that the course is not examined and therefore optional (Bailey, 2006). As a result, some students choose
not to participate in physical education (Diamant, Babey, and Wolstein, 2011; Van der Horst, Chinapaw, Twisk, and Van Mechelen, 2007). In order to prevent time constraints from affecting the organisation of physical education, it is possible for schools to utilise the little time assigned to the course to teach physical education, especially the theoretical aspect. If the school authorities perceive physical education as important (e.g., Sibley and Etnier, 2003), the misconception about the course among students would reduce. Students will therefore be enthusiastic to do more physical activities outside curricular time. Walking to school, for example, could help students accumulate sufficient levels of physical activity (de Nazelle et al., 2011). However, walking has reduced to the extent that the youth are now using transport for short distance travelling (e.g., Hallal et al., 2012; McDonald, 2007). Using motorised transport to school also increases sedentary behaviours associated with travelling (e.g., Hallal et al., 2012). The decline in active transportation to school seems to portray the ineffective teaching of physical education in schools.

2.5 Sedentary Behaviour

Sedentary behaviour is any waking behaviour that involves very low energy expenditure (≤1.5 METS) while sitting or being in a reclining posture (Sedentary Behaviour Research Network, 2012). In simple terms, sedentary behaviour can be described as sitting activities (e.g., Owen,
Sedentary behaviour is different from physical activity because it has distinctive physiological pathways and it is also measured differently from physical activity (Hamilton, Hamilton, and Zderic, 2004; Tremblay, Colley, Saunders, Healy, and Owen, 2010). Figure 2.1 demonstrates the distinction between different intensities of physical activity including sedentary behaviour. Sedentary behaviours include sitting while chatting, relaxing on a sofa, sitting in vehicles, studying, watching television, using the computer, etc. These behaviours can be measured using mechanical devices (e.g., accelerometer) or using self-report questionnaires (Owen, 2012).

![Figure 2.1. Distinction between different intensity of activities (Tremblay et al., 2010)](image)

Note: EE= Energy expenditure; MPA= Moderate intensity physical; VPA= Vigorous intensity physical activity.

Sedentary behaviour is not the absence of physical activity, because a person can be physically active for some duration and then become
sedentary for the rest of the day. It has been found that an individual who does physical activity but engage in high sedentary behaviour may still suffer the health consequences associated with sedentary behaviour (Tremblay et al., 2010). Therefore physical activity does not protect an individual from the negative impact of sedentary behaviour (Dunstan, Howard, Healy, and Owen, 2012; Tremblay et al., 2010). The uncertain issue is how long a person can sit to recover after doing higher amount of physical activities during a day. This area requires clarification. Sedentary behaviour is separately linked with health problems such as diabetes, hypertension and obesity (Hamilton et al., 2004; Healey et al., 2008; Mark and Janssen, 2008; Owen, Healy, Matthews, and Dunstan, 2010; Owen, Leslie, Salmon, and Fotheringham, 2000).

Among young people sedentary behaviour can occur in different contexts including the home, school, during leisure and also when using transportation. Excessive sedentary behaviour has been found among adolescents in Western cultures (Brodersen, Steptoe, Boniface, and Wardle, 2007; Vasques, Mota, Correira, and Lopes, 2012). Sedentary behaviour appears to be prevalent among African adolescents as well. The activity pattern of an average Ghanaian adolescent (Figure 2.2) suggests that youth in Africa could engage in sedentary behaviours for about 7 hours after close from school.
### Schedule of activities of a middle-higher class African Adolescent (Adopted from Tremblay et al., 2010)

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 am</td>
<td>Awake</td>
</tr>
<tr>
<td>6 o’clock</td>
<td>Breakfast (15 mins)</td>
</tr>
<tr>
<td>7 o’clock</td>
<td>Sit in lessons (2hrs)</td>
</tr>
<tr>
<td>8 o’clock</td>
<td>Transport to home (45 mins)</td>
</tr>
<tr>
<td>3 o’clock</td>
<td>Dinner (15 mins)</td>
</tr>
<tr>
<td>6 o’clock</td>
<td>Watch television (2hrs)</td>
</tr>
<tr>
<td>8 o’clock</td>
<td>Transport to school (40 mins)</td>
</tr>
<tr>
<td>9 o’clock</td>
<td>Lunch at home (15 mins)</td>
</tr>
<tr>
<td>10 o’clock</td>
<td>Homework &amp; personal studies (1hr 30min)</td>
</tr>
<tr>
<td>10 o’clock</td>
<td>Sleep 10 O clock</td>
</tr>
<tr>
<td>6 o’clock</td>
<td>House hold chores (30mins)</td>
</tr>
<tr>
<td>7 o’clock</td>
<td>Sit in lessons (2hrs)</td>
</tr>
<tr>
<td>8 o’clock</td>
<td>Extra classes (1hr 30min)</td>
</tr>
<tr>
<td>9 o’clock</td>
<td>Break (40 mins)</td>
</tr>
<tr>
<td>10 o’clock</td>
<td>Sit in lessons (1hr 30min)</td>
</tr>
</tbody>
</table>

**Fig 2.2.** Schedule of activities of a middle-higher class African Adolescent (Adopted from Tremblay et al., 2010)

Until recently, sedentary behaviour was not a problem in Ghana. African weather is hot, so children do not usually spend time indoors (e.g., Arthur, 2003). However, with the introduction of computers and video games
from Western cultures to Africa (e.g., Pratt et al., 2012), African adolescents in urban cities seem to spend more time indoors in order to use screens such as the computer, internet, DVDs and video games. Screen-based sedentary behaviour therefore appears to be prevalent in Africa. Sedentary behaviour and health research is still in its early stages (Hallal et al., 2012). However, it is recommended that both adults and young people should not sit for prolonged periods of time. People should break their sedentary time by standing up or doing some physical activity. Sitting continuously for 2 hours is considered a significant sedentary behaviour which could have adverse effect on well-being (Canadian Sedentary Behaviour Guidelines, 2012).

2.6 What is Health?

Health is a state of well-being in which an individual can cope with normal stresses of life, can work effectively and behave appropriately in society (Pollard and Lee, 2003). It is a broad term which consists of different domains. The main domains of health include physical, psychological, cognitive, social and economic. Good health for example, includes better physical health, absence of depression or self-esteem problems or stress, greater educational attainment and productivity. The common areas of health which have been widely researched among young people include cognitive and mental well-being (Pollard and Lee, 2003; WHO, 2011).
2.6.1 Cognitive Functioning

Cognitive functioning is considered as an aspect of well-being. It is the capability of the brain to think clearly, understand issues in the environment and as a result function well in society (Gregory, 2007; Siegler et al., 2011). Cognitive functioning is closely linked with mental well-being. Poor academic performance is one of the main precipitating factors of mental health problems among young people (e.g., Emerson et al., 2010; Naglieri, 2003; Patel, Flisher, Hetrick, and McGorry, 2007). Researchers have identified 3 main components of cognitive functioning which includes, executive functioning, academic achievement and cognitive skills (Keeley and Fox, 2009).

Executive functioning

Executive functioning reflects the activities of the frontal lobe of the brain. It includes logical analysis, thinking in abstract ways, reasoning, planning and being flexible in thinking (Gregory, 2007; Spearman, 1927). It is considered that every human being has a certain amount of executive functioning (g) that influences the ability to think and learn all intellectual tasks (Siegler et al., 2011). Neuropsychologists have indicated that assessment of executive functioning is necessary for predicting important outcomes such as academic achievement and job performance (Gregory, 2007). Based on the idea that executive functioning is complex, modern executive functioning tests have been designed with many subscales to assess a series of capabilities (Lezak, Howieson, and Loring, 2004).
Currently, one of the most widely used executive functioning test in physical activity research is the Wechsler Intelligence Scale for Children (WISC) (Wechsler, 1991). This test consists of subscales measuring verbal comprehension, perceptual skills, ability to recall, and working speed. Though it is possible to get total scores across the subscales of the test, some respondents may score higher on some subscales than others. This situation on test outcomes makes it difficult to compare respondents’ performances (e.g., Siegler et al., 2011). Raven (1998), however, indicated that executive functioning could be simply defined as reasoning capacity. He therefore developed a non-verbal test, the progressive matrices- test to measure reasoning, which could represent a person’s level of executive functioning. Using a single non-verbal test could make it easier to compare students’ level of executive functioning. Assessing executive functioning with a non-verbal test may reduce the possibility of past learning influencing the test results.

**Development of Executive Functioning During Youth**

Both prenatal and post-natal environmental conditions influence the development of executive functioning. The development of executive functioning is therefore an on-going process, which starts from conception to birth and continues after birth (Comer, 2007; Lezak et al., 2004). Some of the main factors which could affect the normal development of a child’s executive functioning during the prenatal period include
chromosomal abnormalities, poor diet of the mother, and birth complications (Comer, 2007). The mother’s deficiencies in micronutrients and also illnesses suffered by the mother during pregnancy could impair the executive functioning of the unborn baby. The lack of oxygen associated with delayed labour and breech labour which causes anoxia may destroy some delicate brain cells of the baby and result to poor cognitive functioning (Comer, 2007; Rosenzweig, Breedlove, and Leiman, 2002).

Some aspect of executive functioning is acquired before birth. However, the development of executive functioning does not end at birth (Comer, 2007). It continues until around middle adolescence. It has been established that environmental factors (e.g., diet, chronic illness, oxygen intake, etc.) could enhance or impair the development of young people’s executive functioning (American Psychological Association, 1970; Comer, 2007). Children who are deprived of good nutrition and also suffer from long term illnesses in childhood may become stunted and suffer cognitive impairment. Children who do not attend formal school or receive appropriate basic education generally grow up to have deficiencies in executive functioning, including difficulties in making logical analysis (e.g., Lezak et al., 2004). The role of environmental factors in the development of executive functioning implies that healthy behaviours are essential for young people who are still developing executive functioning.
**Academic Achievement and Cognitive Skills**

Academic achievement is performance on the tasks taught in school. Students use their acquired executive functioning to learn academic subjects such as mathematics and social issues; or vocational skills in order to take up work responsibilities in adulthood. Academic achievement may be influenced by children’s socioeconomic background. Academic achievement is mainly assessed using school grades or performance in English and mathematics tests (Siegler et al., 2011). Cognitive skills, on the other hand, reflect the behaviour of children when learning or performing cognitive tasks. They include behaviours such as paying attention to the teacher during lessons, concentrating on the things written on the board and the ability to easily identify irrelevant information in a reading text. Cognitive skills are mostly measured by the time a student spend working on a cognitive task. Students with higher cognitive skills finish reading or complete classroom tasks quickly than those with lower cognitive skills (Siegler et al., 2011).

**2.6.2 Defining Mental Health**

Mental health is mainly associated with a person’s emotions. It reflects having good feelings and a clear state of mind such as being free from negative thoughts. Some mental health indicators include happiness, self-esteem, anxiety, quality of life, and life satisfaction (Pollard and Lee, 2003). Children and adolescents suffer a series of mental health problems
including depression, anxiety, stress-related conditions and self-esteem problems (Comer, 2007).

**Depression:**

Depression is the most common mood disorder that affects both adults and young people. It is however more prevalent among adolescents than in children (Andersen, and Teicher, 2008; Hammen and Rudolph, 2003; Haw et al., 2011). Depression is “a low and sad state in which life seems bleak and its challenges overwhelming” (Comer, 2007; p.223).

Depression in young people begins with feelings of loneliness which usually develop into clinical depression. Two major types of depression have been identified which are reactive and endogenous depression. Endogenous depression is mainly caused by genetic factors. On the contrary, the type of depression which affects most young people is reactive depression (Comer, 2007). Reactive depression is due to environmental factors such as poor academic performance, disappointments, break-up of relationship or unhealthy lifestyles which trigger biological mechanisms to produce depression (Comer, 2007; Sarason and Sarason, 1984).

Currently depression is explained using the diathesis-stress model (Comer, 2007; Garber, 2006; Institute of Medicine, 2009). This indicates that even in situations where the individual has inherited depression and
is bound to break down with the illness, environmental factors could prevent the individual from developing depression (Beck, 1983). For example, less exposure to stress such as family problems may protect an individual from depression (Institute of Medicine, 2009). It is therefore possible that healthy lifestyles may play a role in the prevention and management of psychological problems. Recent studies have also reported that physical activity reduces the impact of negative events on health (Calvete, Camara, Estevez, and Villardón, 2011; Compas et al., 2006; Hashim, Freddy and Rosmatunisah, 2012). The role of physical activity is discussed in more detail later in Chapter 2 through a review of reviews.

**Symptoms of Depression**

The symptoms of depression among young people are similar to those in adults (Gledhill and Hodes, 2008; Harrington, 2002; Thapar, Collishaw, Pine, and Thapar, 2012). People with moderate to severe depression experience a series of depressive symptoms. It has been indicated that even those with mild depression, below clinical level depression, also experience some negative distortions which disrupts their productivity (Goldney, Fisher, Dal Grande, and Taylor, 2004). Some of the symptoms of depression are as follows (Comer, 2007):

- **Emotional symptoms.** Most people who are depressed feel sad and do not get pleasure in doing things.
• **Motivational Symptoms.** Young people who are depressed may not go to school and may withdraw from peer interactions.

• **Behavioural Symptoms.** Depressed people are usually less active and less productive.

• **Cognitive Symptoms.** Depressed people have negative distortions about themselves.

• **Physical Symptoms.** People who are depressed frequently experience physical conditions such as loss of appetite, headaches, body weakness and sleeping problems. Therefore, depression is sometimes misdiagnosed as a physical health problem.

• Among students, it has also been found that depression impairs their cognitive functioning (Asare, 2003; Heiligenstein and Guenther, 1996).

**Intervening Depression**

Drug therapy and psychotherapy are the main treatments for mental health problems (NAMI, 2013; Weller & Weller, 2000). In recent years, drugs such as fluoxetine (trade name Prozac) and sertraline (Zoloft) are commonly used in the treatment of mood disorders in young people. These drugs have some side effects including memory impairment (Harrington, 2002). Therefore drug therapy is recommended only to be used mainly in the intervention of severe depression in young people (National Institute for Health and Clinical Excellence [NICE], 2005).
Presently, Cognitive-behavioural therapy (CBT) has been established as an effective intervention for mental health problems including mild to moderate depression in young people (Comer, 2007). Cognitive therapy is administered to restructure cognitive distortions associated with depression. It also includes the use of pleasurable activities and rewards in the intervention of depression (Beck and Weishaar, 2005; Freeman and Dattilio, 1992). Psychotherapy may involve continuous treatment for at least 6 weeks (Taylor and Montgomery, 2007; Yu, Mooreville, Weller, and Weller, 2011). Research, however, has revealed that young people receiving psychological treatment for mental health difficulties do not attend all the recommended therapy sessions for complete recovery (Yu et al., 2011). In addition, most adolescents and parents do not recognise symptoms of psychological problems (e.g., Burns and Rapee, 2006; Langeveld et al., 2010; Logan, 2000). As a result, only few adolescents with depression, anxiety, low self-esteem and other stress-related conditions receive clinical intervention (Kisch, Leino, and Silverman, 2005; Reavley and Jorm, 2010; Slade et al., 2009).

**Self-esteem, Physical Self-worth and Body Image**

Through socialisation with family and peers, a child becomes aware of his characteristics, such as being clever or not. This awareness is the self-image. In addition, the young person realises that there are some good personal qualities, which represents the ideal self. The evaluation and feelings associated with what a person is and what he/she would have
wanted to be reflects self-esteem (Lawrence, 2006; Smith, Cowie and Blades, 2003). Usually, young people with low self-esteem worry about acne on the face, body shape or stature (Harter, 1999; Shin and Shin, 2008). Findings from clinical research indicate that low self-esteem is a symptom of depression (Battle, 1980; Comer, 2007). Current self-esteem researchers have indicated that global self-esteem is largely determined by physical self-worth, the individual’s evaluations of the physical self (Biddle and Mutrie, 2001; Fox, 1990) studies also indicate that among adolescents judgement about body attractiveness is the main factor that affects their physical self-esteem (Lawrence, 2006; Siegler et al., 2011). (see Figure 2.3).

Fig 2.3. The hierarchy of self-esteem (Fox, 1990; Biddle and Mutrie, 2001)
2.7 Adolescence

Adolescence begins around the age of 12 to 20 years old. This stage of development leads the young person into adulthood. Biologically, puberty indicates the beginning of adolescence. Puberty reflects the growth of the sexual organs, the appearance of secondary sexual characteristics (e.g., development of breast in girls) and the usual growth spurt. These bodily changes which occur in early adolescence are due to the influence of hormones. The growth spurt in height, i.e. the rapid increase in height, begins about the age of 12 years for girls and two years later for boys. Usually boys are taller than girls because the growth spurt in boys begins two years later than girls. Therefore, boys get additional two years of growing before the growth spurt begins, which makes them taller. Weight also increases during adolescence, especially among girls. However, the growth spurt does not cause overweight problems among young people (Siegler et al., 2011).

By the end of early adolescence, the young person acquires a new body shape, which is different from that in childhood. At the middle stage of adolescence, 15-18 years, young people start getting more social responsibilities such as taking care of younger siblings. Adolescence ends when a person completes high school. By the time a young person completes high school, he/she has acquired substantial cognitive development (Siegler et al., 2011). Notably, the increase in academic
demands at high school and the social responsibilities adolescents may receive can precipitate stress and other psychological problems if they are unable to cope (Marshall and Ramchandani, 2008; Siegler et al., 2011; Smith et al., 2003).

2.7.1 Nutritional Practice In Youth

The youth are more likely to conform to societal expectations for beauty (Siegler et al., 2011). The definition of beauty nowadays is a slim body figure (Grogan, 2008). Moreover, physical activity levels have reduced among adolescents (Bennett, Wolin, and Duncan, 2008). Adolescents may not have the knowledge that less participation in physical activities contribute to their weight gain (e.g., Nelson, Lytle, and Pasch, 2009; Tse and Yuen, 2009). Adolescents are more likely to diet in order to lose weight (Grogan, 2008). Besides, depressed adolescents experiencing body distortions and body dissatisfaction may adopt unhealthy eating behaviours (e.g., Goossens, Braet, Bosmans, and Decaluwé, 2011; Grogan, 2008). Increased academic workload in high school places nutritional demands on adolescents. Poor dietary habits which have been identified among adolescents including skipping breakfast, dieting and consuming fast foods are risk for their health (Stanner, 2004; Thompson and Manore, 2012).
2.8 General Literature of Physical Activity, Sedentary Behaviour and Well-being

This section provides other information, including some important estimation about physical activity and sedentary behaviour among youth.

2.8.1 Prevalence of Physical Activity and Overweight Conditions in Adolescents

Compared to children, adolescents do less physical activities (Allison, Adlaf, Dwyer, Lysy, and Irving, 2007; Kelty et al., 2008; Rey-López, Vicente-Rodriguez, Biosca, and Moreno, 2008). Reports from the United States revealed that only about one-half of adolescents do regular vigorous physical activity and only one-fourth of them walk or cycle to school (National Centre for Chronic Disease Prevention and Health Promotion [NCCDPHP], 1998). In another study conducted in the United States, it was found that nearly half (46%) of adolescent females did not do regular moderate to vigorous physical activity (Saxena, Borzekowski, and Rickert, 2002). Pearson, Atkin, Biddle, Gorely, and Edwardson (2009) indicated that only 22% of U.K adolescents did sufficient moderate to vigorous physical activity as specified in the guidelines.

More recently, Iannotti and Wang (2013) investigated into the physical activity patterns of adolescents in the United States. It was found that 47% of these adolescents do not participate in adequate levels of physical activity. Similarly, there is an increased prevalence of obesity in today’s
adolescents. It is estimated that about 20% of young people are obese (Black, White, Viner, and Simmons, 2013; Ogden, Carroll, Kit, and Flegal, 2012; Wells, 2012). The rise in obesity among children and adolescents has been largely linked to lower levels of physical activity and high sedentary behaviours (Bennett et al., 2008; Hu, 2008; Jebb, 2004; Seifert and Hoffnung, 2000).

2.8.2 Prevalence of Sedentary Behaviour in Adolescents
Sedentary behaviour in young people has been researched mainly in Western cultures (Bauman et al., 2012). Studies indicate that a significant number of adolescents are highly sedentary (Hallal et al., 2012; Vasques et al., 2012). Vasques et al (2012) found that about 88% of Portuguese youth use screen devices for more than 2 hours per day. Research also shows that youth in the U.K. spend about 420-460 minutes per day in sedentary activities. Moreover, it has been indicated that young people spend about 60-65% of their time in sedentary behaviours (Department of Health, 2010). However, there is no information about the prevalence of sedentary behaviour in the African cultures (Bauman et al., 2012).

Sedentary Behaviour in Ghana
It has been reported that no study has examined the prevalence of sedentary behaviour in Africa (Bauman et al., 2012). However, it appears that screen based sedentary behaviour is prevalent in Ghana. Electronic and screen devices are not manufactured in Africa but organisations from
the Western countries have been donating computers to Ghana, which are then supplied to schools. Currently, the government of Ghana has also planned to increase information and communication technology (ICT) in schools. To implement this plan, computers are being supplied to the secondary schools (Ghana News Agency, 2012). Therefore, students who do not have computers at home seem to have access to screen devices at school. For example, in October 2012, the government supplied computers and accessories to senior high schools in the Central, Western and Brong-Ahafo regions of Ghana. It has also been arranged that laptops be supplied to the public schools in the whole country. Some of the schools have now received these computers (Ghana News Agency, 2012).

Apart from screen-based sedentary behaviour, adolescents in Ghana are likely to be exposed to other sedentary behaviours including education and travelling. Due to increasing affluent in Ghana, adolescents prefer to use motorised transport to school than walking. The heavy traffic jams in the city therefore contributes to additional sedentary behaviour in vehicles among students. Moreover, parents arrange for extra classes for their children. After close of school, students may sit for extra classes, which are likely to increase sedentary behaviours.
2.8.3 Gender, Physical Activity and Sedentary Behaviour

Boys do more physical activity than girls (Hallal et al., 2012), as confirmed by a systematic review conducted by Park and Kim (2008). In terms of sedentary behaviour, a cross-sectional study which examined the use of internet technology among young people reported that there was no significant difference between males and females in the use of internet. The findings explained further that both males and females use the internet at the same level but for different purposes. While males use the internet for playing games, females are more likely to use the internet for communication (Shaw and Gant, 2002). In 2012, Vaques et al., indicated that boys spend more time on screen-related sedentary activities than girls.

2.8.4 The Health Benefits of Physical Activity in Young People

**Obesity and Type 2 Diabetes**

The problem of physical inactivity in the modern society is not about entire absence of physical activity. Rather it is about the fact that people are not doing sufficient physical activities when compared to people in the previous generation (Hallal et al., 2012; WHO, 2011). The recent increase in obesity among young people has been associated with low levels of physical activity than diet (Hu, 2008). With reference to the energy balance model, young people who consume more calories but expend these calories through physical activity may attain energy balance and therefore are unlikely to be overweight (Thompson and Manore, 2012).
Studies indicate that young people who do regular physical activities are less likely to become obese in adulthood. The risk factor for type 2 diabetes that can easily be modified is obesity (Hardman and Stensel, 2009). Physical activities among young people could control body fat and reduce the increasing occurrence of type 2 diabetes among the youth (Hardman and Stensel, 2009). There is evidence that regular physical activities of at least 5 days per week may reduce body fat within 12 weeks (McArdle et al., 2007).

**Cardiovascular Diseases and Bone Health**

Generally, young people do not suffer from cardiovascular diseases but they can have some risk factors for heart diseases (Hardman and Stensel, 2009). High levels of physical activity, especially aerobic activities, can reduce the risk factors for this illness among young people (McArdle et al., 2007). Hardman and Stensel (2009) found that adolescents who had higher levels of aerobic fitness and physical activities had less risk factors for cardiovascular diseases. Aerobic physical activities improve the efficiency of the heart during youth (e.g., McArdle et al., 2007). On the other hand, strength physical activities such as weight lifting are associated with bone health. Studies show that physical activity during young age could slow down the decline of bone density during older age (e.g., Bouchard et al., 2012).
**Mental Health**

There is evidence that physical activity is helpful in relieving symptoms of mild to moderate depression, and anxiety (e.g., Biddle, 2000; Bouchard et al., 2012; Landers and Petruzzello, 1994). Recently, research findings indicated that physical activity may reduce the negative impact of stress on health (e.g., Sund et al., 2011). Moreover, the psychological intervention of Cognitive Behaviour Therapy (CBT) already involves the use of activities. One of the symptoms of depression is psychomotor retardation (Comer, 2007). Generally people with depression are attracted to sitting activities, which according to mental health experts (e.g., Harrington, 2002) increase the symptoms of depression. Clinicians administering psychotherapy usually include pleasurable activities as part of the treatment to tackle excessive sitting activities typical of people suffering from clinical depression.

Patients with depression who do the scheduled clinical activities achieve enhancement in mood (e.g., Harrington, 2002). In practice, Clinical Psychologists administering CBT introduce behavioural therapy in the first place before cognitive therapy begins. Behavioural therapy, which involves activities, improves clarity of mind for the patients to benefit from cognitive therapy (Freeman and Dattilio, 1992). It is likely that participation in regular physical activities may enhance mood.
2.8.5 Mechanisms Underlying the Relationship Between Physical Activity and Mental Well-being

Both physiological and psychological theories have been developed to explain the factors that might influence the link between physical activity and enhancement in cognitive functioning and mental health (Berger, Pargman, and Weinberg, 2002). Some of these theories are presented below.

**Physical Activity and Cognitive functioning**

Physiological explanations indicate that continuous participation in physical activity improves the efficiency of the heart, particularly by increasing stroke volume (Powers and Howley, 1997). With increasing stroke volume, more oxygen is absorbed for the exercising muscles and also to other parts of the body including the brain. Increased supply of blood flow to the central nervous system produces further stimulation to the brain which may enhance memory (e.g., Blakemore, 2003). Aerobic physical activity interventions have been consistently linked with better memory than strength activities (Haskell, 1994). Experts in neuroscience, through brain activity measurements, have also found that people who participate in continuous physical activities gain higher brain activity levels compared to their brain activity prior to the physical activity (Lezak et al., 2004). However, these areas have some methodological challenges and the exact mechanisms explaining links are still to be identified.
Psychological explanations also underpin the association between physical activity and cognitive functioning. Piaget (1967) mentioned that during physical activity, especially those involving complex techniques, young people learn to respond to spatial stimuli. These activities help them to think more about spatial situations, make estimations and know when to act in spatial tasks. These brain activities that occur during physical activity can be transferred into learning, which may eventually improve cognitive performance. From psychological point of view, physical activity programmes may also help young people to interact more with their peers which may improve their mood. It has been indicated that better mood, including happiness enhances learning (Cheatum and Hammond, 2000).

**Mechanisms of Physical Activity and Depression, and Self-esteem**

The main physiological explanation for the relationship between physical activity and enhancement in mood is the endorphin hypothesis. It has been showed that the brain responds upon receiving information from the exercising muscles. During physical activity, the brain stimulates the production of endorphins. These endorphins, which act similarly to pain killers, have been linked with the improvement in emotional feelings after participation in physical activity (Daniel, Martin, and Carter, 1992).

A popular psychological explanation for the reason why physical activity enhance mood involves the issue of distraction. During physical activity,
such as taking a walk, a person may encounter different environmental stimuli that may distract him/her from the negative thoughts which are associated with anxiety and depression. Distraction from negative thoughts as a result of pleasant environmental stimuli or the task at hand may reduce negative affect as well as depression (Berger et al., 2002; North et al., 1990). In a physical activity intervention, people participate in situations different from the places where they experience the stressors. These comfortable environments may reduce tension, stress and depression (North et al., 1990).

Another psychological explanation indicates that physical activity usually involves the learning of skills. People who participate in physical activity programmes cognitively evaluate their progression in learning the skills involved in the activities. The mastery of these skills during or after the physical activity programme can produce enjoyment, efficacy (mastery) and satisfaction which manifests in positive emotions and improves psychological well-being. This explanation is known as the mastery hypothesis (Petruzzello, Landers, Hatfield, Kubitz, and Salazar, 1991; Thayer, 1996). A behavioural explanation has also been proposed about the link between physical activity and self-esteem and mood. Physical activity provides opportunities for young people to socialise. Young people who participate in physical activity programmes interact more with their peers and may also perform in groups. This interaction and the feeling of belonging to a group may improve social self-esteem and also produce
better feelings (Cheatum and Hammond, 2000). Researchers found that students who participated in a physical activity programme reported better feelings after the programme (e.g., Balyer and Gunduz, 2012; Gabbard, 2004). Participation in physical activities therefore appears to have a clinical significance with regards to enhancement in emotions. While the above discussion provides support for several mechanisms for the link between physical activity and mental health, it remains unclear which mechanism, if any, is mainly responsible. Moreover, the probable explanation is a combination of psychological, social and neuro-biological factors.
PART II

LITERATURE REVIEW OF PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND CONFOUNDERS ON HEALTH

2.9 Overview

This section provides a literature review of physical activity, sedentary behaviour and well-being. It also reviews studies on nutritional practice and parenting styles in order to determine their impact on well-being. The latter section of this part provides the literature review on sedentary behaviour and mental well-being as well as the determinants of sedentary behaviour in young people.

2.10 Physical Activity and Well-being

The link between physical activity and chronic diseases captured research attention for many years. Therefore, research investigating the impact of physical activity beyond physical well-being started not too long (Bouchard et al., 2012). Over the past decade, studies on physical activity and cognitive functioning and mental well-being have increased. However, in the field of physical activity and mental health, more studies are on adults than in young people (Tomporowski et al., 2011).
2.10.1 Physical Activity and Cognitive functioning

There is evidence that physical activity is significantly associated with improvement in cognitive functioning (Chaddock, Pontifex, Hillman, and Kramer, 2011; Tomporowski et al., 2011). This finding is very important; especially for students whose academic performance is one of their main concerns (Siegler et al., 2011). This section therefore reviews research on physical activity and cognitive functioning. It is important to mention that researchers who have investigated physical activity and cognitive functioning have reported on three different components of cognitive functioning (Keeley and Fox, 2009). The literature is therefore reviewed based on these components of cognitive functioning: executive functioning, academic achievement and cognitive skills (Keeley and Fox, 2009).

Physical Activity and Executive Functioning

It has been found that executive functioning continues to develop among young people and it could be influenced by environmental factors (Comer, 2007; Siegler et al., 2011). Researchers have found a link between physical activity and executive functioning. It is important to note that very few studies have examined physical activity and executive functioning compared to other aspects of cognitive functioning (e.g., Best, 2010; Tomporowski et al., 2008). In a randomised controlled trial, to assess the impact of physical activity on executive functioning, Castelli,
Hillman, Hirsh, Hirsh and Drollette (2011) found that there was a significant positive relationship between physical activity and executive functioning. The sample comprised 59 schoolchildren in the U.S. A physical activity programme was planned for participants in the experimental group. These participants participated in the after-school physical activity intervention programme which lasted 120 minutes per session, for 36 weeks. The intervention programme also included a healthy lifestyle education. The control group however, did not do physical activity nor receive lifestyle education. It was mentioned that during the physical activity intervention period, participants in the experimental group wore heart rate monitors to estimate their levels of physical activity.

Moreover, participants’ executive functioning was assessed at pre and post-testing using the Trail Making Test. Results showed that students who participated in the physical activity intervention significantly scored higher on the executive functioning test than the control group participants. The study however, did not assess physical activity at baseline in order to ensure that the improvement in executive functioning was associated with a change in physical activity levels. Moreover, during the physical activity intervention, the physical activity levels of the experimental group participants were measured, but physical activity levels of the control group participants were not measured at post-testing. Therefore there was no comparative data on physical activity for the
experimental and control group. This limitation tends to reduce the strength of Castelli et al’s (2011) findings.

Similar findings were reported by Ruiz et al. (2010) who investigated the relationship between physical activity and executive functioning using a cross-sectional study. The study involved a large sample size of 1,820 Spanish adolescents aged 13 to 19 years. Participants responded to a question about whether they engaged in physical activity during leisure time or not. They also completed the Test of Educational Ability, a cognitive test of executive functioning. It was found that adolescents who engaged in sport activities during leisure time had significantly higher scores on the cognitive test than those who did not do physical activities at leisure time. Even after controlling for a confounding variable of socioeconomic status, physical activity was significantly associated with executive functioning. The limitation of the study is the assessment of only leisure-time physical activity.

Some studies have also examined the association between physical activity and executive functioning among young people diagnosed with cognitive functioning difficulties. For example, Roebroeck et al. (2006) investigated whether cognitive difficulties among adolescents with meningomyelocele are related to medical conditions or physical activity levels. Adolescents, with this clinical condition have difficulties in abstract
thinking. In the study, medical records of 14 participants were analysed. Furthermore, a neuropsychological test was used to assess executive functioning, specifically problem solving ability; and participants’ physical activity levels were assessed for two continuous weekends using an activity monitor. Results from the correlational analyses revealed that participants’ medical problems were not related to their level of executive functioning. Rather, it was found that adolescents who obtained lower scores on the executive functioning test had lower levels of physical activity. Therefore, the study concluded that cognitive functioning difficulties among adolescents with meningomyelocele might be associated with lower levels of physical activity. The limitations of this study however, include the use of a small sample size and the assessment of only weekend physical activity levels.

Furthermore, a cross-sectional study by Gapin and Etnier (2010) found that physical activity was significantly associated with better performance on executive functioning test. The study included 18 boys aged 8 to 12 years diagnosed with attention deficit hyperactivity disorder and who were on medication. Accelerometer, together with the Daily Physical Activity Log, was used to assess participants’ physical activity levels. Executive functioning of these children were also assessed using ‘The Tower of London 2nd edition test’, a test which measures planning. Results from the regression analyses revealed that physical activity was significantly and positively associated with executive functioning. The
strength of this study was the use of a mechanical device to measure participants’ physical activity. The sample size of the study however, was small and included only boys. This study was similar to Ruiz et al. (2010). The main difference between the two studies was the way physical activity was measured. Gapin et al. (2010) used accelerometer to assess overall physical activity, whereas Ruiz et al (2010) assessed only leisure-time physical activity using a single question.

While some studies have found a significant positive relationship between physical activity and executive functioning, other studies did not find a consistent association between physical activity and performance on the entire test of executive functioning. Davis et al. (2007) for example, found that physical activity was significantly associated with higher scores on the planning subscale of the executive functioning test but not on the remaining subscales of the test. The study was a randomised controlled trial with a repeated measures design which examined the benefits of aerobic physical activity on executive functioning among schoolchildren in the U.S. Ninety-four children who were sedentary, overweight but without medical problems, participated in the study. Children were selected to a low and high-dose physical activity groups or to a control group who did not do physical activity. The two physical activity groups performed higher intensity physical activities for 15 weeks but different doses (20 vs. 40 minutes/day). Participants’ executive functioning was assessed at baseline and after the physical activity intervention using the Cognitive
Assessment System. This cognitive test consisted of planning, attention, simultaneous, and successive subscales. The analysis of variance (ANOVA) test was used to examine the differences in post-test scores. The results showed that physical activity was significantly associated with higher scores on the Planning subscale of the executive functioning test but not on the remaining subscales. Moreover, there was no significant difference in performance on the cognitive test between participants in the low-dose and high-dose physical activity groups who did the same intensity of physical activity but different dose. Unlike, Castelli et al. (2011), who did not assess physical activity at baseline and post testing, this study assessed participants level of physical activity at baseline and at post testing. The study however, included only overweight participants. Some children who were sedentary but with normal weight could have been included.

In 2011, Davis et al. conducted another randomised controlled trial, to examine the impact of physical activity on executive functioning in a different sample. The sample included 171 schoolchildren in the U.S who were sedentary and overweight. These participants were assigned to two experimental conditions and a control condition. Similarly to their study conducted in 2007, the children in the physical activity conditions did different doses of physical activity (20 vs. 40 minutes/day). The physical activity intervention, which lasted for 3 months, focused on increasing intensity than skills. Executive functioning was assessed using the
Cognitive Assessment System. The researchers also measured the functional imaging of the brain (pre and post-intervention) among a subsample of the participants (20 children). The results showed that participants in the experimental groups significantly scored higher on the Planning subscale of the executive functioning test than participants in the control group. Physical activity, however, was not associated with the remaining three subscales of the executive functioning test. In addition, the brain imaging results showed that there were changes in brain activity among participants in the intervention groups. Moderator analysis revealed that participants in the high-dose physical activity group performed significantly better on the Planning subscale than those in the low-dose physical activity group. The strength of this study was the assessment of brain activity in addition to executive functioning. The limitation of the study however, was the inclusion of only overweight children in the study.

A study conducted in Scotland by Fisher et al. (2011) found that physical activity was significantly associated with scores on one of the two tests which were used to assess executive functioning. This study was a randomised controlled trial involving 64 schoolchildren. A 10-week aerobic physical activity programme was planned for children in the intervention group. Participants in the control group however, did not do physical activity. Participants’ physical activity levels and executive functioning were assessed at baseline and post-testing. Executive functioning was
assessed using the Cognitive Assessment System and the Cambridge Neuropsychological Test Battery. Participants in the intervention group scored significantly higher on the Cognitive Assessment System test but not on the neuropsychological test. Perhaps the neuropsychological test could not assess executive functioning accurately. The study however, was conducted as a pilot study so that the procedures could be followed by future researchers.

Interestingly, Martinez-Gomez et al. (2011) reported that physical activity was significantly associated with improvement in executive functioning among girls but not boys. The researchers conducted a cross-sectional study to determine the association between active travelling to school and executive functioning among adolescents. Data for the study was obtained from a previous large scale survey among Spanish adolescents. Participants self-reported how they travelled to school and also completed cognitive tests. It was found that girls who walked to school for more than 15 minutes obtained significantly higher scores on executive functioning than girls who did not walk to school. This inconsistent finding for boys and girls could be due to the use of a secondary data. Possibly the main aim of the original study might not be addressing physical activity and executive functioning and as such validated tests were not used to assess physical activity or executive functioning. For example, in the original study, physical activity was measured using 2 questions and only one context of physical activity, active travelling, was measured. Other kinds
of physical activities such as games were not assessed. These limitations in the primary study might have accounted for the weak association found between physical activity and executive functioning. Generally, systematic reviews have reported that the few studies which have examined physical activity and executive functioning have found some association, though a number of these studies did not find a consistent association across the subscales of executive functioning tests (Barenberg et al., 2011; Best, 2010).

**Physical Activity and Academic Achievement**

Physical education is part of school curriculum but students are not motivated to do physical education (Pühse and Gerber, 2005; Sibley and Etnier, 2003). However, over the past decade, there has been increasing evidence revealing that students who do sufficient physical activities, including school physical activities, tend to perform well in school and therefore obtain better grades (Chaddock et al., 2011). Dwyer, Sallis, Blizzard, Lazarus, and Dean (2001), investigated whether physical activity was associated with academic performance among students. They conducted a large cross-sectional study involving 7,961 Australian schoolchildren and adolescents who were 7-15 years old. Participants’ physical activity levels were assessed using a questionnaire. Academic performance was assessed using school records. From the correlation analysis, there was a significant positive relationship between physical activity and academic performance. Even after controlling for confounding
variables such as socioeconomic status, physical activity was still associated with academic performance.

In a recent cross-sectional study, So (2012) also found a positive relationship between physical activity and academic achievement. In this study, data from a previous national survey was used. Participants were 75,066 Korean adolescent students. Data about participants’ physical activity levels and academic performance was based on self-report. Results from the logistic regression analysis showed that participants who did moderate to vigorous physical activity for at least twice a week, were more likely to rate their academic performance as average or above. Participants’ socioeconomic background and body mass index were controlled in the analyses. However, a validated tool was not used to assess physical activity. Balyer and Gunduz (2012), used qualitative data, to examine the relationship between school physical activities and academic performance. The study involved a small sample size of 20 adolescents who responded to questionnaires to indicate how physical education affected their academic work. Responses from the participants showed that participation in physical education is associated with enhanced academic performance and social skills. This study provides the actual experiences of students about doing physical education which substantiate the results from quantitative analyses.
The findings of cross-sectional studies are consistent with results of longitudinal studies which have examined physical activity and academic performance. For example, Donnelly and Lambourne (2011) conducted a longitudinal study to examine the impact of classroom-based physical activities on academic achievement. A total of 167 children participated in the 3-year intervention study. The 77 participants in the experimental school were taught by incorporating physical activities into class lessons whereas participants in the control school had their usual classroom lessons. Physical activity levels were measured using accelerometers. The academic performance test measured reading, writing, mathematics, and language skills. Results indicated that over the 3 year intervention period, children in the experimental school had 27% increases in physical activity levels compared to children in the control schools. Moreover, participants in the experimental school scored significantly higher on the academic achievement test than participants in the control schools.

A longitudinal study conducted among Australian schoolchildren also found that physical activity was significantly associated with higher academic performance. The study was conducted in two different schools and involving a total of 620 participants. In the experimental school, students did regular physical education whereas in the control school, students did physical education once a while. Academic performance on verbal and numeric tests was assessed at baseline and after the 2-year observation period. The results from the repeated measures ANOVA
showed that participants in the experimental school obtained significantly higher scores in the numeric test (10.9 points better) and writing test (10.1 points better) than participants in the comparison group (Telford et al., 2012).

On the other hand, Martinez-Gomez et al. (2011) who examined the association between walking to school and academic performance reported that walking to school was significantly associated with academic performance only among girls. This study however, did not use a validated test to assess physical activity. Therefore, physical activities during leisure time were not measured. Generally, review studies (e.g., Keeley and Fox) have reported that participation in regular physical activities is associated with better school grades.

**Physical Activity and Cognitive Skills**

Students’ ability to concentrate and pay attention in class forms an essential part of learning (Chaddock et al., 2011). Recently, studies investigating physical activity and well-being have found that participation in regular physical activities helps to enhance concentration (Chaddock et al., 2011). This finding is very promising, especially for students who need elevated attention span during lessons.
In a recent randomised controlled trial, Castelli et al. (2011) found that physical activity was significantly associated with higher cognitive skills. The study included 59 schoolchildren in the U.S. Participants in the experimental group participated in after-school physical activities everyday, which lasted 120 minutes per session. The control group participants did not do physical activity. Participants’ cognitive skills were assessed using the Stroop Colour-Word Test. Results from the regression analysis revealed that physical activity had a significant positive impact on scores of the attention test. The study however, did not assess physical activity at baseline.

Some studies have also examined whether physical activity is beneficial for improvement in cognitive skills among children diagnosed with attention deficit hyperactivity disorder (ADHD). Generally, young people with this disorder have attention problems and impulsive behaviours. For example, Kang, Choi, Kang and Han (2011) conducted an intervention study involving 28 adolescents who were receiving treatment for ADHD. The participants were assigned to a 6-week physical activity intervention group or to a comparison group who received education to control their attention problems. Participants’ attention was assessed using the Digit Symbol Test and the Trail Making Test. It was found that participants who received the physical activity intervention significantly scored higher on the attention tests than participants who received education to manage
attention problems. This finding indicated that physical activity had a significant positive impact on attention.

A recent experimental study by Verret, Guay, Berthiaume, Gardiner, and Béliveau (2012) also found that physical activity was associated with improvement in attention among children with attention deficit hyperactivity disorder. The study was conducted in France among 21 schoolchildren aged 7 to 12. Participants in the intervention group did physical activity 3 times a week for 10 weeks. Participants’ attention and response inhibition were measured at pre and post-testing using the Test of Everyday Attention for Children. For example, some of the attention tests required the participants to count the number of times they heard some sounds which were presented. The results showed that children who did physical activity had significant improvement in attention, and information processing. They also had significant decrease in impulsive behaviours than those in the control group. This study however, did not measure baseline and post-intervention physical activity levels. In summary, review studies have indicated that physical activity is beneficial for improvement in attention or concentration (e.g., Sibley and Etnier, 2003).
2.10.2 Physical Activity and Depression

Quite a number of studies have investigated the relationship between physical activity and depression among young people, though the evidence base is still inadequate (Ahn and Fedewa, 2011; Bauman et al., 2012; Larun et al., 2009). Both cross-sectional and longitudinal studies have found an association between physical activity and depression, suggesting that physical activity could be used as an intervention to manage depression in young people. A cross-sectional study conducted among students in Germany found that students who participated in regular sports had significantly lower levels of depression than those who did not do sports. The study involved 988 adolescent boys and girls aged 14-18 years. Participants’ participation in sports was assessed using a questionnaire developed by the researchers. A behaviour checklist was used to assess depression. It was found that, even after controlling for confounders such as physical health and substance use, there was a significant inverse association between physical activity and depression (Kirkcaldy, Shephard and Siefen, 2002). This study however, did not use a validated tool to assess physical activity.

These findings were supported by Parfitt and Eston (2005), who found a significant inverse association between physical activity and depression. The study was conducted in England, which involved 70 schoolchildren between 9 and 12 years old. Participants’ physical activity levels were assessed for one week using pedometers and the Children Depression
Inventory was used to assess depression. Using correlational test to analyse the data, it was found that physical activity was significantly associated with less depression. In addition, it was found that schoolchildren who accumulated 12,000 or more steps a day had significantly lower scores on depression than those who accumulated less than 9,000 steps a day. The strength of the study was the use of a mechanical devise to assess participants’ level of physical activity. These findings were supported by a cross-sectional study which examined the association between physical activity and depression among 1,100 students in Nigeria. The study happens to be the only study that has examined physical activity and depression in African adolescents. The participants were 12 to 17 years old. Physical activity levels were measured using the adolescent version of the Physical Activity Questionnaire (PAQ-A), and depression was assessed using the Children’s Depression Inventory. The results of the study showed that students who did higher levels of physical activity had significantly lesser symptoms of depression (Adeniyi, Okafor and Adeniyi, 2011).

Longitudinal studies that have examined the relationship between physical activity and depression also reported results which were consistent with the cross-sectional findings indicating that young people who participate in higher levels of physical activity are less likely to suffer depression. Jerstad, Boutelle, Ness, and Stice (2010) examined the reciprocal relationship between physical activity and depression among 496 young
people in the U.S. Participants were girls of 11 to 15 years who were assessed at baseline and after 6 years. The findings of the study revealed that participants who had higher levels of physical activity at baseline had significantly fewer depressive symptoms when assessed at the second time. In addition, participants who were depressed at the initial assessment had significantly lower levels of physical activity during the second assessment. The results indicated that regular physical activity reduces the risk of developing depression in the future. The findings also suggest that depressed adolescents are less likely to do physical activities.

A prospective longitudinal study by Raudsepp and Neissaar (2012) found a significant association between physical activity and lower depressive symptoms. Participants were 277 urban adolescent girls aged 12 to 13 years at the beginning of the study. Participants were assessed at 3 different time points for 3 years. Physical activity was measured using the 3-day Physical Activity Recall questionnaire and depressive symptoms were assessed using the Centre for Epidemiological Studies Depression Scale. It was found that participants who had higher levels of physical activity at baseline had significantly less depressive symptoms during subsequent assessments whereas those who had lower levels of physical activity at baseline experienced significantly higher depression over time.
Similar findings were reported by Stavrakakis, de Jonge, Ormel, and Oldehinkel (2012) who examined the prospective associations between physical activity and depression. The study was conducted among 2,230 Dutch students. Participants were assessed at 3 different time points from age 10 to 17 years. Physical activity was measured using 2 questions and depression was assessed using a self-report questionnaire. Participation in physical activities reduced the likelihood of experiencing depression in the subsequent years.

Some studies have also reported more promising findings, indicating that participation in sufficient physical activity could prevent people from developing mental health problems even when they encounter severe stress. These studies have therefore concluded that physical activity has a buffering impact on stress. Sigfusdottir, Asgeirsdottir, Sigurdsson and Gudjonsson (2011) examined the relationship between physical activity and depression among 7,430 Icelandic adolescents. Physical activity and family conflict were assessed with questionnaires. Depression was assessed using the Derogatis scale. Results from the analyses showed that among the participants encountering family conflicts, those who did higher physical activities had significantly less depression than those who did less physical activities. This finding is consistent with Sund et al. (2011), who also identified that physical activity buffers the negative effects of stress.
On the contrary, some studies have reported a weak or partial relationship between physical activity and reduction in depression. Desha, Ziviani, Nicholson, Martin and Darnell (2007) found that physical activity was not significantly associated with depression in either boys or girls. It was found however, that physical activity in specific contexts was associated with lower depression for boys and girls. Previous data was utilised, to examine the relationship between physical activity and depressive symptoms. Participants were 727 adolescents aged 13 to 18 in the U.S. Physical activity for one weekday and a weekend day was assessed using time-use diaries and depression was assessed using the short version of the Children’s Depression Inventory. The findings showed that physical activity was not significantly associated with depression. It was found however, that students who had joined physical activity clubs reported significantly fewer depressive symptoms than those who did not join physical activity clubs.

A longitudinal study conducted by Duncan, Seeley, Gau, Strycker and Farmer (2012), found that physical activity was not associated with depression over time. However, analyses of the data at baseline showed that physical activity was significantly associated with less depression. The study comprised 371 students who were assessed from age 12 to 17 years. Physical activity was measured using validated questionnaires and depression was measured using the Centre for Epidemiologic Studies Depression Scale. The studies which did not find associations between
physical activity and depression still reported a link between physical activity and reduction of depression among some sections of the sample (e.g., Desha et al., 2007; Duncan et al., 2012).

2.10.3 Physical Activity and Self-esteem

Studies have found that participation in physical activity is associated with enhancement in self-esteem. For example, Tremblay, Inman and Willms (2000) examined physical activity and self-esteem among 6,923 schoolchildren in Canada. Physical activity levels and self-esteem were assessed using self-report questionnaires. There was a significant positive relationship between physical activity and self-esteem. The study however was based on secondary data and a validated questionnaire was not used to assess physical activity.

A longitudinal study by Schmalz, Deane, Birch, and Davison (2007) also supported the cross-sectional findings indicating that physical activity was significantly associated with global self-esteem. One hundred and ninety-seven girls in Europe were assessed when they were 9, 11, and 13 years old. Participants’ involvement in sports and structured physical activities were assessed using activity checklist, and global self-esteem was assessed using the Self-Perception Profile for Children. Confounding factors including puberty stage and body mass index were examined. The findings of the study revealed that participants who had higher levels of
physical activity at age 9 scored significantly higher on self-esteem at age 11 and also at age 13. Concerning the direction of the association, it was found that physical activity determined self-esteem in the future. The study however did not use a validated questionnaire to assess physical activity.

Studies which assessed the relationship between physical activity and specific domains of self-esteem also reported that participation in physical activity is significantly associated with body image. Altıntaş and Aşçi (2008) in examining the relationship between physical activity and physical self-esteem found that participation in physical activity was significantly associated with higher scores on all the domains of physical self-esteem. The study was cross-sectional design conducted among 803 Turkish students. Physical activity was assessed using a weekly activity checklist and self-esteem, was assessed with the Physical Self-Perception Profile. The study also examined confounding factors such as pubertal status.

A consistent finding was reported by Haugen, Säfvenbom, and Ommundsen (2011) who also examined the association between physical activity and body satisfaction. The study was conducted among 2,055 Norwegian adolescents from ages 13 to 18 years. Physical activity was measured using a single question. Body satisfaction was assessed with a self-image questionnaire. Results from the correlational analysis indicated
that adolescents who were physically active were more satisfied with their body than those who were less active.

Experimental studies have also found that physical activity has a positive impact on self-esteem. Boyd and Hrycaiko, (1997), conducted an intervention study among 181 participants aged 9 to 16 years. Prior to the intervention global self-esteem was assessed. Students in the experimental group participated in physical activity for 6 weeks whereas the control group participants did not do any physical activity. Results from the ANOVA analysis revealed that participants in the intervention group significantly scored higher on self-concept than participants in the control group. Furthermore, participants who had substantial self-esteem problems at baseline had significant enhancement in self-concept than those with less self-esteem problems. The study however, did not measure physical activity at baseline and post-intervention.

These findings were supported by an intervention study which examined the impact of physical activity on body dissatisfaction and physical self-perceptions (Burges, Grogan, and Burwitz, 2006). The participants were 50 British adolescent girls aged 13-14 years. Prior to the intervention, self-esteem and physical activity levels were measured. Body satisfaction and physical self-perceptions were assessed using the body attitudes questionnaire and Physical Self-Perception Profile respectively. Physical
activity was assessed using the Leisure Time Physical Activity Questionnaire. Participants were randomly allocated into an aerobic dance physical activity intervention group or to a comparison group. A cross-over design was used, therefore participants did both the experimental (aerobic dance) and the comparison (swimming) activities for 6 weeks. The results from the multivariate analysis of variance revealed that participation in aerobic dance was significantly associated with less body dissatisfaction and improvement in physical self-perceptions than participation in swimming. The study however did not use a control group, therefore the findings suggest that aerobic dance had significant impact on self-esteem than swimming. Another intervention study conducted among 68 British schoolchildren aged 10-11 years also reported that physical activity had a significant impact on body self-esteem. The experimental group participants did physical activity twice a week for 6 weeks and body satisfaction was assessed at post-testing using a self-report measure (Duncan, Al-Nakeeb, and Nevill, 2009). This study however, did not assess physical activity at post intervention.

Some studies, however, have found that physical activity is strongly associated with some domains of global self-esteem but not other aspects of self-esteem. For example, a cross-sectional study conducted by Daley (2002) found that physical activity was significantly associated with body satisfaction and physical self-worth but not associated with the other domains of self-esteem such as sports and social competence. Physical
activity was measured using a self-report questionnaire and self-esteem was assessed using the Physical Self-Perception Profile. Results from the ANOVA showed that students who had higher physical activity levels obtained significantly higher scores on body satisfaction and physical self-worth but not on the remaining subscales of self-esteem. Systematic reviews have reported that physical activity has a significant positive impact on young people’s self-esteem (e.g., Ekeland, Heian, and Hagen, 2005; Farb et al., 2012).

2.11 Confounding Factors of Physical Activity, Sedentary Behaviour and Health

There are potential factors that could also influence the relationship between physical activity and sedentary behaviour and well-being. The major confounding factors considered in the current research are nutritional practice and parental attachment.

2.11.1 Nutritional Practice and Cognitive Functioning

Research among young people has found that adolescents have poor eating habits. They are more likely to skip meals and consume fast foods (Seifert and Hoffnung, 2000; Stanner, 2004). Poor dietary habits among the youth seem to be a problem in both Western (e.g., Siegler et al., 2011) and non-Western cultures (e.g., Asare, 2006). Poor nutritional practice has been associated with impairment in cognitive functioning
(Lynn, 1990). For example, Black (2003) conducted a systematic review to examine the relationship between micronutrient deficiencies and cognitive functioning in young people. Findings showed that iron and Vitamin B-12 deficiencies are strongly associated with impaired cognitive functioning, especially difficulties in concentration.

Findings from a systematic review by Rampersaud, Pereira, Girard, Adams, and Metzl (2005), indicated that students who skipped breakfast did not meet the recommended nutrient intake. Moreover, breakfast intake was significantly associated with higher academic performance. Another systematic review conducted by Hoyland, Dye and Lawton (2009), which examined breakfast consumption and academic performance, found that students who eat breakfast are more likely to perform better in academic work than those who frequently skip breakfast. In a longitudinal study, Kim et al. (2010) examined the association between fish intake and academic achievement among 9448 Swedish adolescents. Participants completed questionnaires which measured dietary habits. One year later, the school grades of these participants were obtained from the national registers. It was found that frequent fish consumption was significantly associated with higher school grades.
2.11.2 Parenting Style and Mental Well-being

Parenting style which is less controlling and allows children to express themselves has been associated with good mental health in young people than parenting style which is mainly controlling (Barlow and Stewart-Brown, 2004; DeVore and Ginsburg, 2005). Kaslow, Deering and Racusin (1994) conducted a systematic review to examine whether family interactions contribute to depression in children and adolescents. It was found that young people who could freely dialogue with their parents on issues had significantly lower levels of depression whereas those who perceived their parents as dominant in decision making had significantly higher symptoms of depression. These findings were similar to subsequent studies that investigated the impact of parenting on children’s mental health.

For example, Stewart et al. (1999) investigated whether parenting style was associated with depression among 996 adolescents in China. These students completed questionnaires to rate how they perceived their parents in terms of caring, understanding, restriction, and the frequency parents had conflict with them. In addition, depression was measured using a self-report questionnaire. The study showed that adolescents who perceived their parents to be understanding were less likely to have depression. In a cross-sectional study in Australia, Goldstein and Heaven (2000) explored the relationship between parental discipline styles and
emotional well-being in adolescents. A 40-item scale was used to measure parental discipline styles such as punitive and love-withdrawal and dialogue. A self-report questionnaire was used to measure emotional well-being. It was found that adolescents who indicated that their parents were punitive and often withdrew love, had significantly more emotional problems than those who mentioned that their parents were not punitive nor withdrew love for them.

Similar findings were reported by Xia and Qian (2001), who utilised a cross-sectional study, to examine the relationship between parenting styles and adolescents’ mental health. The participants were 127 Chinese students of 16 to 22 years old. The participants completed questionnaires which measured perceived parenting styles and mental health. The findings of the study indicated that adolescents who described their parents as warmth and understanding reported significantly fewer mental health problems. On the other hand, adolescents who described their parents as rejecting, punitive and overprotective had significantly more mental health problems. In a study to assess the association between parenting style and depression, Brand, Hatzinger, Beck, and Holsboer-Trachsler (2009) found that adolescents whose parents were controlling, punitive, or less concerned with their activities were more likely to report more depressive symptoms. The study involved 246 students from Switzerland. They completed a parenting style inventory to indicate how they perceived their parents. Depression was measured using a 16-item
scale. Parenting styles which were less controlling, less punitive and involved concern for children were significantly associated with lower symptoms of depression among adolescents. In a meta-analysis examining the association between parenting style and depression, McLeod, Weisz and Wood (2007) found that parenting style was associated with depression but accounted for a small proportion of the changes in adolescents’ depression. This review included 45 studies that have mainly examined parenting styles and depression in young people. Parenting was categorised into two broad dimensions of rejection and control. Parental rejection was considered as parents who were less interested in the activities of their children, and parental control defined as parents who prevented children from making personal decisions or parents who were punitive. Findings of the review showed that parental rejection and control were significantly associated with depression, though the effect size was small.

On the contrary, some studies from non-Western cultures have found that parenting style; especially authoritarian parenting is not associated with mental well-being in adolescents. These studies therefore suggested that perhaps authoritarian parenting style within an authoritarian culture (i.e. places where parents or people in authority are mainly controlling) might not be as detrimental as within a non-authoritarian culture. For example, a cross-sectional study in Egypt (Dwairy and Menshar, 2006), found that authoritarian parenting style was not associated with depression in
adolescents. This study examined three types of parenting styles-authoritarian, authoritative, and permissive parenting in relation to depression among adolescents. The sample comprised 351 students aged 16 to 17 years. These students completed the parental authority questionnaire and the psychological state scale. There was no significant difference between the three parenting styles on depression. Recently, Lavasani, Borhanzadeh, Afzali, and Hejazi (2011) investigated the relationship between parenting style and psychological well-being among 398 adolescent girls in high school. Parenting styles and psychological well-being were assessed using self-report questionnaires. Findings showed that authoritative parenting style was not associated with psychological well-being. In summary, studies seem to show that parenting styles which are harsh, controlling, and are less interested in the activities of children are associated with mental health problems in young people.

2.12 Literature Review of Sedentary Behaviour and Mental Well-Being

Research into sedentary behaviour and mental well-being is still developing (Hallal et al., 2012). However, the link between sedentary lifestyle and other health outcomes became known to researchers much earlier. Morris, Heady, Raffle, Roberts and Parks (1953) found that workers, such as drivers, whose job required sitting, were more likely to
develop cardiovascular disease than workers whose job involved physical activities (e.g. bus conductors). Studies indicate that sedentary behaviour is associated with mental health problems (Tremblay et al., 2010).

Schmitz et al. (2002) examined the use of screen devices and depression among students who were 11 to 15 years. Participants reported the amount of time they watched television and played videogames. They also completed the Center for Epidemiologic Studies Depression Scale. It was found that participants who watched television for longer hours had significantly higher depression than those who watched television less. Ybarra, Alexander, and Mitchell (2005) also reported that screen-based sedentary behaviour was associated with depression. The study was conducted among 1,501 schoolchildren and adolescents in Europe. Participants completed a 4-item questionnaire which measured the number of hours they used the internet per day. They also completed a depression scale. Findings showed that participants who used the internet for 3 hours and beyond reported significantly higher depression than those who used the internet less than 3 hours a day.

Some studies that investigated the link between sedentary behaviour and mental well-being also assessed physical activity in order to examine how the two constructs are related to mental well-being. The findings indicate that sedentary behaviour has a negative impact on mental health.
independent of physical activity levels (e.g., Ussher, Owen, Cook and Whincup, 2007). Iannotti, Janssen, et al. (2009), for example, examined sedentary behaviour, physical activity and depression among schoolchildren and adolescents. Participants were 204,534 students in Europe and America. Students reported the amount of time they used screen devices. They also completed a physical activity questionnaire and a self-esteem scale. The multiple regression test was used to examine the associations between physical activity, and sedentary behaviour and self-esteem. It was found that students who used screen devices often reported significantly lower self-esteem independent of their physical activity levels.

Researchers using longitudinal studies have also reported results which support the cross-sectional findings that sedentary behaviour is detrimental to mental well-being. Van den Eijnden, Meerkerk, Vermulst, Spijkerman and Engels (2008) reported that using the internet for a longer period of time was significantly associated with depression over time. The study involved 663 students, aged 12 to 15 years who were observed for 6 months. Participants responded to questions about their schedule of internet use and they also completed a depression checklist. Greater amount of internet use at baseline was significantly associated with higher symptoms of depression and loneliness at follow-up.
On the contrary, some studies have reported a weak association between sedentary behaviour and mental well-being. Colwell and Payne (2000) examined whether excessive playing of computer games had negative influence on self-esteem. The researchers found that playing computer games for more hours was significantly associated with low self-esteem in boys but not among girls. The study was cross-sectional design conducted among 204 schoolchildren in London. The participants completed a questionnaire on screen use and the Rosenberg self-esteem scale. Durkin and Barber (2002) reported that students who played computer games for longer time had significantly higher level of depression than those who used the computer for less amount of time. However, the researchers found that excessive computer use was associated with higher self-esteem. Participants were 1,304 adolescents from the U.S. This study however measured self-concept.

In summary, a number of studies have found an association between sedentary behaviour and mental health in young people. A recent systematic review by Tremblay et al. (2011) reported that sedentary behaviour is significantly associated with poor mental health among young people. However, the effect size for this association has not yet been determined. The effect size for sedentary behaviour and mental well-being in young people was therefore examined in the present research (Study 1) and reported in Chapter 3 in this thesis.
2.12.1 Socio-economic Background and Sedentary Behaviour in Young People

Unlike physical activity, the contributing factors of sedentary behaviour have not been extensively studied (Bauman et al., 2012). Gordon-Larsson, McMurray, and Popkin (2000), for example, indicated that the main factors leading to physical inactivity are different from sedentary behaviour. Research from Western cultures indicates that children from higher socioeconomic backgrounds are less sedentary than children from lower socioeconomic backgrounds (Gorely, Marshall, and Biddle, 2004; Schmitz et al., 2002; Van der Horst et al., 2007). Gorely et al., 2004 found that children whose parents were more educated watched less television. Therefore, it has been identified that in Western cultures, higher socioeconomic background does not lead to sedentary behaviour among young people.

However, it has been indicated that the weather has been a major contributing factor to sedentary behaviour among children and adolescents in Western cultures. Research from Western cultures shows that during the winter seasons, young people are more likely to be sedentary than in the summer seasons (Bélanger, Gray-Donald, O’Loughlin, Paradis, and Hanley, 2009; Tucker and Gilliland, 2007). Notably, Bauman et al. (2012) have suggested the need for investigating the major contributing factors of sedentary behaviour in the African
culture. Though there is currently no study about the major contributing factor of sedentary behaviour among African young people, the weather does not contribute to sedentary behaviour among young people in Africa. This is because, the weather in Africa is generally hot and does not compel young people to stay indoors, unlike in the Western countries. In Africa, affluence seems to be the main contributing factor of sedentary behaviour in young people. Young people from affluent homes have access to computers, internet, video games and other electronic entertainment devices at home because their parents can generally afford the cost of these devices. Young people from higher socio-economic backgrounds may be attracted to stay indoors after school hours in order to use these screen devices. Although no data have been located, young people from lower socio-economic backgrounds are likely not to have these entertainment screen devices at home. Therefore, they are more likely to participate in outdoor activities after school hours, which reduce their likelihood of being sedentary.

In Ghana, it appears that students from affluent homes are likely to attend private schools because generally, their parents can afford the higher cost of tuition fees in the private schools. Specifically, private schools are owned by individual people. There is much more strict supervision of the students’ learning in the private schools than in the public schools, which are owned by the government. Moreover, there are much more qualified teachers in the private schools than in the
government school. The private schools also have attractive educational amenities such as decorated surroundings, provision of buses for students, etc. Therefore people with middle to higher income status prefer their children to go to the private schools than the public schools. The public schools however, are likely to be attended by mostly students from low socio-economic backgrounds because it is managed by the government and the cost is subsidised.
PART III

A SYSTEMATIC REVIEW OF REVIEWS
ON PHYSICAL ACTIVITY AND MENTAL WELL-BEING

2.13 Introduction

There is strong evidence that physical activity is associated with physical health conditions including obesity, hypertension, diabetes, and other physiological diseases (Gill and Cooper, 2008; Hardman and Stensel, 2009). Research on physical activity and mental health, however, is still developing (Hallal et al., 2012). Currently, there is a need for other behavioural interventions for the treatment of mental health problems in young people because drug therapy, for example, may produce side effects of memory impairment among some students receiving treatment for mental health conditions (Harrington, 2002).

Research findings suggest that physical activity has the potential of being incorporated into the treatment of mental health problems (Dinas, Koutedakis, and Flouris, 2011). In order to recommend physical activity as an intervention for mental health problems, especially for young people, adequate information must be obtained about the extent to which physical activity improves mental well-being. A systematic review of reviews was therefore conducted to examine the magnitude of association
between physical activity and mental well-being in young people. This review of reviews provides information about the state of the literature on physical activity and cognitive functioning, depression and self-esteem.

### 2.14 Method for Review of Reviews

The following databases were searched for review papers up to December 2012: PubMed, SPORTDiscuss, PsychINFO, Web of Science, Medline, Cochrane Library, and ISI Science Citation Index. The review papers were searched with the terms reflecting the exposure variable (e.g., exercise, sport, physical activity). The search terms for the outcome variable measures were centred on mental health (i.e., cognitive functioning, depression and self-esteem). The searches focused on young people (e.g., children, adolescents) and limited to review papers (e.g., reviews, systematic reviews, meta-analyses). The review papers which were identified were further screened using the research inclusion criteria. For inclusion in this review, the review papers were to: (1) report on moderate to vigorous intensity physical activity; (2) report on chronic physical activity. Review papers which reported on both acute and chronic physical activity were included but only the information on chronic physical activity were examined and reported; (3) provide a report on the relationship between physical activity and at least one indicator of well-being including cognitive functioning, depression, and self-esteem; (4) provide some information on young people below the age of 20 years. Papers which reported on both young people and adults were included but
only the information or effect size determined for young people was examined and reported. Data were extracted from the reviews by the author and checked by one other person.

2.15 Review Studies of Physical Activity and Cognitive Functioning

Researchers have identified 3 main components of cognitive functioning including executive functioning, academic achievement and cognitive skills. Executive functioning is a person’s working memory, which is assessed using a validated test of cognition; academic achievement represents school grades; and cognitive skills reflects concentration, or time spent in doing cognitive tasks (Miyake et al, 2000; Keeley and Fox, 2009). Based on these suggested components of cognitive functioning, the present research examined the relationship between physical activity and the three aspects of cognitive functioning. Eleven review studies, which have examined the relationship between physical activity and cognitive functioning in young people, were identified. Findings from these reviews are as follows:

2.15.1 Physical Activity and Executive Functioning

The earliest systematic review on physical activity and cognitive functioning in young people was by Shephard (1997). Four studies were reviewed, one of which was unpublished. Participants were children and
adolescents mainly from France and Australia. One of the 4 studies, which was a longitudinal design, investigated the relationship between school physical education and executive functioning. It was found that schoolchildren who received additional physical education, with a 14% reduction in curriculum time, significantly performed better on the verbal subscale and one aspect of the non-verbal subscale of the Wechsler Intelligence Scale for Children (WISC) compared to the control group who had more curricular time. Moreover, there was no significant difference between the experimental and control group participants on the Goodenough cognitive test. The association between school physical activity and students’ executive functioning was not conclusive, because physical activity was positively associated with scores on some of the subscales of the WISC test but not on others. The study however, did not use a true control group because the comparison group also did physical education.

Later on, Sibley and Etnier (2003) conducted a meta-analysis to examine the relationship between physical activity and domains of cognitive functioning. Participants were children and adolescents including those with developmental delays and physical disabilities. Forty-four studies were examined but only 16 studies, which were interventions, assessed executive functioning. Most of the studies assessed aerobic physical activity. An effect size of 0.32 was found, which showed that physical activity was significantly associated with executive functioning. The effect
size was larger for perceptual skills than other tests of executive functioning. The effect was also larger for adolescents compared to children less than 9 years. Studies used to calculate the effect size however, included 7 studies which were not published. It was also reported that the studies included used different tests of executive functioning, many of which were not validated. A positive but small association was found between physical activity and executive functioning.

To provide an update on previous reviews, Tomporowski, Davis, Miller and Naglieri (2008) conducted a systematic review to examine the association between physical activity and cognitive functioning among children. Six experimental studies assessed executive functioning and mainly aerobic physical activities. Findings indicated that physical activity was significantly associated with higher scores on some aspects of the executive functioning tests. For example, it was found that physical activity was significantly associated with high scores on the Verbal subscale and the Full scale of the WISC intelligence test but not on the Performance subscale of the test. Some studies also found that physical activity significantly had an impact on scores of the planning subscale of the executive functioning test but not on the perceptual motor skills test. Physical activity however, seemed to be consistently associated with scores on creative thinking. However, most of the experimental studies did not use true control groups. The control group participants received lesser dose of physical activity or educational activities.
A recent systematic review by Best (2010) was conducted to examine the relationship between physical activity and executive functioning by including only intervention studies. Ten experimental studies were identified but only 3 had examined chronic physical activity. A significant positive association was found between physical activity and creativity but not with other subscales (e.g. perceptual motor-skills) of the executive functioning tests. The findings were similar to previous reviews (Tomprowski et al. 2008), which indicates that experimental studies have not found a consistent positive impact of physical activity across the entire aspects of the tests used to assess executive functioning. However, Best’s (2010) findings were based on only 3 studies.

To thoroughly examine the relationship between physical activity and executive functioning, Barenberg, Berse, and Dutke (2011) conducted a systematic review on physical activity and executive functioning. Unlike previous systematic reviews (e.g. Sibley et al., 2003; Tomporowski et al., 2008) which have examined various aspects of cognitive functioning, this review, as well as Best (2010), examined only executive functioning and also included only intervention studies. Barenberg et al. (2011) identified 10 intervention studies on executive functioning. Findings showed that physical activity was significantly associated with improvements on some tests of executive functioning but not on others. This finding is consistent with previous reviews (Best, 2010; Tomporowski et al., 2008) which did not also find consistent positive impact of physical activity on executive
functioning. It was mentioned that very few studies have examined executive functioning. In addition, studies have used different tests to assess executive functioning. Systematic reviews have reported similar findings, indicating that physical activity is significantly associated with increased performance on some of the subscales of executive functioning tests.

2.15.2 Physical Activity and Academic Achievement

An earlier systematic review, Shephard (1997) investigated whether school physical education had a negative impact on academic performance. Findings from 3 longitudinal studies indicated that increasing physical education time by 14-26% did not have detrimental impact on academic performance. Sibley and Etnier (2003) conducted a meta-analysis to examine the relationship between physical activity and components of cognitive functioning among children and adolescents. Studies included all research designs which mostly assessed aerobic physical activity. Academic performance was measured using school grades, verbal and mathematics test. An overall effect size of 0.30 was found, indicating that physical activity is significantly associated with improvement in academic performance. Some of the studies however, were not published.
To provide an update on previous reviews, Tomporowski et al. (2008) did a systematic review to examine the relationship between physical activity and academic achievement. Findings from 9 studies showed that physical activity has a significant positive impact on academic performance. A moderate relationship was established. Longitudinal studies however did not use true control groups. Another systematic review conducted by Trudeau and Shephard (2008) also examined the relationship between physical activity and various aspects of cognitive functioning. Seven experimental studies and 10 cross-sectional studies examined academic achievement. Physical activity was associated with higher academic performance. Quasi-experimental studies however, did not use true control groups.

Keeley and Fox (2009) reviewed 17 studies to examine the relationship between school physical activities and cognitive functioning. Participants included children and adolescents mainly from Europe, America, Australia and Asia. Studies included varied research designs. Findings from 10 studies indicated that school physical activities do not have negative impact on academic performance. Recently, The Centres for Disease Control and Prevention (2010) examined the relationship between school physical activities (e.g., physical education, recess, classroom physical activity, extracurricular physical activity) and cognitive functioning among schoolchildren. Fifty studies of experimental and longitudinal research designs were reviewed. Fourteen studies reported that increasing school
physical education did not have negative impact on academic performance. It was concluded that there is a significant and strong positive association between school physical activities and academic performance.

Rasberry et al. (2011) also found a significant positive association between physical activity and academic performance. Fifty studies of varied research designs on school physical activities were included. Academic performance was assessed using standardized tests and teacher ratings. Eight of 10 intervention studies reported significant positive associations between physical activity and school performance. The findings were similar to previous systematic reviews. A more recent systematic review was conducted by Farb and Matjasko (2012) in order to update previous findings. This review examined 24 studies on school extracurricular activities published between 2004 and 2009. Studies were mostly longitudinal and cross-sectional designs. Participants were adolescents from the U.S and Canada. It was found that school physical activities had a significant positive association or at least no association with academic performance. This finding is similar to that of previous review studies (e.g., CDC, 2010; Keeley et al., 2009; Rasberry et al., 2011) which also examined school-based physical activities. The findings that increased time for physical education did not interfere with academic performance suggest the likelihood of a positive relationship between
physical activity and academic performance. However, some studies included in the systematic reviews did not use true control groups.

2.15.3 Physical Activity and Cognitive Skills

An earlier systematic review by Shephard (1997) investigated the relationship between physical activity and cognitive skills. Findings from 3 longitudinal studies showed schoolchildren who do regular physical education to have significantly higher attention than those who participate less in physical education. Follow-up studies showed that physical activity has long-term benefits on attention. Sibley and Etnier (2003), who reviewed studies with varied research designs, also reported that physical activity is significantly associated with cognitive skills. In 2008, Tomporowski et al. reviewed experimental studies and found that children who did higher levels of physical activity obtained higher scores on attention tests and also completed cognitive tasks more quickly. Studies however included comparison groups who did lesser dose of physical activities.

Trudeau et al. (2008) also found a strong and significant positive relationship between physical activity and cognitive skills including better composure in classroom. In a recent systematic review, The Centres for Disease Control and Prevention (2010) reported that schoolchildren who
do higher physical activities have significantly better attention, concentration and memory.

A systematic review conducted by Ramstetter et al. (2010) examined 15 studies of experimental, longitudinal and cross-sectional designs. Almost all the studies found that there is a significant positive relationship between school physical activities and attention, concentration, and cooperative behaviours in the classroom. Studies indicated that introduction of recess in schools would facilitate learning. The findings were similar to the CDC (2010). Recently, Rasberry et al. (2011) examined school physical activities and cognitive skills. Studies were interventions with observation period of up to 4 months. Eight of 10 studies found significant positive associations between physical education and cognitive skills. These findings are consistent with previous systematic reviews. Systematic reviews have consistently reported a significant positive relationship between physical activity and cognitive skills.

2.15.4 Overall Conclusions of Review Studies on Physical Activity and Cognitive Functioning

**Physical Activity and Executive Functioning**

Findings on the relationship between physical activity and executive functioning are unclear. So far, systematic reviews have not established a
conclusive finding. Review studies have found that physical activity is significantly associated with increased performance on some aspects of the tests used to measure executive functioning, especially on creativity (Best, 2010; Sibley and Etnier, 2003; Tomporowski et al., 2008). Studies have mostly examined aerobic physical activities.

**Physical Activity and Academic Achievement**

A significant positive relationship or at least no association has been established between physical activity and academic achievement. Findings from the review studies have consistently indicated that increasing school physical education time does not impair academic performance. A significant moderate relationship has been established between physical activity and academic achievement.

**Physical Activity and Cognitive Skills**

A consistent positive relationship has been found between physical activity and cognitive skills including concentration, attention, working speed and co-operation in the classroom. The magnitude of this association seems to be moderate to high.

### 2.16 Review Studies of Physical Activity and Depression

In an attempt to determine the relationship between physical activity and depression in young people 7 systematic reviews were identified. The earliest meta-analysis to investigate the relationship between physical activity and depression was conducted by North, McCullagh and Tran
(1990). Findings from 5 studies showed a significant moderate effect size ($ES=-0.49$) for young people. Calfas and Taylor (1994) conducted the first systematic review to investigate the relationship between physical activity and depression in adolescents. Findings from 9 experimental studies showed that physical activity was significantly associated with a reduction in depression ($ES=-0.38$). However, studies included small sample sizes which limit the generalizability of the findings.

Subsequently, Craft and Landers (1998) conducted a meta-analysis to examine the benefits of physical activity and depression. Only 3 studies reported on young people which showed that physical activity has a significant impact on depression ($ES=-0.15$). With the aim of updating previous systematic reviews, Larun, Nordheim, Ekeland, Hagen and Heian (2009) conducted a meta-analysis to determine whether physical activity interventions could reduce mental health problems in young people. Five randomised controlled studies were examined. Similarly to previous findings, physical activity had a significant impact on depression ($ES=-0.66$). A moderate effect size was determined similar to Calfas and Taylor (1994). Recently, Ahn and Fedewa (2011) conducted a meta-analysis to determine the relationship between physical activity and mental well-being in children and adolescents. Seventy-three studies, with varied research designs were included. Studies were mostly from the Western countries including Australia, Canada, Germany, Switzerland, U.K and the U.S. Only one study was from Africa. Physical activity was significantly
associated with lower depression ($ES = -0.14$), though the effect size was small. However, some of the studies were unpublished. The small effect size could be due to the inclusion of varied research designs. Studies which found a larger effect size examined only experimental studies (e.g., Larun et al., 2009).

Johnson and Taliaferro (2011) conducted a systematic review on physical activity and depression by examining 19 studies with varied research designs. Studies were mainly from Europe and the U.S. There was a consistent finding across the studies, which indicated that physical activity is significantly associated with lower depression. The findings are consistent with previous meta-analysis (Calfas and Taylor, 1994; Larun et al., 2009) which found moderate associations. To update previous systematic reviews, Farb et al. (2012) examined studies from 2004 to 2009. Studies were mostly from Canada and the U.S. It was found that school-based physical activities were significantly associated with reduction in depression.

### 2.16.1 Overall Conclusions of Review Studies on Physical Activity and Depression

Systematic review studies have consistently reported that physical activity is significantly associated with lower depression. A moderate effect size
has been established for the relationship between physical activity and depression in young people.

### 2.17 Review Studies of Physical Activity and Self-esteem

Low self-esteem is a common problem facing today’s adolescents (Siegler et al., 2011). There is evidence that physical activity is associated with enhanced self-esteem, which is an indicator of good mental health (e.g., Bouchard et al., 2012). Seven review studies which have examined physical activity and self-esteem were identified. The first meta-analysis which examined the relationship between physical activity and self-esteem in young people was conducted by Gruber (1986). Twenty-seven experimental studies were included in the meta-analysis. It was found that physical activity was significantly associated with improved self-esteem $(ES= 0.41)$. A larger effect was however found for children and adolescents with emotional problems and learning disabilities $(ES= 0.57)$.

Calfas and Taylor (1994), conducted a meta-analysis on physical activity and self-esteem by including varied research designs. Findings from 10 studies showed a significant positive relationship between physical activity and self-esteem $(ES= 0.12)$. However, some of the studies did not use control groups which could have resulted to the small effect size. Ekeland et al. (2005) also conducted a meta-analysis to determine the relationship between physical activity and self-esteem by including experimental
studies. Physical activity was significantly associated with enhanced self-esteem ($ES= 0.51$). However, it was mentioned that there were limited experimental studies. Recently, Ahn and Fedewa (2011) conducted a meta-analysis to determine the association between physical activity and self-esteem in children and adolescents. Seventy-three studies, with varied research designs were included. Findings showed that physical activity is significantly associated with enhanced self-esteem. An overall effect size for randomised controlled trials was 0.30 and for non-randomised controlled trials was 0.57, which generally represents a small to moderate association. It was reported that some of the studies were unpublished.

In a recent systematic review, Farb and Matjasko (2012) examined 20 studies with varied research designs. Similarly to previous findings, it was found that students who participated in school-based or community-based extracurricular activities had higher self-esteem than their counterparts who did not participate. In a more recent meta-analysis, Shin and Park (2012) examined 14 experimental studies of physical activity and self-esteem. A large effect size was determined ($ES= 0.90$) which indicated that participation in physical activities have a strong positive impact on self-esteem in young people. Moreover, a systematic review conducted by Lubans, Plotnikoff, and Lubans (2012) on 10 intervention studies showed that physical activity is strongly associated with higher self-esteem. It
was however reported that there were few well-designed experimental studies.

2.17.1 Overall Conclusions of Review Studies on Physical activity and Self-esteem

Systematic reviews have consistently found that physical activity is significantly associated with enhancement in self-esteem. A moderate effect size has been determined for the association between physical activity and self-esteem in young people.

2.18 Limitations of the Evidence of Physical Activity and Well-being

The following are the main limitations of previous studies that have examined physical activity and cognitive functioning, depression and self-esteem.

2.18.1 Physical Activity and Cognitive Functioning

Based on the findings of systematic reviews, there is a consistent positive association between physical activity and academic achievement and cognitive skills, though this effect size is moderate. The uncertain area however, is executive functioning. Currently, there are unclear findings for the relationship between physical activity and executive functioning. This is something very important which needs to be urgently addressed. The inconclusive findings for physical activity and executive functioning...
could be due to the limited number of experimental studies that have examined executive functioning (Barenberg et al., 2011; Best, 2010). Best’s (2010) review, for example, identified only 3 intervention studies. In addition, primary researchers in this area have operationally defined executive functioning in a broad way and as a result used tests with many subscales to assess it (Barenberg et al., 2011; Tomporowski et al., 2008). For example, the WISC test involves mathematics and language aspects, which are more likely to be influenced by participants’ past learning (e.g., Tomporowski et al., 2008).

The construct ‘executive functioning’ is broad (Siegler et al., 2011). Therefore, there is a need for narrowing the definition of executive functioning in order to use simpler tools to assess this construct. So far, this has not mainly been done. This is something important which the research in this thesis considered. Another important gap in the literature is that studies on physical activity and cognitive functioning in young people have been done mainly in Western cultures. As a result, the cognitive benefits of physical activity in African young people have not yet been established.

### 2.18.2 Physical Activity and Depression

Relatively few studies have examined the relationship between physical activity and depression in young people. Therefore, the basis for the
association between physical activity and depression is not strong. Moreover, systematic reviews have reported that a number of primary studies have used small sample sizes to examine physical activity and depression (Larun et al., 2009). Another big gap which has been identified in the current literature is that, the relatively few studies on physical activity and depression in young people have been done mostly in Western cultures (Bauman et al., 2012). As a result, little is known about the association between physical activity and depression among young people in the African culture. To date, there is no established evidence that physical activity has a universal benefit for both Western and African young people. These important gaps need to be addressed.

2.18.3 Physical Activity and Self-esteem

There are relatively few studies that have investigated the association between physical activity and self-esteem in young people. In addition, systematic reviews have reported that experimental studies that have examined physical activity and self-esteem have huge methodological limitations. A number of intervention studies for example, have not used true control groups, i.e. studies have used comparison groups who also had physical activity but lesser dose (e.g., Calfas and Taylor, 1994; Ekeland et al., 2005). Therefore, there is the possibility that the intervention effect of physical activity has been underestimated. Review studies have therefore recommended additional research in this area using well-designed experimental studies (e.g., Ahn et al., 2011; Ekeland
et al., 2005). Moreover, it has been reported that some studies investigating physical activity and self-esteem have measured self-concept instead (Ekeland et al., 2005; Gruber, 1986). This is another issue which needs to be considered in research into this area. Again, the inadequate studies on physical activity and self-esteem in young people have been done mainly in Western cultures (e.g., Bauman et al., 2012). This is a big gap in the current literature which needs to be urgently addressed.

2.19 Future Directions of Physical Activity, Sedentary behaviour and Well-being

The present research in this thesis included three different studies which attended to the important gaps concerning physical activity, sedentary behaviour and mental health research in young people. The main issues which were investigated are as follows:

2.19.1 The Association Between Sedentary Behaviour and Mental Health in Children and Adolescents: A Meta-analysis (Study 1)

First, the present thesis involved a meta-analysis to determine the effect size for the association between sedentary behaviour and mental well-being in young people (Study 1). Mental well-being outcomes including depression, self-esteem, anxiety, psychological distress, and health related quality of life which previous researchers, in the field of sedentary behaviour, have assessed were examined. This study is the first meta-
analysis conducted on young people concerning sedentary behaviour and mental health.

2.19.2 The Relationship Between Physical Activity, Sedentary Behaviour and Mental Well-Being In Ghanaian Adolescents (Study 2)

Secondly, the present thesis examined physical activity, sedentary behaviour and their association with mental well-being among adolescents in the African culture (Study 2). Mental well-being indicators of depression and self-esteem were investigated. In addition, an important confounding factor of parenting style was examined. Unlike some previous studies which have used non-clinical measures, a clinical diagnostic tool was used to assess depression. Furthermore, physical self-worth and body image, which largely contribute to adolescents’ self-esteem (Siegler et al., 2011), were also examined. It is important to note that in Africa, sedentary behaviour seems to be a newly adopted lifestyle among the youth. However, its impact on mental well-being has not been studied. Study 2 is therefore the first to examine the association between sedentary behaviour and mental well-being in Africa.
2.19.3 Physical Activity, Cognitive functioning and Other Indices of Mental Health: An Intervention Study (Study 3)

Thirdly, this thesis examined the impact of a physical activity intervention on cognitive functioning and some indicators of mental well-being among adolescents in African culture (Study 3). Specifically, executive functioning (an aspect of cognitive functioning), and self-esteem (an indicator of mental well-being) were examined. In addition, an important confounding factor of nutritional practice was examined. Unlike previous studies which have used complex tools to assess executive functioning, the present study in this thesis operationally defined executive functioning simply as ‘reasoning’ (Raven, 1998) and therefore used a single non-verbal standardised tool to assess it. Previous researchers have not mainly considered this. Again, physical self-worth and body image which significantly contribute to self-esteem in adolescents (e.g., Siegler et al., 2011) were directly examined. Overall, the current research contributes greatly to existing literature because for instance, sedentary behaviour is new in African culture which has not yet been examined.
CHAPTER 3
THE ASSOCIATION BETWEEN SEDENTARY BEHAVIOUR AND MENTAL HEALTH IN CHILDREN AND ADOLESCENTS: A META-ANALYSIS

3.1 Introduction

It has been established that many of the health problems people encounter are due to unhealthy behaviours which trigger physiological responses (Bernard and Krupat, 1994). For some time now, findings from research studies have indicated that physical activity is associated with well-being (Craft and Landers, 1998; Janssen and LeBlanc, 2010; Larun et al., 2009). The health benefits of physical activity have led to the development of physical activity guidelines for both adults and young people (Chief Medical Officers, 2011). However, even young people who are expected to be more active than adults (McArdle et al., 2007) are not meeting the physical activity guidelines for health (Chief Medical Officers, 2011; Hallal et al., 2012).

Interestingly, another unhealthy part of lifestyle, that of ‘sedentary behaviour’ is highly prevalent among young people (Chief Medical Officers, 2011; Hallal et al., 2012). In addition to the inadequate levels of physical activity, adolescents have transferred their interests to using screen devices for leisure which make them sit for long hours (Çankaya &
Odabaşı, 2009; Hallal et al., 2012). These sitting activities are known as sedentary behaviours (Dunstan et al., 2012). Recently, sedentary behaviour has been associated with physical conditions such as obesity (Chinapaw, Proper, Brug, Van Mechelen, and Singh, 2011) as well as mental health problems in young people (Edwardson et al., 2012; Tremblay et al., 2011).

Mental health issues have now received considerable attention by researchers and in public health (National Health Service, 2009). In the present generation, mental health difficulties have become common among young people, especially adolescents. It has been estimated that every year about 20% of young people suffer mental health problems particularly depression (WHO, 2011). The rise in mental health problems among young people could dramatically increase health care costs (Chief Medical Officers, 2011). Moreover, mental health problems may affect cognitive functioning and create learning problems for students (e.g., Emerson, Mollet, and Harrison, 2005; Hysenbegasi, Hass, and Rowland, 2005).

Due to the increasing prevalence of mental health problems in young people, researchers have been investigating possible contributing factors. While physical activity and mental well-being has been studied extensively in adults, but less in young people (Biddle and Asare, 2011),
there is currently no synthesis of evidence aggregating findings on sedentary behaviour and mental health in young people. Therefore it is timely to review the evidence. The first study in this research thesis, systematically reviewed the studies that have investigated the association between sedentary behaviour and mental health in young people. Specifically, the size of the association and any moderators that might account for variability in this association were examined.

3.2. Study Objective

The specific objective of study 1 was to determine the effect size for the association between sedentary behaviour and mental health in young people.

Rationale of Objective

There is evidence from few available studies, indicating that sedentary behaviour is associated with mental health problems in young people, independent of physical activity levels (Hallal et al., 2012). The actual effect size for this association however, has not yet been investigated. It is important to determine the extent to which sedentary behaviour is associated with mental well-being in young people, in order to guide public education messages on sedentary behaviour and also to decide sedentary behaviour guidelines for young people. To address this gap in the sedentary behaviour literature, Study 1 was planned as a meta-analysis to determine a quantitative estimate of the association between
sedentary behaviour and mental health. This study examined the mental health outcomes that have been investigated in the field of sedentary behaviour.
METHODS

3.3 Literature Search

Papers were searched using key terms indicating: 1) sedentary behaviour (e.g., sedentary, television, video, DVDs, computers, screen-time and sitting); 2) mental well-being outcomes (e.g., mental health, psychological well-being, health related quality of life, quality of life, depression, stress, anxiety and self-esteem); and 3) youth population (e.g., children, adolescents, teenagers and young people). PubMed, Science Direct, SPORTDiscus, PsychINFO, Medline, Web of Science, Cochrane Library and Google Scholar databases were searched using the specified key terms (see Appendix 5).

Inclusion and exclusion criteria

To be eligible for inclusion the study must: 1) involve children or adolescents aged 5-18 years; 2) have a quantified measure of sedentary behaviour (studies that measured the content rather than quantity of time consuming screen-based sedentary behaviour, such as aggressive movies, horror films, etc., were excluded); 3) have a measured mental health outcome as specified in the key terms list; 4) provide a quantified association between sedentary behaviour and a mental health outcome; 5) be published in a peer-reviewed journal in the English language up to June 2012 (see Appendix 6).
3.4  Data Extraction

Information from the studies were extracted onto standardised forms (Appendix 7). Information extracted included: authors, country of study, type of study, type of population, sample size, age range of the sample, response rate, type of sedentary behaviour assessed, mental health outcome assessed, and validity and reliability of measures used to assess sedentary behaviour and mental health. This information was extracted to allow data coding for entry into the Comprehensive Meta-Analysis (CMA) software, for analyses. Some authors of the papers were contacted for clarification of some information when necessary.

3.5  Quality Assessment of Studies

The quality of all the studies were evaluated mainly based on their methodological strengths using a checklist (Chinapaw et al., 2011; Craggs, Corder, van Sluijs, and Griffin, 2011; Uijtdewilligen et al., 2011). The criteria evaluated included the sampling procedure, inclusion of adequate sample size, tools for assessing the constructs being investigated, and statistical analyses. Similar criteria were used to evaluate both cross-sectional and longitudinal studies, but longitudinal studies were evaluated with an additional two items. Specifically, these criteria evaluated adequate response rate at follow up and appropriate description of follow up duration or assessment (Appendix 8). Thus, the total score for the quality grading was 11 points for cross-sectional studies and 13 points for
longitudinal studies. In this meta-analysis, studies that obtained scores equal to or above the mean score were classified as high quality whereas studies with scores below the mean score were classified as low quality studies.

3.6 Data Coding

The studies were coded on a number of characteristics, based on hypothesised moderators. The relevant information in relation to these characteristics was entered into the CMA software. The following characteristics were coded:

**Design**

All study designs were included in the meta-analysis. Two main study designs were identified and coded as cross-sectional or longitudinal.

**Subject characteristics**

Studies were coded for the age group of the participants. The codes were children (5-12 years), adolescents (13-19 years), and children and adolescents combined (5-19 years).

**Type of sedentary behaviour**

The studies in this meta-analysis assessed mostly screen-based sedentary behaviour. However, studies were coded for the type of screen assessed in order to compare the impact of particular screen use on mental well-being. Coding included television, computers, video/DVDs, screen, and sedentary behaviour.
**Mental well-being indicator**

Studies were coded for mental health indicators including anxiety, depression, self-esteem, psychological distress, and quality of life.

**Study quality**

Irrespective of the research designs, the quality of the studies included was evaluated. Therefore, studies were coded as high quality or low quality based on the criteria specified above.

### 3.7 Statistical Analyses

The Comprehensive Meta-Analysis (CMA) version-2 software was used to calculate effect sizes for the relationship between sedentary behaviour and mental well-being. The effect sizes for the individual studies were computed. An overall effect size was calculated for all the studies. The effect size was expressed as Hedges’ $g$, using the fixed effects model. A fixed effects model was used in the calculation of the effect size because there was not large heterogeneity in the results of the studies included. Also, the studies included assessed a similar exposure variable, i.e. screen-based sedentary behaviour. It has been indicated that the fixed effects model should be used when there is no large differences in the results of the studies and also when the comparative variable is similar across studies (Egger, Smith, and Altman, 2003).

While random effects models can also be used, it is often a matter of judgement as to which to choose (Egger et al., 2003). The National
Research Council, as well as meta-analysis experts, has suggested that researchers can opt for the fixed effects model because of its simplicity (Hunter and Schmidt, 2004). The effect of heterogeneity was estimated using the $Q$ statistic. Where the test of heterogeneity was significant, it meant that there was a need to examine moderator variables. Some moderator variables hypothesized before the meta-analysis included: i) the research design, ii) age group of participants, iii) type of sedentary behaviour, iv) type of mental health outcome and v) study quality. The magnitude of effect sizes were assessed using Cohen’s (1988) criteria: small= 0.2-0.49; moderate= 0.5-0.79; and large=≥0.8.
RESULTS

3.8 Identification of Relevant Studies

Potentially relevant articles were selected by (1) screening the titles; (2) screening the abstracts; and (3) if abstracts were not available or did not provide sufficient data, the entire article was retrieved and screened to determine whether it met the inclusion criteria. A customised ‘in-out’ form was used to appraise the studies for inclusion or exclusion. This led to 69 papers being excluded and 35 papers included for the meta-analysis. The screening process followed the PRISMA guidelines (Moher, Liberati, Tetzlaff, Altman, and the PRISMA Group, 2009). The screening procedure is shown in Figure 3.3.1.
Study Characteristics

The studies included were mostly conducted in the U.K, U.S., Canada, Germany and China. Almost all the studies examined screen-based sedentary behaviour. Only about two studies (e.g., Murdey et al., 2004)
assessed total sedentary behaviour. The majority of the studies used the Centres for Epidemiologic Studies Depression scale to measure depression (e.g., Lemola et al., 2011; Primack et al., 2009; Schmitz et al., 2002). Only a few studies used a clinical diagnostic tool such as the Beck Depression Inventory to measure depression. A number of the studies used the Strengths and Difficulties Questionnaire to measure mental health (e.g., Griffiths et al., 2010; Ussher et al., 2007). Most of the studies used the physical self-perception scale (Fox and Corbin, 1989) to assess self-esteem.

**Participant Characteristics**

Overall, studies included 373,512 young people. The majority of the studies included both children and adolescents. Some of the studies included only children. However, very few studies focused solely on adolescents.

**Quality Assessment**

Generally the quality of the studies included was quite poor. This was mainly because a significant number of the studies did not use validated tools to measure sedentary behaviour. Some studies which assessed depression did not use a clinical diagnostic tool. Some of the studies also measured mental well-being by proxy reports which may not accurately represent the children’s mental well-being. Three studies were rated the highest score of 8 out of 11 points. Sixteen studies obtained lower scores ranging from 5 to 3 points (see Appendix 3).
3.9 Meta-analyses

An overall effect size and effect sizes for moderator variables were computed. The effect sizes are presented below:

3.9.1 Overall Effect Size

The mean overall effect size for the association between sedentary behaviour and mental well-being was small but significant ($ES = -0.30$, 95% confidence intervals= -0.20, -0.45, $p<0.001$; $K=37$; $n=373,512$) (Cohen, 1988). The test of heterogeneity was also significant [$Q(36) = 20706.43$, $p<.001$], therefore potential moderators of the association between sedentary behaviour and mental well-being were examined. The $Q$ values, significant levels and the effect sizes of the moderator variables are presented in Table 3.3.1.

3.9.2 Effect Sizes for Moderator Variables:

**Study Design**

Both types of research design had significant effect sizes. Cross-sectional studies had a larger effect size than longitudinal studies, although the latter had only 4 studies.

**Subject Characteristics**

Most of the studies that have investigated sedentary behaviour and mental well-being have not reported effects separately for children and
adolescents. Therefore, the meta-analysis could only provide effect sizes for children and adolescents combined.

**Type of Sedentary Behaviour**

All types of sedentary behaviour were significantly associated with mental health except total sedentary behaviour ($ES = -0.05$, 95% confidence intervals= -0.03, 0.10, $p>0.05$). The largest effects were seen for general screen use ($ES = -0.51$, 95% confidence intervals= -0.34, -0.65, $p<0.001$) and television viewing ($ES = -0.47$, 95% confidence intervals= -0.35, -0.62, $p<0.001$).

**Measures of Mental Well-being**

The largest effects were seen for depression ($ES = 0.55$, 95% confidence intervals= 0.42, 0.68, $p<0.001$) and psychological distress ($ES = 0.41$, 95% confidence intervals= 0.30, 0.56, $p<0.001$). The smallest effects were identified for anxiety and quality of life. However, there was no significant effect for self-esteem.

**Study Quality**

Only the high quality studies had significant effects ($ES = -0.31$, 95% confidence intervals= -0.20, -0.45, $p<0.001$).
Table 3.3.1. Homogeneity tests and effect sizes for moderator variables

<table>
<thead>
<tr>
<th>Moderator Variable</th>
<th>Q</th>
<th>df</th>
<th>Level</th>
<th>ES</th>
<th>95% CI</th>
<th>n</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross-sectional</td>
<td>20403.77</td>
<td>32</td>
<td>p &lt; 0.001</td>
<td>0.30</td>
<td>0.21, 0.42</td>
<td>33</td>
<td>*</td>
</tr>
<tr>
<td>Longitudinal</td>
<td>5.83</td>
<td>3</td>
<td>p &gt; 0.05</td>
<td>0.05</td>
<td>0.03, 0.16</td>
<td>4</td>
<td>**</td>
</tr>
<tr>
<td>Type of Sedentary behaviour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV</td>
<td>898.44</td>
<td>6</td>
<td>p &lt; 0.001</td>
<td>0.47</td>
<td>0.35, 0.62</td>
<td>7</td>
<td>*</td>
</tr>
<tr>
<td>Computers/internet</td>
<td>159.32</td>
<td>9</td>
<td>p &lt; 0.001</td>
<td>0.10</td>
<td>0.05, 0.21</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>Video/DVDs</td>
<td>10.22</td>
<td>2</td>
<td>p &gt; 0.05</td>
<td>0.21</td>
<td>0.10, 0.34</td>
<td>3</td>
<td>*</td>
</tr>
<tr>
<td>Screen</td>
<td>6919.82</td>
<td>5</td>
<td>p &lt; 0.001</td>
<td>0.51</td>
<td>0.34, 0.65</td>
<td>6</td>
<td>*</td>
</tr>
<tr>
<td>Total sedentary</td>
<td>3.05</td>
<td>1</td>
<td>p &gt; 0.05</td>
<td>0.05</td>
<td>-0.02, 0.10</td>
<td>2</td>
<td>n.s</td>
</tr>
<tr>
<td>Mental well-being outcome</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>6.99</td>
<td>4</td>
<td>p &gt; 0.05</td>
<td>0.31</td>
<td>0.14, 0.45</td>
<td>5</td>
<td>*</td>
</tr>
<tr>
<td>Depression</td>
<td>2206.49</td>
<td>9</td>
<td>p &lt; 0.001</td>
<td>0.55</td>
<td>0.42, 0.68</td>
<td>10</td>
<td>*</td>
</tr>
<tr>
<td>Self-esteem</td>
<td>10.95</td>
<td>7</td>
<td>p &lt; 0.05</td>
<td>0.01</td>
<td>-0.01, 0.02</td>
<td>8</td>
<td>n.s</td>
</tr>
<tr>
<td>Psychological distress</td>
<td>1812.87</td>
<td>3</td>
<td>p &lt; 0.001</td>
<td>0.41</td>
<td>0.30, 0.56</td>
<td>4</td>
<td>*</td>
</tr>
<tr>
<td>Quality of life</td>
<td>73.50</td>
<td>2</td>
<td>p &lt; 0.001</td>
<td>-0.15</td>
<td>-0.12, -0.23</td>
<td>3</td>
<td>*</td>
</tr>
<tr>
<td>Study quality</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>18757.05</td>
<td>19</td>
<td>p &lt; 0.001</td>
<td>0.31</td>
<td>0.20, 0.45</td>
<td>20</td>
<td>*</td>
</tr>
<tr>
<td>Low</td>
<td>268.52</td>
<td>16</td>
<td>p &lt; 0.001</td>
<td>0.03</td>
<td>0.02, 0.04</td>
<td>17</td>
<td>n.s</td>
</tr>
</tbody>
</table>

*p < 0.001  **p < 0.05

3.10 Discussion

This meta-analysis is the first to evaluate the association between sedentary behaviour and mental well-being in young people. Studies indicate a small but significant negative association between sedentary behaviour and mental health when assessing mainly screen-based sedentary behaviour and various indicators of mental health. The present
findings are consistent with a recent systematic review with young people that reported that sedentary behaviour is significantly associated with poor mental health in children and adolescents (Tremblay et al., 2011). Moreover, a systematic review by Teychenne, Ball, and Salmon (2010) reported that sedentary behaviour is associated with higher levels of depression in adults. The present findings are also consistent with those findings that sedentary behaviour influences physical well-being independent of physical activity levels (Hamilton et al., 2004; Tremblay et al., 2010).

All types of screen use were significantly associated with poorer mental health among young people. Among the kinds of screen assessed, television use had the largest association with mental health. Research studies indicate that children are more likely to use television than computers (e.g., Biddle, Pearson, Ross, and Braithwaite, 2010; Jolin and Weller, 2011). It has also been found that a key period in which young people are sedentary is after-school hours when they have returned home (Shann, 2001). With television being the most common entertainment device at home (e.g., Rideout, Roberts, and Foehr, 2010), young people are more likely to use television for leisure activity than other kinds of screen. For example, it has been indicated that about 60% of young people have television in their bedroom (Sisson, Broyles, Newton, Baker, and Chernausek, 2011), which is predictive of greater amount of television viewing.
It should also be noted that when not accounting for television, the highest effect size occurred for combined screen use. There is the possibility that the larger effect size for combined screen use was associated with television use than other kinds of screen. However, total sedentary behaviour was not significantly associated with mental health. This finding was not surprising because few studies have assessed overall sedentary behaviour and only 2 studies were assessed here. Moreover, since total sedentary time was associated with poor mental health but was not significant, it also suggests that perhaps screen use constitutes the main aspect of sedentary behaviour in young people than other aspects of sedentary behaviour associated with reading, sitting to chat without screen and travelling. Strasburger (2004), for example, mentioned that young people spend a greater proportion of their leisure time using screen devices than any other activity.

Regarding the indicators of mental health, depression has the largest effect compared to the other measures of mental well-being. This finding seem to be consistent with the recent finding which indicates that depression is the most common mental health problem among young people in the present society (NAMI, 2013; WHO, 2011). However, sedentary behaviour was not associated with self-esteem. This finding contradicts studies which have shown that depression is highly associated with low self-esteem (Comer, 2007). Based on the evidence that individuals who are depressed are more likely to experience self-esteem
problems, it could be hypothesized that sedentary behaviour would be associated with self-esteem as well. However the current finding is supported by studies which have shown that the use of some screens is associated with improvement in some aspects of self-esteem among young people (Durkin and Barber, 2002).

Specifically some studies have found that the use of a computer for communicating is associated with improvement in social self-esteem (Shaw and Gant, 2002; Valkenburg, Peter, and Schouten, 2006). Therefore it could be that young people who used computers experienced some improvement in some aspects of their self-esteem (e.g., Valkenburg et al., 2006) which resulted to a reduction of the possible impact that computer use might have on overall self-esteem. It should however be noted that the use of computers have been associated with some aspect of self-esteem, i.e. social self-esteem, but not all the domains of self-esteem. The non-significant association between sedentary behaviour and self-esteem could also be because studies measured different aspects of self-esteem. A number of studies, for example assessed self-concept as an indicator of self-esteem.

Concerning the age group of the young people examined, the lack of studies assessing children and adolescents separately did not allow for a comparison of the impact of sedentary behaviour on these two age groups. Given that findings indicate that adolescents are more likely to be
sedentary than children (Brodersen et al., 2007) and adolescents are more prone to depression than children (Lack and Green, 2009), it is important to determine the extent to which sedentary behaviour might differentially affect children and adolescents.

Among the studies that have assessed sedentary behaviour and mental well-being, nearly half were rated as low quality. Interestingly, the high quality studies showed larger effects than the low quality studies. A number of the studies in this meta-analysis did not use standardised tests to measure mental well-being (e.g., Choo et al., 2010; Deyreh et al., 2011). A review study by Pate, Mitchell, Byun, and Dowda, (2011) also found that researchers investigating sedentary behaviour have not used validated tests to assess sedentary behaviour. Therefore, there is a possibility of underestimation of the association between sedentary behaviour and mental health as a result of methodological issues in previous studies (Pate et al., 2011). It is important to note that all the studies included in the present meta-analysis found some associations between sedentary behaviour and mental health. The few studies that did not find significant associations (i.e., Colwell and Payne, 2000; Durkin and Barber, 2002; and Selfhout et al., 2009) still reported that students who used screen devices excessively had mental health problems compared to those who used screen devices less.
4.1 Introduction

An important lifestyle problem which has been recently identified among young people, apart from insufficient physical activity, is sedentary behaviour (Hallal et al., 2012; WHO, 2011). Most adolescents have shifted their time from participation in active pursuits into sedentary behaviours as a result of increase in technology (Valkenburg and Peter, 2011; Witt, Massman, and Jackson, 2011). Information and communication technologies (ICT) were invented to facilitate communication, help people living apart stay in touch, enhance the efficiency of workplaces, and aid students in learning (Bargh and McKenna, 2004; Ilomäki and Rantanen, 2007). However, young people are now mainly using ICTs in additional ways (Strasburger, 2004). During leisure-time, adolescent boys in particular sit for long hours to play videogames (Biddle et al., 2010; Witt et al., 2011). Girls also use the internet, including for social activity. The recent development of the Webcam has made it more exciting and attractive to use the internet to communicate (Appel, 2012; Shaw and Gant, 2002).
Communication technologies have resulted in internet addiction among the youth (Acier and Kern, 2011; Armstrong, Phillips, and Saling, 2000). Internet addiction has contributed to the perpetuation of sedentary behaviours (Appel, 2012; Strasburger, 2004). It is estimated that around 15% of adolescents in Western cultures have become addicted to the computer (King, Delfabbro, Griffiths, and Gradisar, 2011; Weinstein and Lejoyeux, 2010; Winkler, Dörsing, Reif, Shen, and Glombiewski, 2013). Excessive use of computers appears to be prevalent in Ghana. Currently, computers are being supplied to schools through donations from the Western countries. The government has also been providing computers to schools (Ghana News Agency, 2012). Therefore adolescents who do not have computers at home use computers at school or go to the internet café. Apart from screen-based sedentary behaviours, adolescents in Ghana are likely to engage in other sedentary behaviours especially those associated with sedentary travelling.

Mental health problems have been increasing among Ghanaian adolescents in present times (Progressive Life Center, 2011). The findings of an epidemiological study conducted in Africa, indicated that about 20% of youth suffer from depression and stress-related conditions every year (Abd Elhamid et al., 2009). This finding is similar to the prevalence of mental health problems in Western young people (Ford, Goodman, and Meltzer, 2003). Recent research has shown that sedentary behaviour is detrimental to young people’s health (Tremblay et al., 2011). In Ghana,
screen-based sedentary behaviour appears to be a recent lifestyle among adolescents. However, the impact of sedentary behaviours on young people’s health has not yet been investigated in the African culture. The present study therefore examines physical activity, sedentary behaviour and their impact on African adolescents’ mental well-being. It has been recommended that studies examining mental health in young people should include assessment of family relationships (NICE, 2005). Therefore, the present research also examined whether adolescents mental well-being is associated with parenting style.

4.2 Study Objectives and Hypotheses

The specific objectives of study 2 are presented and justified below. Based on the study objectives, the hypotheses to be investigated are also outlined.

Objective One

The first objective of study 2 was to examine the relationship between physical activity and mental well-being in African adolescents.

Rationale of Objective One

There is a high prevalence of mental health problems in adolescents worldwide (WHO, 2011). It has also been found that students on psychotherapy do not usually attend all the therapy sessions required for adequate recovery (e.g., Yu et al., 2011). New interventions in the
management and prevention of mental health problems in young people are therefore needed (e.g., Reavley and Jorm, 2010).

Research studies have found associations between higher levels of physical activity and lower depression and enhanced self-esteem (e.g., Larun et al. 2009), which indicate a good mental well-being. However, the basis of this evidence is not strong because relatively few studies have examined the mental health benefits of physical activity in young people. In addition, little information is known about the association between physical activity and mental well-being in African culture (Bauman et al., 2012). Therefore there is no strong evidence that the mental health benefit of physical activity is universal for both Western and African young people. Particularly, it is important to assess depression and self-esteem which are the most common mental health problems in young people (e.g., Comer, 2007). It has also been indicated that physical self-worth and body image largely contribute to adolescents’ self-esteem (e.g., Siegler et al., 2011). For these reasons, Study 2 of this thesis was planned as a cross-sectional study, with generalizable sample size, to investigate the relationship between physical activity and mental well-being indicators of depression and self-esteem among African adolescents. Specifically, physical self-worth and body dissatisfaction (indicators of self-esteem) were examined. The following hypotheses in relation to the first objective of Study 2 were examined.
Hypothesis One: There will be a significant negative relationship between physical activity and depression.

Hypothesis Two: There will be a significant positive relationship between physical activity and physical self-worth.

Hypothesis Three: There will be a significant negative relationship between physical activity and body dissatisfaction.

Objective Two
To examine whether parenting style moderates the relationship between physical activity and depression.

Rationale of Objective Two
There is evidence that a higher level of physical activity is associated with lower depression in young people. However, it has been recommended that studies investigating mental health in young people should also assess family relationships (NICE, 2005) because parental difficulties have also been associated with depression in young people (e.g., Marshall and Ramchandani, 2008). Studies on family relationships have found that authoritarian parenting style is associated with depression in young people (e.g., Goldstein and Heaven, 2000; Juang and Silbereisen, 1999). Authoritative parenting however, has been identified as the appropriate parenting style (DeVore and Ginsburg, 2005). Notably, findings from studies (e.g., Richter and Dawes, 2008) suggest that authoritarian parenting style is more prevalent in the African culture, which could be
associated with depression among African young people. It was therefore the objective of the study to explore whether the relationship between physical activity and depression in adolescents is dependent on parenting style. The hypothesis examined based on the second objective of Study 2 was as follows:

**Hypothesis Four**: Students with high physical activity and authoritarian parenting style will experience significantly greater depression than those with low physical activity with authoritative parenting style.

**Objective Three**
To investigate the prevalence of sedentary behaviour in public and private schools in Ghana.

**Rationale of Objective Three**
In the Western countries, the weather contributes largely to sedentary behaviour in young people. Specifically, during cold winter seasons young people spend more time indoors where they are more likely to participate in sedentary games (Bélanger et al., 2009). In the African countries however, sedentary behaviour was not a problem among young people because the weather is generally hot and therefore children and adolescents spent more time outdoors (e.g., Arthur, 2003). However, with the introduction of computers from the Western countries to Africa (e.g., Pratt et al., 2012), it appears that sedentary behaviour has become a new lifestyle in African young people recently.
Sedentary behaviour appears to be particularly common among students who attend private schools in Ghana. Children in private schools mostly come from affluent homes whose parents can generally afford to buy them computers and video games. These children are also driven to school and picked from school in their parents' cars, which also predisposes them to be sedentary. After school, because they have computers and internet at home, they do not engage in outdoor activities. Rather, they stay indoors playing computer games, chatting with friends on the internet, or watching television. Children in the public schools however, mostly come from low to middle income families whose parents cannot generally afford to buy them personal computers and video games. After school, because they do not have access to computers and internet at home, they participate in outdoor games, which possibly reduce the likelihood of being sedentary. In Ghana, there is no study about young people's socioeconomic background and their access to screen devices. Therefore this issue was examined in the present research. The hypothesis examined in correspondence to this objective was as follows:

**Hypothesis Five**: Students from private schools will be more sedentary than students from public schools.

**Objective Four**

To examine the relationship between sedentary behaviour and depression among African adolescents.
Rationale of Objective Four

Research into sedentary behaviour and mental health started quite recently (Hallal et al., 2012). The few available studies in this field have found that higher sedentary behaviours are associated with depression in young people (e.g., Ha et al., 2007; Primack et al., 2009; Sund et al., 2011). The studies that have examined sedentary behaviour and mental well-being however, have assessed mainly screen-based sedentary behaviour (Pate et al., 2011). Other contexts sedentary behaviour among young people such as sitting to chat, time spent in motorised transport, and doing personal studies have been less studied. Currently, sedentary behaviour has not been assessed adequately.

Moreover, sedentary behaviour seems to be a new lifestyle among young people in African culture. However, its impact on their mental well-being has not yet been studied (e.g., Bauman et al., 2012). This is a new area which needs to be investigated. It is important to note that depression is the most serious mental health problem in adolescents as it sometimes requires admission and medication treatment (Comer, 2007). Depression is closely associated with low-self-esteem in adolescents (Battle, 1980) and worst of all, it could lead to suicide (Comer, 2007). There is a need for interventions to prevent depression in young people (e.g., Reavley and Jorm, 2010). In view of this, study 2 was designed as a cross-sectional study with relatively large sample size to examine the association between sedentary behaviour and mainly depression. While
addressing the third objective, study 2 of this thesis also considered the gap in the sedentary behaviour literature by assessing entire sedentary behaviour. The hypothesis examined in correspondence to the fourth objective was as follows:

**Hypothesis Six**: There will be a significant positive relationship between sedentary behaviour and depression.

**Objective Five**
To examine whether parenting style moderates the relationship between sedentary behaviour and depression.

**Rationale of Objective Five**
Evidence shows that sedentary behaviour is associated with depression in young people (e.g., Sund et al., 2011). It has been recommended that studies investigating mental health problems among young people should also assess family relationships (NICE, 2005). Studies have shown that young people from authoritarian homes are more likely to experience depression than those from authoritative families (Goldstein and Heaven, 2000; McLeod et al., 2007). Findings of some studies suggest that authoritarian parenting style is common in Africa (e.g., Richter and Dawes, 2008). Study 2 therefore examines whether the influence of sedentary behaviour on depression is dependent on parenting style. The hypothesis examined based on the fifth objective was as follows:
**Hypothesis Seven:** Students with low sedentary behaviour and authoritarian parents will experience significantly higher depression than those with high sedentary behaviour and authoritative parents.

**Objective Six:**
To examine the prevalence of depression and self-esteem problems in public and private school students in Ghana.

**Rationale of Objective Six**
The few available studies have found that sedentary behaviour is associated with mental health problems in young people (e.g., Ha et al., 2007; Primack et al., 2009; Sund et al., 2011). In Ghana students in the private schools seem to be more sedentary than those in the public schools. To thoroughly examine the impact of sedentary behaviour among Ghanaian students it is necessary to compare the mental well-being of students in the public and private schools. The two most common mental health problems in young people i.e. depression and self-esteem (Comer, 2007) were examined. The hypothesis examined in relation to the sixth objective was as follows:

**Hypothesis Eight:** Students from private schools will significantly experience more depression, low physical self-worth and high body dissatisfaction than students from public schools.
4.3 Research Design

This was an observational study to examine the prevalence of physical activity and the trend of sedentary behaviour in African adolescents and to examine the relationship between physical activity and sedentary behaviour and mental health of these adolescents.

4.4 Study Setting

The study was conducted in Accra, Ghana, located on the west coast of Africa. Accra is the capital city of Ghana and the most highly developed city. There is high technological development including easy access to motorised transport and ICT, similar to that in Western countries. A large number of people living in Accra own private cars. Regarding education, Ghana has 12,130 primary schools and 5,450 junior secondary schools including public and private schools, for a population of about 10 million young people (www.ghanaweb.com). Most of the private schools in Ghana are located in the city. Physical education is part of the curriculum in the schools in Ghana, however a number of the schools in the cities do not teach Physical Education because of the priority given to other subjects such as English, Mathematics and Science (Pühse and Gerber, 2005).
Junior high schools were the site of data collection due to the nature of the study, which focused on well-being in adolescents. Sixteen junior high schools were contacted in Accra. Using purposive random sampling, two junior high schools were chosen for data collection. Participants were recruited from a public and a private school. This is because in Ghana, the private schools are attended mostly by students from high socio-economic backgrounds and the public schools are attended mostly by students from middle-to-low socio-economic backgrounds. The schools which participated in the study included Abofu Presby Junior high (a public school) and New Life Institute (a private school) in Accra.

Abofu Presby School is a public school situated in Achimota, East of Accra. The school was established in 1992. It is a day school with a school site size of about 3 acres. It has a compound of about 300X400 yards. It is a large school with both basic and junior high school classes. The total population of the school is 550. New Life Institute is a private school established in 1990. It is situated in Gbawe, West of Accra. It is a day school with a school site size of about 1 acre. It has a compound of about 200X300 yards. The school comprises both basic and junior high school. The total population of the school is 410.
A public School

A private school
4.5 **Determination of Sample Size**

The sample size (n) for the study was determined by using the a-priori sample size calculator for multiple regression. A sample of 300 participants was sufficient to detect a small effect size ($d=0.1$) based on a statistical power of 0.9 with a probability level of 0.1 and allowing for 10 predictor variables.

4.6 **Sampling Technique**

A combination of purposive, stratified and simple random sampling was used to select participants. Purposive sampling method was used because participants were recruited from a specific public and a private school. Moreover, the junior high schools (JHS) in Ghana comprised three academic levels - JHS one, two and three. Also, each academic level comprises A and B classes. The various classes were put into strata, and simple random sampling was used to recruit 80 participants from each stratum. Thus, 240 participants were recruited from each school. The recruited participants were given an informed consent package to be signed by themselves and their parents and to be returned to the school within one week. The consent form was such that if the parents did not respond within one week it was assumed that they had agreed for their child to participate in the study (the ‘opt-out’ method). Finally, simple random sampling method was used to select the required number of participants for the study.
4.7 Sample Size

The final participants were 300 junior high school students, with 150 from the public school and 150 from the private school. The response rate was 99% (150 students from the public school and 146 students from the private school).

4.8 Tools for Data Collection


4.8.1 Assessment of Physical Activity levels: The Physical Activity Questionnaire for Older Adolescents

The Physical Activity Questionnaire for Older Adolescents (PAQ-A), developed by Kowalski, Crocker, and Donen (2004), was used to assess physical activity levels of the participants. This test was chosen over other self-report physical activity questionnaires because it has been successfully used in physical activity research to examine physical activity levels among school students (Chinapaw, Mokkink, van Poppel, van Mechelen, and Terwee, 2010) and has been positively evaluated against similar scales (Biddle, Gorely, Pearson, and Bull, 2011). It is a self-administered recall questionnaire designed to measure physical activity levels among adolescent students aged 13 to 19 years of age. The PAQ-A
can also be administered as a group test. It measures students’ physical activity in different domains (e.g. home, school, leisure, transport, etc.) during the past 7 days.

It consists of 8 items which enquire about the frequency of doing particular physical activities. Respondents read each item and then rate how often they do specific physical activities by using the response options provided (see Appendix 11). The PAQ-A has good validity. It correlates significantly with scores on the 7-day Physical Activity Recall interview (PAR, \( r = 0.60 \)), the Activity Rating questionnaire (\( r = 0.73 \)) as well as with the Caltrac motion sensor (\( r = 0.33 \)) (Kowalski, Crocker, and Kowalski, 1997). The PAQ-A was slightly modified to suit the African culture. Specifically, some of the games in question 1 of the PAQ-A were replaced with common traditional games in Ghana, which also involves high intensity physical activities. Only three items in question 1 were modified.

It takes about 20 minutes to administer this test. The PAQ-A is scored using the scoring guide provided in the test manual (Table 4.2.1). The score on the PAQ-A indicates a person’s total physical activity score from the eight items, which each is scored on a 5-point scale. When interpreting the scores, a score of 1 indicates low physical activity level, whereas a score of 5 indicates a high physical activity level.
Table 4.2.1. Scoring guidelines for the PAQ-A

<table>
<thead>
<tr>
<th>Item 1</th>
<th>Calculate the mean of all activities (&quot;no activity being a 1, &quot;7 times or more&quot; being a 5) on the activity checklist to form a combined score for item 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 2-7</td>
<td>Use the reported value that is ticked for each item (the lowest activity response being a 1 and the highest activity response being a 5).</td>
</tr>
<tr>
<td>Item 8</td>
<td>Calculate the mean of all days of the week (&quot;none&quot; being a 1, &quot;very often&quot; being a 5) to form a combined score for item 8.</td>
</tr>
<tr>
<td>Item 9</td>
<td>Not used as part of the scoring</td>
</tr>
</tbody>
</table>

4.8.2 Assessment of Sedentary behaviour: The Adolescent Sedentary Activity Questionnaire (ASAQ)

The Adolescent Sedentary Activity Questionnaire (ASAQ), developed by Hardy, Booth, and Okely (2007), was used to assess sedentary behaviour. The ASAQ was used because it is the best available questionnaire that measures a variety of sedentary behaviours among young people. In addition, the use of this questionnaire was useful in addressing the methodological shortcomings of previous studies, which have assessed sedentary behaviour using few questions. It consists of 32 items on a variety of sedentary behaviours associated with entertainment, education, travel, and social activities. It requires respondents to think about a normal week during school term, and to report how long they usually
spend in doing specific sedentary behaviours before and after school hours. Respondents also report how long they spend in doing sedentary behaviours during weekend days (Appendix 13). The ASAQ has good face validity. The intra-class correlation coefficients for each category of sedentary behaviour and total sedentary time for weekdays and weekend days, with respect to sex and grade were all ≥0.70, which indicates a high reliability (Hardy et al., 2007). This test can be administered to an individual or a group.

It takes about 15 minutes to complete the test. When scoring the test, time spent in sedentary behaviour for each weekday is summed and then divided by 7 days to obtain the average time of sedentary behaviour for a typical weekday. Similarly, the time spent in sedentary behaviour in each weekend day is summed up and then divided by 2 in order to obtain the amount of time spent in doing sedentary behaviours for a typical weekend day. The time spent in sedentary behaviours can also be summed across weekdays and weekend days to obtain the total time spent in doing sedentary behaviours per day. A score of ≥ 4hrs/day indicated high sedentary behaviour. Some previous sedentary behaviour studies among young people have also used a cut-off point of ≥ 4hrs/day to indicate high levels of sedentary behaviour (Dumith et al., 2010; Ybarra et al., 2005).
4.8.3 Assessment of Depression: The Children’s Depression Inventory

The Children’s Depression Inventory (CDI), full version, (Kovacs, 1992) was used to assess depression. It was chosen over other well established self-report measures of depression such as the Beck Depression Inventory (Beck, 1963) because it is designed entirely for school-aged children and adolescents. In addition, the CDI has been validated in Ghana (Akude, 2005). The full version of the CDI questionnaire consists of 27 sets of statements that describe a series of depressive symptoms associated with disturbed mood, hedonic capacity, vegetative functions, self-evaluation and interpersonal behaviours. Each item on the CDI consists of three sets of statements, labelled 0, 1, and 2 in which a higher score indicates more severity of a depressive symptom. Respondents read each item and choose statements which describe themselves for the past two weeks (see Appendix 14).

The CDI can be used as a routine screening tool in a number of institutions, including schools, clinics, residential treatment centres, and child protective services for decisions on placement and clinical referrals. Internal consistency of the CDI in the normative sample is 0.86, indicating good internal reliability. Test-retest reliability coefficients range from 0.41 to 0.87 which indicates that the CDI has good stability levels. The CDI’s ability to accurately identify individuals with diagnosed depression has been determined which shows that the CDI has good
discriminant validity. The CDI has adequate concurrent validity. It correlates highly with the Coppersmith Inventory \((r = 0.67)\) and the short version of the Piers-Harris Children’s Self Concept Scale \((r = 0.66)\). It generally takes about 15 minutes to complete. As the person completes the test, the responses get transferred to the QuikScore form, which is underneath the answer sheet. In scoring the CDI, the QuikScore form (the scoring key) is separated from the answer sheet. The scores of each item, on the QuikScore form, are added and the total score is written in the box labelled as “TOTAL CDI SCORE”. The corresponding T-score on the Profile form is reported as a person’s score obtained on the CDI. The T-scores used for the CDI are linear T-scores (Kovacs, 1992).

Table 4.2.2. Interpretation Guidelines for T-scores of the CDI

<table>
<thead>
<tr>
<th>T-Score</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 70</td>
<td>Very much above average</td>
</tr>
<tr>
<td>66-70</td>
<td>Much above average</td>
</tr>
<tr>
<td>61-65</td>
<td>Above average</td>
</tr>
<tr>
<td>56-60</td>
<td>Slightly above average</td>
</tr>
<tr>
<td>45-55</td>
<td>Average</td>
</tr>
<tr>
<td>40-44</td>
<td>Slightly below average</td>
</tr>
<tr>
<td>35-39</td>
<td>Below average</td>
</tr>
<tr>
<td>30-34</td>
<td>Much below average</td>
</tr>
<tr>
<td>Below 30</td>
<td>Very much below average</td>
</tr>
</tbody>
</table>
4.8.4 Assessment of Self-esteem: Physical Self-Worth (PSW)

Participants’ physical self-worth was assessed using the subscale from the Physical Self-Perception Profile (Fox and Corbin, 1989). The Physical Self-Perception Profile (PSPP) consists of five subscales, each containing 6 items, which measures self-esteem in specific domains, including perceived competence in sports (Sport), perceived bodily attractiveness (Body), perceived physical development (Strength), perceived ability to do exercise (Condition), and overall physical self-worth (PSW). The PSPP has been widely used in physical activity research to examine the association between physical activity and self-esteem among young people (Stein, 1996). The PSW subscale was chosen instead of using the entire scale because research indicates that among adolescents, evaluations about their physical self is an important element of their overall self-esteem (Harter, 1990).

The PSW scale of the PSPP is designed to assess physical self-worth at the domain level. It assesses self-respect, satisfaction and confidence about personal characteristics in the physical domain. The PSW consists of 6 items. Respondents read each item and rate how it describes themselves using the response options ranging from 1 ‘Not at all like me’ (lowest score) to 5 ‘Very much like me’ (highest score) (Appendix 15). The internal consistency of the PSW is between 0.6 and 0.7. The test-retest reliability coefficients were between 0.74 and 0.92 for a 16-day period.
and between 0.81 and 0.88 for a 23-day period (Fox and Corbin, 1989).
It takes 5-10 minutes to complete this test. The test is scored by adding up the score circled for each of the 6 items. Items 2, 4 and 6 are reversed when adding up the scores. A higher score on this test indicates a high physical self-worth or related sub-domain. The response options for the Physical Self-Worth sub-scale of the PSPP were modified from two-directional to a one-directional response options such as 1) ‘Not at all like me’ to 5) ‘Very much like me’. A pilot study was conducted to ensure that participants understood the instructions on the questionnaire.

**The Body Image Silhouette test**

The Body Image Silhouette test (Stunkard, Sorensen and Schulsinger, 1983) was used to assess body image. It was chosen because it has been found that among adolescents an evaluation about their body image is the most important determinant of their self-esteem and well-being (Seifert and Hoffnung, 2000). This test consists of 9 pictures of different human figures which range from thin to obese. Respondents look at the pictures and then rate on a 9-point scale, their current perceived body size and then, separately, their ideal body size. Different pictures are designed for boys and girls (Appendix 16). The silhouette rating scales are widely used to assess body image and body dissatisfaction in physical activity research (Hart, 2000).
The scales have good face validity and it takes a very short time to administer (Hart, 2000; Thompson and Altabe, 1991; Truby and Paxton, 2002). It is a highly reliable scale and has been used among adults and young people (Sherman, Iacono and Donnelly, 1995; Thompson and Altabe, 1991). Test-retest reliability scores range from 0.89 to 0.92 for assessment of current body image and 0.71 to 0.82 for ideal body image among males and females (Thompson and Altabe, 1991). It takes about 3 minutes to complete this test. When scoring the test, the difference between scores of the current body image and scores of the ideal body image is calculated. A high score on the Silhouette test indicates greater body dissatisfaction.

4.8.5 Assessment of Parenting Style: Parenting Style Questionnaire:

The Parenting Style Questionnaire (Kremers, Brug, de Vries, and Engels, 2003; Lamborn, Mounts, Steinberg, and Dornbusch, 1991; Van der Horst et al., 2007) was used to assess parenting style. This is a 17-item self-report questionnaire which measures adolescent perceptions of parental involvement (e.g. ‘When I have a bad result at school, my parents encourage me to do better’), and strictness (e.g. ‘My parents know exactly where I am after school’). Respondents read each statement and rate the extent to which it applies to them on a 5-point scale (‘1’, strongly disagree to ‘5’ strongly agree)(Appendix 17). A reliability coefficient of 0.85 and 0.73 has been reported for the involvement and strictness
subscales respectively (Kremers et al., 2003). It takes 10-15 minutes to complete the test.

The score on the involvement subscale is obtained by adding up the scores circled for items 2, 3, 4, 5, 6, 8, 11, 13, 14 and 15. The score on the strictness subscale is obtained by adding up the scores circled for items 1, 7, 9, 10, 12, 16 and 17. The median score of each of the subscales is calculated. These median values are then used to classify four types of parenting: authoritative, authoritarian, permissive/indulgent and neglecting parenting styles. Authoritative parenting style represents scores above the median value of both involvement and strictness subscales, whereas Neglectful parenting style represent scores below the median values in both dimensions. Authoritarian parenting style represents scores below the median value of the involvement subscale and above the median value of the strictness subscale. Permissive/Indulgent parenting style represents scores above the median value of involvement subscale and below the median value of strictness subscale.

4.8.6 Assessment of Socioeconomic Status

Socio-economic status was assessed together with demographic variables. Demographic variables assessed included age, gender, and grade (J.H.S. 1, 2, or 3). Socio-economic background was assessed by parental
education level. It was assessed through a single question which required respondents to indicate the highest education level of both parents (<senior high school, senior high school, or tertiary). Parental education was assessed as a proxy of socio-economic status because in Ghana people with tertiary education generally have higher income than those with secondary level education. Moreover, people with higher education mostly can afford to take their children to private schools which are more expensive than the public schools. Previous physical activity studies have also assessed parental education level as a proxy of young people’s socio-economic background (Pate et al., 2011).

4.9 Procedure

The data were collected during one day in each school. During the data collection, participants were seated in the school’s assembly hall. These participants were given information about the purpose of the study and what they were being requested to do. They were told that the questionnaires were not an exam. In addition, the information they provided was solely for research purposes and that they would not be identified with the information they gave. Therefore they should be honest when responding to the questionnaires. Participants were asked to call for assistance when they did not understand anything on the questionnaires. After the introductory guidelines, participants were provided with pens, then the study questionnaires on physical activity, sedentary behaviour, depression, self-esteem and parenting style were
distributed. The researcher read out the instructions of each questionnaire to the students. Research assistants were also around to assist students who needed assistance regarding completion of the questionnaires. The data collection lasted 1 hour 30 minutes. Table 4.2.3. shows the data collection procedure of the study.

### Table 4.2.3. Data Collection Procedure of Study 2

<table>
<thead>
<tr>
<th>Activity</th>
<th>Measure</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assessment of Physical Activity</td>
<td>PAQ-A</td>
<td>20 mins</td>
</tr>
<tr>
<td>2. Assessment of Sedentary behaviour</td>
<td>ASAQ</td>
<td>15 mins</td>
</tr>
<tr>
<td>3. Assessment of Depression</td>
<td>CDI</td>
<td>15 mins</td>
</tr>
<tr>
<td>4. Break</td>
<td></td>
<td>5 mins</td>
</tr>
<tr>
<td>5. Assessment of Physical Self-worth</td>
<td>PSW test</td>
<td>10 mins</td>
</tr>
<tr>
<td>6. Assessment of Body dissatisfaction</td>
<td>Silhouette test</td>
<td>5 mins</td>
</tr>
<tr>
<td>7. Assessment of Parenting Style</td>
<td>Parenting style Questionnaire</td>
<td>15 mins</td>
</tr>
</tbody>
</table>

**Total Duration**

**1hr 20 mins**

### 4.10 Additional Information on the Data Collection

Data collection started in November 2011 and finished in May 2012. During the first two months (i.e. November to December), junior high schools were contacted in order to make arrangements for data collection. During this time, research assistants were also recruited and trained. Research assistants were graduate psychology students from the
University of Ghana. Moreover, a pilot study was conducted to ensure that students understood the instructions on the questionnaires. All the questionnaires were completed in English. In order to ensure that participants received similar instructions for the completion of the questionnaires, the instructions for each questionnaire was printed out and read aloud to the participants by the principal researcher only. Research assistants were around to supervise the students and also attend to participants who needed some assistance in completing the questionnaires. In each school, participants were given a 5 minutes break during the questionnaire completion time.

4.11 Data Analysis

The Statistical Package for Social Sciences (SPSS) version 19.0 was used to analyse the data. Data were coded and entered. Initial analyses were conducted to ensure that there was no violation of the assumptions of normality, linearity and homogeneity of variance. The cut off point for sedentary behaviour was $\geq 4$ hours sitting time per day. A major confounding variable controlled in the analyses was parenting style. Specifically, bivariate correlation and multiple regression analyses were performed to examine physical activity, sedentary behaviour, and their association with mental health. In addition, two-way Analysis of Variance (ANOVA) and independent t-tests were performed to examine differences in physical activity and sedentary behaviour among some groups of the
participants. The details of the statistical analyses are provided in the results section.

4.12 Ethical Approval

Ethical approval for the study was granted by Loughborough University Ethical Advisory Committee (Appendix 21). Permission letters were sent to the school heads in order to conduct the study in the schools (Appendix 22). Moreover, informed consent was obtained from the parents and the students before data collection.
4.13 Sample Characteristics

The socio-demographic characteristics, physical activities and sedentary behaviours of the sample are presented in Table 4.3.1
Table 4.3.1. Socio-demographic characteristics, and physical activity and sedentary behaviour of the sample.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Sample (N = 296)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
</tr>
<tr>
<td>Age</td>
<td>14.85</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>150</td>
</tr>
<tr>
<td>Females</td>
<td>146</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
</tr>
<tr>
<td>JHS 1</td>
<td>98</td>
</tr>
<tr>
<td>JHS 2</td>
<td>112</td>
</tr>
<tr>
<td>JHS 3</td>
<td>86</td>
</tr>
<tr>
<td>Socio-economic status</td>
<td></td>
</tr>
<tr>
<td>Low (Public school)</td>
<td>103</td>
</tr>
<tr>
<td>Low (Private school) (Parental education &lt; tertiary)</td>
<td>33</td>
</tr>
<tr>
<td>High (Public school)</td>
<td>47</td>
</tr>
<tr>
<td>High (Private school) (Parental education up to tertiary)</td>
<td>113</td>
</tr>
<tr>
<td>Physical Activity levels</td>
<td></td>
</tr>
<tr>
<td>Low (score ≤2 on the PAQ-A)</td>
<td>131</td>
</tr>
<tr>
<td>Mod-H (score &gt;2 on the PAQ-A)</td>
<td>165</td>
</tr>
<tr>
<td>Sedentary Behaviour levels</td>
<td></td>
</tr>
<tr>
<td>Low (≤4 hrs)</td>
<td>136</td>
</tr>
<tr>
<td>High (≥4 hrs)</td>
<td>160</td>
</tr>
<tr>
<td>Contexts of Sedentary Behaviour</td>
<td>M (SD)</td>
</tr>
<tr>
<td></td>
<td>(h/d)</td>
</tr>
<tr>
<td>TV/video</td>
<td>1.14 (1.32)</td>
</tr>
<tr>
<td>Computer/internet</td>
<td>4.65 (5.25)</td>
</tr>
<tr>
<td>Sitting</td>
<td>1.01 (2.75)</td>
</tr>
<tr>
<td>Travelling</td>
<td>2.16 (2.82)</td>
</tr>
<tr>
<td></td>
<td>M (SD)</td>
</tr>
<tr>
<td></td>
<td>(h/d)</td>
</tr>
<tr>
<td></td>
<td>Weekday</td>
</tr>
<tr>
<td></td>
<td>Males</td>
</tr>
<tr>
<td></td>
<td>1.90 (2.23)</td>
</tr>
<tr>
<td></td>
<td>7.09 (7.32)</td>
</tr>
<tr>
<td></td>
<td>0.54 (1.01)</td>
</tr>
<tr>
<td></td>
<td>0.36 (.83)</td>
</tr>
</tbody>
</table>

* p < 0.001

Abbreviations: Mod-H=Moderate to high physical activity levels; h/d=hour per day

Of the 300 participants sampled for the study, 296 (99%) provided responses. As shown in Table 4.3.1, the final sample consisted of relatively equal number of males and females (50.7% versus 49.3%
respectively). Their mean age was 14.85 (1.36) years. As expected, a larger proportion of students from the private school (77.4%) were from high socioeconomic backgrounds compared to students in the public school (31.3%). Concerning physical activity participation, nearly half of the participants (44.3%) had low physical activity levels, with more females being physically inactive than males (55.0% versus 45.0% respectively). Similarly, about half of the participants (54.1%) were highly sedentary, and again with more females being highly sedentary than males (52.5% versus 47.5% respectively). Regarding the context of sedentary behaviour, it appears that computer and internet use contributed largely to the total sedentary time of both boys and girls (weekday: 4.65 h/d, 4.08 h/d; weekend: 7.09 h/d, 6.41 h/d). Computer and internet use were higher during weekend days than weekdays. Boys and girls use the computer for similar hours (4.65 h/d, 7.09 h/d versus 4.08 h/d, 6.41 h/d respectively).

4.14 Physical Activity and Mental Well-being in Ghanaian adolescents

It was the objective of this study to investigate the association between physical activity and well-being in Ghanaian adolescents in order to broaden the evidence base. This was accomplished by examining the following hypotheses.
**Hypothesis One:** There will be a significant negative relationship between physical activity and depression.

**Hypothesis Two:** There will be a significant positive relationship between physical activity and physical self-worth.

**Hypothesis Three:** There will be a significant negative relationship between physical activity and body dissatisfaction.

The results of hypotheses One, Two and Three are presented in Table 4.3.2 and 4.3.3 below.

**Table 4.3.2.** Pearson correlation coefficients for physical activity, depression, physical self-worth and body dissatisfaction.

<table>
<thead>
<tr>
<th></th>
<th>Depression</th>
<th>Physical self-worth</th>
<th>Body dissatisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity</td>
<td>-0.78*</td>
<td>0.71*</td>
<td>-0.76*</td>
</tr>
</tbody>
</table>

* *p < 0.001

**Table 4.3.3.** Regression coefficients for physical activity and mental well-being.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Depression</th>
<th>Physical Self-worth</th>
<th>Body dissatisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.04</td>
</tr>
<tr>
<td>Gender</td>
<td>0.03</td>
<td>-0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>Socioeconomic status</td>
<td>0.00</td>
<td>-0.05</td>
<td>-0.01</td>
</tr>
<tr>
<td>Physical Activity</td>
<td>-0.64*</td>
<td>0.63*</td>
<td>-0.57*</td>
</tr>
</tbody>
</table>

Note: Standardized regression coefficients with age, gender, socio-economic status, and Sedentary behaviour in the model

* *p < 0.001
From Table 4.3.2, there was a significant negative relationship between physical activity and depression ($r = -0.78, p<0.001$). This finding indicates that participants who had higher physical activity levels were less likely to report depressive symptoms, hence supporting hypothesis one. With regards to self-esteem, there was a significant positive relationship between physical activity and physical self-worth ($r = 0.71, p<0.001$). Moreover, there was a significant negative relationship between physical activity and body dissatisfaction ($r = -0.76, p<0.001$), indicating a high association. These results indicate that physical activity was significantly associated with high self-esteem, thus supporting hypothesis two and three. In addition, the results from the regression analysis in Table 4.3.3 show that the association between physical activity and mental well-being is independent of sedentary behaviour. Specifically, physical activity was associated with 0.64 standard deviations reduction in depression ($\beta = -0.64$) and an average of 0.60 standard deviations improvement in self-esteem (physical self-worth: $\beta = 0.63$; body dissatisfaction: $\beta = -0.57$).

### 4.15 Physical Activity, Parenting Style and Depression

To explore whether the relationship between physical activity and depression in adolescents is dependent on parenting style, the following hypothesis was examined:
**Hypothesis Four**: Students with high physical activity and authoritarian parenting style will experience significantly greater depression than those with low physical activity with authoritative parenting style.

Relevant information about hypothesis four is presented in Tables 4.3.4 and 4.3.5. Participants with high physical activity and authoritarian parenting style scored lower on depression [36.95 (3.11)] than those with low physical activity with authoritative parenting style [59.83 (10.41)]. Results from Table 4.3.5 shows that parenting style was not significantly associated with depression \([F (3, 284) = 2.49, \ p>0.05]\). However, physical activity was significantly associated with depression \([F (2, 284) = 218.67, \ p<0.001]\). From the findings, participants with low physical activity but with an authoritative parenting style reported significantly higher depressive symptoms. Therefore hypothesis four was not supported.
Table 4.3.4. Summary of the descriptive Statistics on physical activity, parenting style and depression.

<table>
<thead>
<tr>
<th>Parenting style/ Physical Activity</th>
<th>Authoritative</th>
<th>Authoritarian</th>
<th>Indulgent</th>
<th>Neglectful</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Low</td>
<td>36</td>
<td>59.83</td>
<td>10.41</td>
<td>21</td>
<td>57.24</td>
</tr>
<tr>
<td>Moderate</td>
<td>16</td>
<td>54.19</td>
<td>11.61</td>
<td>3</td>
<td>55.33</td>
</tr>
<tr>
<td>High</td>
<td>46</td>
<td>36.87</td>
<td>3.75</td>
<td>22</td>
<td>36.95</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
<td>48.13</td>
<td>13.55</td>
<td>46</td>
<td>47.41</td>
</tr>
</tbody>
</table>
Table 4.3. Summary table of two-way ANOVA results on physical activity, parenting style and depression.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity (PA)</td>
<td>33265.02</td>
<td>2</td>
<td>16632.51</td>
<td>218.67</td>
<td>0.000*</td>
</tr>
<tr>
<td>Parenting Style (PS)</td>
<td>567.42</td>
<td>3</td>
<td>189.14</td>
<td>2.49</td>
<td>0.061</td>
</tr>
<tr>
<td>Interaction (PA*PS)</td>
<td>260.23</td>
<td>6</td>
<td>43.37</td>
<td>0.57</td>
<td>0.754</td>
</tr>
<tr>
<td>Error</td>
<td>21601.74</td>
<td>284</td>
<td>76.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>803152.00</td>
<td>295</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

4.16 Prevalence of Sedentary Behaviour in Public and Private School Students in Ghana

In Ghana, it appears that students from private schools who are mostly from affluent homes are more likely to be sedentary because they have access to screen devices particularly the internet and computer games at home. There is no study about young people’s socioeconomic background and their access to screen devices in Ghana. It was therefore the objective of this study to explore the prevalence of sedentary behaviour in public and private school students in Ghana. The following hypothesis was examined in relation to this study objective:

**Hypothesis Five:** Students from private schools will be more sedentary than students from public schools.

The results of hypothesis 5 are presented in Table 4.3.6 below.
Table 4.3.6. Summary of Independent t-test results on sedentary behaviour in public and private schools

<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public</td>
<td>150</td>
<td>4.78</td>
<td>5.71</td>
<td>-7.29</td>
<td>294</td>
<td>0.000*</td>
</tr>
<tr>
<td>Private</td>
<td>146</td>
<td>9.91</td>
<td>6.37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*P<0.001

As shown in Table 4.3.6, students from the private school scored higher on sedentary behaviour than those in public school [(9.91 (6.37) h/day versus 4.78 (5.71) h/day respectively]. The results from the t-test shows that this difference is significant [t (294) =-7.30, p<0.001], thus supporting hypothesis five.

4.17 Sedentary Behaviour and Mental Well-being in Ghanaian Youth

Hypothesis Six: There will be a significant positive relationship between sedentary behaviour and depression.

Relevant information about the sixth hypothesis is presented in Table 4.3.7. There was a significant positive relationship between sedentary behaviour and depression (r = 0.68, p<0.001), which indicates a high association (Cohen, 1988). This finding shows that participants who were sedentary were more likely to report depressive symptoms, thus supporting hypothesis six. In addition, the results from the regression
analysis shown in Table 4.3.7 shows that the association between sedentary behaviour and depression is independent of physical activity. Specifically, sedentary behaviour was associated with 0.20 standard deviations increase in depression (β= 0.20).

Table 4.3.7. Regression coefficients for sedentary behaviour and depression independent of physical activity.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Depression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>-0.02</td>
</tr>
<tr>
<td>Gender</td>
<td>0.03</td>
</tr>
<tr>
<td>Socio-economic status</td>
<td>0.00</td>
</tr>
<tr>
<td>Sedentary behaviour</td>
<td>0.20*</td>
</tr>
</tbody>
</table>

Note: Standardized regression coefficients with age, gender, socioeconomic status, and physical activity in the model.

*p<0.001

4.18 Sedentary Behaviour, Parenting Style and Depression

Hypothesis seven: Students with low sedentary behaviour and authoritarian parents will experience significantly higher depression than those with high sedentary behaviour and authoritative parents.

Relevant information about hypothesis seven is presented in Tables 4.3.8 and 4.3.9. Participants with low sedentary behaviour and authoritarian parenting style scored lower on depression [36.96 (3.11)] than those with high sedentary behaviour with authoritative parenting style [58.91]
Results from Table 4.3.9 shows that parenting style was not significantly associated with depression \( F (3, 288) = 2.39, p > 0.05 \). However, sedentary behaviour was significantly associated with depression \( F (1, 288) = 383.74, p < 0.001 \). From the findings, participants with high sedentary behaviour but with an authoritative parenting style reported significantly higher depressive symptoms, thus not supporting hypothesis seven.
Table 4.3.8. Summary of the descriptive statistics on sedentary behaviour, parenting style and depression

<table>
<thead>
<tr>
<th>Parenting Style / Sedentary behaviour</th>
<th>Authoritative</th>
<th>Authoritarian</th>
<th>Indulgent</th>
<th>Neglectful</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>38.20</td>
<td>6.57</td>
<td>22</td>
<td>36.96</td>
</tr>
<tr>
<td>High</td>
<td>47</td>
<td>58.91</td>
<td>10.58</td>
<td>24</td>
<td>57.00</td>
</tr>
<tr>
<td>Total</td>
<td>98</td>
<td>48.13</td>
<td>13.55</td>
<td>46</td>
<td>47.41</td>
</tr>
</tbody>
</table>

| Total                                | 296 | 50.22 | 13.87 |


Table 4.3.9. Summary of two-way ANOVA results on sedentary behaviour, parenting style and depression

<table>
<thead>
<tr>
<th>Variables</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary Behaviour (SB)</td>
<td>31466.42</td>
<td>1</td>
<td>31466.42</td>
<td>383.74</td>
<td>0.000*</td>
</tr>
<tr>
<td>Parenting Style (PS)</td>
<td>589.99</td>
<td>3</td>
<td>196.67</td>
<td>2.39</td>
<td>0.068</td>
</tr>
<tr>
<td>Interaction (SB*PS)</td>
<td>44.79</td>
<td>3</td>
<td>14.93</td>
<td>0.18</td>
<td>0.909</td>
</tr>
<tr>
<td>Error</td>
<td>23615.77</td>
<td>288</td>
<td>81.99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>56738.16</td>
<td>295</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

4.19 Prevalence of Mental Health Problems in Public and Private School Students in Ghana

This study investigated the prevalence of mental health problems between public and private school students in Ghana. The hypothesis examined with respect to this objective was as follows:

**Hypothesis eight:** Students from private schools will significantly experience more depression, low physical self-worth and high body dissatisfaction than students from public schools.

The results of hypothesis eight are presented in Table 4.3.10 below:
Table 4.3.10. Summary of Independent t-test results between public and private schools on depression, physical self-worth and body dissatisfaction

<table>
<thead>
<tr>
<th>Variables</th>
<th>Public School</th>
<th>Private School</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
</tr>
<tr>
<td>Depression</td>
<td>150</td>
<td>44.07</td>
<td>10.79</td>
<td>146</td>
<td>56.53</td>
</tr>
<tr>
<td>Physical self-worth</td>
<td>150</td>
<td>21.43</td>
<td>8.17</td>
<td>146</td>
<td>14.04</td>
</tr>
<tr>
<td>Body dissatisfaction</td>
<td>150</td>
<td>1.31</td>
<td>1.61</td>
<td>146</td>
<td>2.56</td>
</tr>
</tbody>
</table>

*p<0.017 (Bonferroni)

As shown in Table 4.3.10, participants in the private school scored higher [56.53 (13.87)] on depression than those in the public schools [44.07 (10.79)], the t-test shows that the difference is significant \[t(294)=-8.65, p<0.017\]. This finding indicates that students in the private school significantly reported higher symptoms of depression than students in the public school. Regarding self-esteem, students in the private school scored lower on physical self-worth [14.04 (7.83)] than students from the public school [21.43 (8.17)]; this difference was significant \[t(294)=7.36, p<0.017\]. In addition students from private school had more symptoms of body dissatisfaction [2.56 (1.64)] than students from the public school [1.31 (1.61)]; again this difference was significant \[t(294)=-6.65, p<0.017\]. Putting these findings together, it suggests that students from private schools have more mental health problems which support hypothesis eight.
4.20 Summary of Results

- There was a significant negative relationship between physical activity and mental well-being among Ghanaian adolescents [depression \( r = -0.78, p<0.001 \); physical self-worth \( r = 0.71, p<0.001 \); body dissatisfaction \( r = -0.76, p<0.001 \)].

- Affluence is a significant contributing factor of sedentary behaviour in Ghanaian adolescents \[ t (294) = -7.30, p<0.001 \].

- Ghanaian adolescents’ sedentary behaviour was mainly associated with the use of screen devices, especially computers and internet [weekend computer/internet use (7.09 hr/day; 6.41 hr/day) versus weekend TV/video (1.90 hr/day; 2.17 hr/day) \( p<0.001 \)].

- There was a significant positive relationship between sedentary behaviour and depression among Ghanaian adolescents \( r=0.68, p<0.001 \).

4.21 Discussion

The present study found that physical activity is significantly associated with good mental health among Ghanaian youth. This finding is consistent with studies conducted among Western young people, which also indicated that physical activity is associated with good mental health (Burges et al., 2006; Jerstad et al., 2010; Kirkcaldy et al., 2002; Parfitt
and Eston, 2005; Raudsepp and Neissaar, 2012; Schmalz et al., 2007; Stavrakakis et al., 2012; Tremblay et al., 2000). Specifically physical activity was significantly associated with low depression. Physical activity was also significantly associated with a higher self-esteem. The present results confirm research findings which indicate that depression is strongly associated with low self-esteem (Battle, 1980; Comer, 2007). Comer (2007) mentioned that low self-esteem is one of the symptoms of depression. Therefore, the reason for the present finding is that young people who do regular physical activity tend to experience less depression and therefore have higher self-esteem.

With regards to sedentary behaviour, the present findings showed that there is a high prevalence of sedentary behaviour in Ghanaian youth. This is the first study that has extensively examined sedentary behaviour in African young people. Research (e.g., Bauman et al., 2012) indicates that sedentary behaviour has not been studied in the African culture. Studies from Western cultures have also indicated that there is a high prevalence of sedentary behaviour among adolescents in the present society (e.g., Elgar et al., 2005; Hallal et al., 2012; Vasques et al., 2012). The present study found that sedentary behaviour among Ghanaian young people is mainly associated with screen use, especially computers, followed by television and videogames. Computer was the screen that was largely used by Ghanaian adolescents. However, some studies from Western cultures have reported that television is the popular screen used by young
people (Jolin and Weller, 2011). The reason for the present findings could be that adolescents are more likely to use computers than other screens. Biddle et al. (2010) found that children are more likely to use television for leisure whereas adolescents are more likely to use computers. This indicates that children have more interest in using television which is a popular screen in most homes. However as children grow, they begin to show interest in the use of computers because the computer can be used for varied activities such as communication, playing games, etc. compared to television. For example, studies have found that the computer/internet is the most appreciable screen among adolescents. Moreover, adolescents are more likely to be addicted to the computer/internet than any other screen (Valkenburg and Peter, 2011; Witt et al., 2011).

One of the significant findings of the present study showed that affluence is a significant contributing factor of sedentary behaviour in Ghanaian adolescents. This is a new finding which contributes largely to the sedentary behaviour literature. Based on this finding, it has now been indicated that whereas the weather is one of the main contributing factors of sedentary behaviour in Western young people (e.g., Bélanger et al., 2009; Tucker and Gilliland, 2007), affluence is a significant contributing factor of sedentary behaviour in Ghanaian youth. From the present study, students in the private school who were mainly from high socio-economic backgrounds were significantly more sedentary than students from the
public school who were mostly from low socio-economic backgrounds. Moreover, sedentary behaviour among Ghanaian adolescents was mostly associated with the use of computers which further indicates that adolescents from high income families would get access to these computers. Again students from the private school, who were highly sedentary, were more likely to experience depression and self-esteem problems than students from the public school who were less sedentary. This finding also confirms that a high sedentary behaviour is associated with poor mental health.

The main limitation of the present study, however, is that the study was conducted in a specific public and private school in the city of Accra and the findings might not be representative of the entire students’ activity patterns and health in Ghana. This should therefore be considered when utilising the findings of the current study. In summary, the present study has showed that low levels of physical activity and high sedentary behaviours are independently associated with poor mental health. The new finding which emerged from the present study is that affluence is a significant contributing factor of sedentary behaviour in African young people, whereas studies from the Western cultures indicate that the weather is a significant contributing factor of sedentary behaviour in Western young people. This new finding contributes largely to the existing sedentary behaviour literature, in which research from the African culture is lacking (e.g., Bauman et al., 2012).
CHAPTER 5
PHYSICAL ACTIVITY, COGNITIVE FUNCTIONING AND OTHER INDICES OF MENTAL HEALTH IN AFRICAN YOUTH: AN INTERVENTION STUDY

5.1 Introduction

Physical inactivity has been identified as a major contributing factor for non-communicable diseases (Lee et al., 2012). Physical activity, however, has decreased among young people, especially among adolescents (WHO, 2010). Many adolescents do not meet physical activity guidelines of 60 minutes moderate to vigorous physical activity each day (Pearson et al., 2009; WHO, 2010). Low levels of physical activity have been associated with health problems among young people from Western cultures (Biddle and Asare, 2011; Janssen and LeBlanc, 2010; National Health Service, 2009; Taras, 2005).

Findings also indicate that adequate levels of physical activity could prevent and protect young people from mental health problems (Ahn and Fedewa, 2011; Larun et al., 2009). There is, however, little research about the potential benefits of physical activity among young people in the African culture (Bauman et al., 2012). Mental health problems are recently a major issue among adolescents in Africa, including Ghana (Abd Elhamid et al., 2009; PLC, 2010). In Ghana, there is a high expectation
by parents for their children to perform well in school. Therefore, students experiencing learning difficulties tend to manifest emotional and behavioural problems which often require psychological intervention (PLC, 2010). Adequate physical activity has a potential to improve well-being (e.g., Martinsen, 2008). However, it appears that physical activity levels in Ghanaian young people have been highly influenced by the affluent society. Previously, young people walked to school (e.g., Arthur, 2003) which enabled them to achieve desirable levels of physical activity. These days parents with high socioeconomic status drive their children to and from school. Adolescents from Ghana perceive walking to school as an indication of poverty (PLC, 2010). Therefore, those adolescents from middle to low income families who walk to school feel uncomfortable because of unfavourable social comparisons. This situation seems to have contributed to a large decrease in walking to school. Since adolescence is a time when young people become more sensitive to the social environment and are most influenced by peers (e.g., Seifert and Hoffnung, 2000; Siegler et al., 2011), adolescents whose parents do not own cars use public transportation to school.

Less participation in physical activities has become common in African young people (e.g., WHO, 2010). The health benefits of physical activity have, however, been less studied in the African culture. Another health behaviour which has longed been associated with well-being including cognitive functioning, is nutritional practice (e.g., Thompson and Manore,
2012). Studies indicate that adolescents also have poor eating habits, including skipping meals, and consuming fast foods and snacks. These behaviours could limit healthy food intake (Seifert and Hoffnung, 2000; Siegler et al., 2011; Thompson and Manore, 2012). This study is therefore designed to examine the impact of physical activity on cognitive functioning and mental health among adolescents in Ghana. Nutritional practice is also examined to determine its impact on cognitive functioning.

5.2 Study Objectives and Hypotheses

The following are the objectives with the corresponding hypotheses of the third study of this thesis:

Objective One
To examine the impact of physical activity intervention on students’ physical activity levels.

Rationale of Objective One
It has been reported that previous studies which have examined the impact of physical activity intervention on well-being have methodological limitations (Tomporowski et al., 2008). Specifically most of the studies have not used true control groups. For example, in some studies control group participants took the school usual physical education classes. Additionally, some intervention studies assessed only baseline physical activity levels of participants but not post-intervention physical activity levels (Tomporowski et al., 2008). Data on post intervention physical
activity levels is necessary, in order to determine whether the physical activity intervention significantly increased physical activity levels or not. Study 3 was therefore designed to consider these methodological limitations by recruiting control group students from schools which do not do physical education and also assessing post intervention physical activity levels. The hypothesis examined based on the first objective of study 3 was as follows:

**Hypothesis One**: There will be a significant increase in physical activity levels among students in the experimental group compared with those in the control group.

**Objective Two**

The second objective of Study 3 was to examine the impact of physical activity on cognitive functioning in African adolescents.

**Rationale of Objective Two**

Researchers have indicated that cognitive functioning involves three main components, which are executive functioning, academic achievement (school grades) and cognitive skills (e.g. attention) (Keeley and Fox, 2009). There are consistent findings that higher levels of physical activity are beneficial for academic performance and cognitive skills such as attention (Centres for Disease Control and Prevention, 2010; National Health Service, 2009). The association between physical activity and executive functioning, however, is not conclusive (Barenberg et al., 2011;
Best, 2010). Notably, research indicates that the brain continues to develop after birth until around late adolescence (Siegler et al., 2011). It has also been indicated that environmental factors could influence executive functioning (Siegler et al., 2011). On the other hand, some studies have found some association between physical activity and executive functioning, though not consistent (Barenberg et al., 2011).

Moreover, it has been mentioned that the few studies that have examined physical activity and executive functioning have used tests with many subscales to assess executive functioning which creates difficulties when comparing performance on these tests (Barenberg et al., 2011; Sibley and Etnier, 2003; Tomporowski et al., 2008). Conclusive evidence on physical activity and executive functioning is necessary for school decisions on physical education (Bailey, 2006; Sibley and Etnier, 2003). Study 3 was therefore designed as an intervention study to examine the impact of physical activity on executive functioning. While addressing the second objective, this study took into account the limitations of previous studies, by operationally defining executive functioning simply as ‘reasoning’ and also using a single standardised tool to assess this construct. The corresponding hypothesis examined was as follows:

**Hypothesis Two**: There will be a significant improvement in cognitive functioning among students who receive the physical activity intervention compared to those in the control group.
Objective Three

To examine the causal relationship between physical activity and mental well-being.

Rationale of Objective Three

The impact of physical activity on mental well-being has been examined in the Western culture (Larun et al., 2009). This is necessary because some studies suggest that mental health problems could make people less interested in participating in physical activities (e.g., Aronen, Simola, and Soininen, 2011). In order to examine the influential capacity of physical activity in the African culture, it was necessary to examine the relationship between physical activity and mental well-being with intervention studies. Review studies have also reported that there are some methodological limitations in previous studies examining physical activity and mental health (Ahn and Fedewa, 2011; Ekeland et al., 2005; Larun et al., 2009). Particularly, most of the intervention studies have not used true control groups (e.g., Larun et al., 2009). In view of these limitations, reviews have suggested the need for additional experimental studies (Ahn and Fedewa, 2011; Larun et al., 2009). In order to address the third objective, Study 3 was planned as an intervention study with improved research design to tackle the major methodological limitations in previous studies. This was accomplished by recruiting students from schools which did not do physical education. The present study examined self-esteem, one of the key mental health indicators in adolescents (e.g.,
Jones and Bradley, 2007). Therefore the following hypotheses were examined.

**Hypothesis Three:**
There will be a significant increase in physical self-worth among students in the intervention compared to those in the control group.

**Hypothesis Four:** There will be a significant reduction in body image dissatisfaction among students in the intervention compared to those in the control group.

**Objective Four:** To investigate whether nutritional practice moderates the relationship between physical activity and executive functioning.

**Rationale of Objective Four**
There is evidence that good nutritional practice is associated with enhanced cognitive functioning (e.g., Black, 2003; Hoyland et al., 2009). Moreover, over the past years, studies have shown that physical activity is significantly associated with enhanced cognitive performance including executive functioning (e.g., Castelli et al., 2011; Donnelly and Lambourne, 2011; Kim and So, 2012; Rees and Sabia, 2010). Study 3 therefore examines whether the impact of physical activity on executive functioning is dependent on nutritional practice. The hypothesis examined in correspondence to the fourth study objective was as follows:

**Hypothesis Five:** The impact of physical activity on executive functioning will show an interaction with nutritional practice.
METHODS

5.3 Research Design
The present study is a repeated measures experimental design to examine the impact of a physical activity intervention on the well-being of African adolescents. Well-being outcomes examined were executive functioning, and physical self-worth and body dissatisfaction, which are indicators of self-esteem.

5.4 Study Setting
Junior high schools were the site of data collection. The study was conducted in 3 private junior high schools in Accra, the capital city of Ghana: God’s Home Academy, Mt. Olivet Methodist Academy and Kings College International. These schools were private schools and similar in terms of their ranking on academic performance.

God’s Home Academy is situated in Dansoman, West of Accra. The school was established in 2000. It is a day school with a school size of about 1 acre. It has a compound of about 200x300 yards. The school comprises both basic and junior high schools. The total population of the junior high school (JHS) classes is 422. This school does not have PE as part of their curriculum. Mt. Olivet Methodist Academy was established in 1995 and is situated in Dansoman, West of Accra. It is a day school with a school size
of about 3 acres. It is a large school with about 300X400 yard playground. The school comprises basic and junior high schools. The total population of the JHS classes is 433. This school has PE as part of their curriculum but it was not conducted. The school was chosen to be the experimental school because the school authorities recognise PE and therefore it was easy to introduce the research to the school. Kings College International is situated in Circle, Central Accra. The school was established in 1990. It is a day school with a school size of about 1 acre. It has a compound of about 200x300 yards. The school comprises both basic and junior high school. The total population of the JHS classes is 300. This school does not have PE as part of their curriculum.

5.5 Determination of Sample Size
A sample size calculation indicated that a sample of 30 participants per group was sufficient to detect a large effect size \((d=0.8)\) for physical activity and cognitive functioning, based on a statistical power of 0.8 with a probability level of 0.05. This calculation supports the practical limitation that was encountered in the schools whereby only 60 students were likely to be available. The large effect size may be an overestimate and it is a limitation.

5.6 Sampling Technique
A combination of purposive, stratified and simple random sampling was used to select participants. Purposive sampling method was used because
participants were recruited from 3 specific private schools. Moreover, the junior high schools in Ghana comprised three academic levels of JHS one, two and three. Each academic level comprised classes A and B. The various classes were put into strata, and simple random sampling was used to recruit 30 participants from each stratum. Therefore, 90 participants were recruited from each school. The recruited participants were given an informed consent package to be signed by themselves and their parents and to be returned to the school within one week. The consent form was such that if the parents did not respond within one week it was assumed that they had agreed for their child to participate in the study.

5.7 Sample Size
The final participants of Study 3 were 60 junior high school students, with 30 participants in each of the experimental and control schools. Response rate at post intervention assessment was 97%. The number of drop outs was similar in the experimental and control groups.

5.8 Tools for Data Collection
Data collection consisted of six kinds of measurement: The following gives the areas assessed and the tools that were used to assess the constructs being investigated.

1) Assessment of eligibility for physical activity
2) Assessment of physical activity
3) Assessment of cognitive functioning
4) Assessment of self-esteem
5) Assessment of nutritional practice
6) Assessment of anthropometric characteristics

5.8.1 Assessment of Eligibility for Physical Activity

A Weighing Scale

A weighing scale, specifically a Seca scale, was used as a screening tool to measure the weight of participants in both the experimental and control groups. It was used to identify participants who were underweight and unhealthy to do moderate to vigorous physical activity (Spurr et al, 1983; Spurr et al, 1986; Spurr et al, 1988; Martins et al, 2011). The participants were measured in light clothing and bare-footed. Weight was recorded to the nearest kilogram. Using the norms of weight-for-age of Frisancho (2008), participants with weight ≤ 5th percentile were classified as underweight (see Appendix 10).

The Health Screening Questionnaire

This was used as a screening tool for health problems. It was used to find out participants who had serious health conditions and therefore inappropriate to do moderate to vigorous physical activity (ACSM, 2010). The health screening tool is a questionnaire which has a list of major
health problems including cardiovascular disease, asthma, injuries, etc. It requires parents to read through the list and tick the health problems which are applicable to their children (Appendix 9). Participants who experience any of the health conditions were screened out of moderate to vigorous physical activity (ACSM, 2010).

5.8.2 Assessment of Physical Activity

The Physical Activity Questionnaire for Older Adolescents

The Physical Activity Questionnaire for Older Adolescents (PAQ-A), developed by Kowalski et al. (2004), was used to assess physical activity. This test was chosen over other self-report physical activity questionnaires because it has been successfully used in physical activity research to examine physical activity levels among school students (Chinapaw et al., 2010) and has been positively evaluated against similar scales (Biddle et al., 2011). It is a self-reported recall questionnaire designed to measure physical activity levels among adolescents aged 13 to 19 years of age. It measures students’ physical activity in different domains during the past 7 days. It consists of 8 items which enquire about the frequency of doing particular physical activities. Respondents read each item and then rate how often they do specific physical activities by using the response options provided (see Appendix 11).
The PAQ-A has satisfactory validity for a self-report scale. It correlates significantly with scores on other well-established physical activity measures such as the 7-day Physical Activity Recall interview (PAR, \( r = 0.60 \)), and the Activity Rating questionnaire (\( r = 0.73 \)) (Kowalski et al., 1997). The PAQ-A was slightly modified to suit the African culture. Specifically, some of the games in question 1 of the PAQ-A were replaced with common traditional games in Ghana, which also involves high intensity physical activities. Only three items in question 1 were modified. It takes about 20 minutes to administer this test. The PAQ-A is scored using the scoring guide provided in the test manual (Table 3.2). The score on the PAQ-A indicates a person’s total physical activity score from the eight items, each scored on a 5-point scale. When interpreting the scores, a score of 1 indicates low physical activity and 5 indicates high physical activity.

**New lifestyles (NL)-800 Pedometer**

A pedometer was used to objectively assess ambulatory physical activity levels. It is a battery-operated electronic device that measures steps and distances when walking or running (Washburn et al., 1980). It was chosen over other objective mechanical measures of physical activity, such as the accelerometer, because the pedometer measures walking, which is the most popular form of physical activity, and is cheap to use (Welk, 2002). Brisk walking, is a form of moderate physical activity, which has been associated with physical health benefits including a
reduced risk for cardiovascular diseases, diabetes and cancer (Bouchard et al., 2012; Manson et al., 1999). Brisk walking is highly recommended by the Centers for Disease Control and Prevention and the American College of Sports Medicine (ACSM) (Pate et al., 1995).

The NL-800 was chosen over other new electronic pedometer models because it has been used in a wide range of research and has been found to have a higher validity and reliability than other pedometers (Clemes, O’Connell, Rogan and Griffiths, 2011). To use the pedometer, it is usually put on a waist belt or waistband. It has a horizontal, spring-suspended lever that moves up and down with each step the person makes. It only responds to vertical movements of the hip that occur when walking and running. It shows the accumulated steps on a digital screen.

It has been indicated that accumulating 10,000 steps a day provides substantial health benefits (Hatano, 1997). When using the pedometer in research, demonstrations are made to show participants how to wear the device. Research shows that the use of the pedometer motivates people to do physical activity. Therefore, in order to control participants’ reactivity to the pedometer, it has been suggested that participants be told that it is a body posture device (Clemes et al., 2011). The pedometer provides an accurate measure of ambulatory physical activity and it is less expensive to use than some other devices (Clemes et al., 2011).
**The Physical Activity Log**

This was used to record the time the pedometer was worn and the time it was taken off. It is a single sheet which consists of specified dates in the week, as well as a column for time (see Appendix 12).

**5.8.3 Assessment of Cognitive Functioning**

**The Standard Progressive Matrices**

The Standard Progressive Matrices (SPM), a non-verbal reasoning test (Raven, 1998) was used to assess participants’ executive functioning. Executive functioning was assessed with a non-verbal reasoning test because tests with verbal items might be influenced by respondents past learning and are not culture-free. Moreover, tests with many subscales such as the Wechsler Intelligence Scale for Children (WISC) (Wechsler, 1991) may create difficulties when comparing respondents’ performances (e.g., Siegler, 2011) because of the tendency for some respondents to score higher on some subscales than others. The Progressive matrices test was chosen over other tests to measure non-verbal reasoning because it is a single and culture-free test which assesses reasoning capabilities irrespective of respondents’ education or nationality (Raven 1998). In the present research, executive functioning was operationally defined in a simpler term of ‘reasoning’ (Raven, 1998), hence the main reason for choosing the matrices test over other cognitive tests. The Progressive Matrices test is in a form of a book which consists of 60
problems divided into Sets A, B, C, D and E. On every page in the book, a figure with a missing part is presented. Below each figure are response options of the missing parts. Respondents have to understand the meaningless figures, consider how the patterns are related in each figure, and then select the appropriate missing part to complete the figure. The problems appear simple at the beginning and become increasingly more difficult (see Appendix 18).

The Progressive Matrices have been standardised among representative samples of British people, from 6 to 65 years of age. The test has also been standardised in Ghanaian young people (Annum, 2001; Bully 1972). The test-retest reliability of the Progressive Matrices ranges from 0.83 to 0.88, which indicates a high reliability. It also correlates significantly with the Mill-Hill Vocabulary test (0.44 to 0.60). It has been found that physical or mental illness does not significantly affect the re-test reliability of the matrices (Raven, 1998). The test is suitable for comparing people regarding their capabilities for immediate observation, clear thinking and understanding. It can be used as an individual or group test. It takes 45 minutes to complete the test. A stencil marking key is used to score the test. The score on the matrices is the total number of problems the person solved correctly on the test. The total score is converted to percentile score using the norms for the Progressive Matrices. The test provides an evaluation of a person’s reasoning capability, irrespective of nationality or education (Raven, 1998).
Table 5.2.1. Interpretation Guidelines for the Standard Progressive Matrices

<table>
<thead>
<tr>
<th>Percentile</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>95th</td>
<td>Superior cognitive capacity</td>
</tr>
<tr>
<td>75th</td>
<td>Above average cognitive capacity</td>
</tr>
<tr>
<td>25th - 75th</td>
<td>Average cognitive capacity</td>
</tr>
<tr>
<td>25th</td>
<td>Below average cognitive capacity</td>
</tr>
<tr>
<td>5th</td>
<td>Defective cognitive capacity</td>
</tr>
</tbody>
</table>

5.8.4 Assessment of Self-esteem: Physical Self-Worth (PSW)

Participants’ physical self-worth was assessed using the subscale from the Physical Self-Perception Profile (PSPP; Fox and Corbin, 1989). The PSPP consists of five subscales, each containing 6 items, which measures the following domains of self-esteem: perceived competence in sports (Sport), perceived bodily attractiveness (Body), perceived physical development (Strength), perceived ability to do exercise (Condition), and overall physical self-worth (PSW). The PSPP has been widely used in physical activity research to examine the association between physical activity and self-esteem among young people (Stein, 1996). The PSW subscale was chosen instead of using the entire scale because research indicates that among adolescents evaluations about their physical self is an important element of their overall self-esteem (Harter, 1990).
The PSW scale of the PSPP is designed to assess physical self-worth; i.e., feelings of self-respect, satisfaction and confidence in the physical domain. The PSW consists of 6 items. Respondents read each item and rate how it describes themselves using the response options ranging from 1 'Not at all like me' (lowest score) to 5 'Very much like me' (highest score) (Appendix 15). The internal consistency of the PSW is between 0.6 and 0.7. It also has a high test-retest reliability (Fox and Corbin, 1989). It takes 5-10 minutes to complete this test. The test is scored by adding up the score circled for each of the 6 items. Items 2, 4 and 6 are reversed when adding up the scores. A higher score on this test indicates a high physical self-worth or related sub-domain. The PSW scale was modified from two-directional to a one-directional response options such as 1) 'Not at all like me’ to 5) ‘Very much like me’. A pilot study was conducted to ensure that participants understood the instructions on the questionnaire.

**The Body Image Silhouette test**

The Body Image Silhouette test (Stunkard et al., 1983) was used to assess body image. It was chosen because it has been found that among adolescents an evaluation about their body image is the most important determinant of their self-esteem and well-being (Seifert and Hoffnung, 2000). This test consists of 9 pictures of different human figures, ranging in body size from thin to obese. Respondents look at the pictures and then rate, on a 9-point scale, their current perceived body size and also their ideal body size. Different pictures are designed for boys and girls.
(Appendix 16). The silhouette rating scales are widely used to assess body image and body dissatisfaction in physical activity research (Hart, 2000).

The silhouette rating scales have good face validity (Hart, 2000; Thompson and Altabe, 1991; Truby and Paxton, 2002). In addition, the scales consist of visual images and therefore require less verbal skills to complete compared to other questionnaires (Truby and Paxton, 2002). It is a highly reliable scale and has been used among adults and young people (Sherman et al., 1995; Thompson and Altabe, 1991). Test-retest reliability scores range from 0.89 to 0.92 for assessment of current body image and 0.71 to 0.82 for ideal body image among males and females (Thompson and Altabe, 1991). It takes about 3 minutes to complete this test. When scoring the test, the difference between scores of the current body image and scores of the ideal body image is calculated. A high score on the Silhouette test indicates greater body dissatisfaction.

5.8.5 Assessment of Nutritional Practice: The Food Frequency Questionnaire

Nutritional practice was assessed using a Food Frequency Questionnaire (FFQ) developed by Rockett et al. (1997). The FFQ was chosen over other well established measures of nutritional practice such as the 24-hour dietary recall because it assesses dietary intake for a longer period of
time. For example, the 24-hour dietary recall measures food intake only for a single day. It is a list of food items with response options that show how often each food is consumed. The FFQ used in the present research consisted of 28 food items about the intake of carbohydrates, proteins, vitamins and minerals (Appendix 19). Respondents have to indicate, using the response options, how often each food item is eaten in the past week.

The FFQ has good validity. Correlation coefficients between the FFQ and the 24-hour dietary recall range from 0.21 to 0.58 (Rockett et al., 1997). It takes about 15 minutes to complete the questionnaire. In scoring the FFQ, a score of 7 is assigned to the response option which indicates food consumption of ‘4 or more times/day’, 6 for ‘3 times/day, 5 for ‘twice/day’ through to a score of 0 which is assigned to the response option ‘not eaten’. The score ticked for each of the food items are summed up in order to provide the total frequency of food consumed daily. A higher score on the FFQ indicates high food intake, whereas a lower score indicates less food intake.

5.8.6 Assessment of Anthropometric Characteristics

Stadiometer

A stadiometer was used to measure the height of the participants. Participants were measured bare-footed and height was taken to the nearest centimetre. Using the norms of height-for-age of Frisancho (2008)
(Appendix 10), participants with height \(\leq 5^{th}\) percentile were classified as stunted.

### 5.9 Procedure

The study procedure consisted of three stages:

1) The Screening process
2) The study assessment (data collection)
3) The Physical activity intervention

#### 5.9.1 Study Screening

Participants in both the experimental and control groups were screened on health conditions, weight status and physical activity levels. Participants who had health problems as indicated on the health screening questionnaire were excluded from the study. Moreover, the participants in both the experimental and control schools were weighed with a Seca scale in kilograms. Using the norms of weight-for-age of Frisancho (2008), subjects with weight \(\leq 5^{th}\) percentile were classified as underweight and excluded from the study. This is because it is not healthy for underweight participants to do moderate to vigorous physical activity (Spurr and Reina, 1988). The subjects’ baseline physical activity levels were assessed using the PAQ-A and the pedometer. Those who scored highly on physical activity were also excluded from the study. This is because the main purpose of the intervention was to increase physical activity among
participants who did not meet the recommended levels of physical activity. Again, using a simple random sampling method, further participants were excluded and finally 60 participants were selected to participate in the actual study. The screening procedure of study 3 is presented in Figures 5.2.1 and 5.2.2.
Recruited Participants
N=180

Participants who declined participation
n=12

Participants with health problems
n=15

Underweight participants
n=30

Physically active participants exclusion
n=35

Further exclusion (after selecting 60 participants)
n=23

Initial sample for Experimental group
n=30

Drop out
n=1

Final sample n=29

Initial sample for Control group
n=30

Drop out
n=3

Final sample n=27

**Figure 5.2.1.** Chart illustrating the recruitment of participants and the screening process for the intervention study in one school (pilot study)
Figure 5.2.2. Chart illustrating the recruitment of participants and the screening process for the intervention study in two separate schools.
5.9.2 Study Assessment

The experimental study was to determine the impact of a physical activity intervention on participants’ physical activity level, executive functioning, physical self-worth and body image. First of all, a pilot study of the experimental study was carried out in one school in order to find out if there was the need for modification of the study procedure. In the single school, where the pilot study was conducted, participants were separated into experimental and control groups. The actual experimental study, however, was conducted in two separate schools. First, baseline assessments were taken on physical activity, cognitive functioning, physical self-worth, body image and nutritional practice for both the experimental and control groups during the first week. Next, a moderate to vigorous physical activity programme was planned for the subjects in the experimental school only. Participants in the control school did not do any physical activity.

After the physical activity intervention, both the experimental and control groups did a post-test on physical activity, cognitive functioning, physical self-worth and body image in order to find out the outcome of the physical activity intervention on participants’ physical activity levels and well-being. It is important to note that the baseline and the post-intervention assessment were conducted in the morning in order to avoid the possible influence of tiredness on the cognitive test performance. It
has been suggested that cognitive tests should be administered in the morning time when students seem to have a better concentration level (Brucewalsh and Betz, 1995). During the baseline and post-test assessments, participants were comfortably seated in a classroom. They were given some brief information about the purpose of the study and what they were supposed to do. They were told that the questionnaires they would be completing were not an exam. In addition, the information they provided is solely for research purposes and that they would not be identified with the information they give. Therefore, they should be honest when responding to the questionnaires. Participants were asked to call for assistance when they do not understand anything on the questionnaires. After the introductory guidelines, the subjects were provided with pens. Then the study questionnaires on physical activity, cognitive functioning, and self-esteem were distributed.

The researcher read out the instructions of each questionnaire to the students. Research assistants were also around to assist students who needed help regarding completion of the questionnaires. The data collection lasted about 2 hours. After the students finished responding to the questionnaires, the completed questionnaires were collected. In addition, 15 participants were randomly selected from each school to wear pedometers for one week. The pedometer measurement was done in order to confirm the reported physical activity levels (via the PAQ-A) with the actual physical activity levels (via the pedometer).
Demonstrations were done to show the selected participants how to wear the pedometer. Finally, the students were thanked for responding to the questionnaires.

The Data collection procedure is presented in Figure 5.2.3.

5.9.3 Physical Activity Intervention

A moderate to vigorous physical activity programme was planned for the experimental school. Participants in the experimental school engaged in an after-school physical activity programme of two times a week for 6 weeks. The programme included skipping, jumping, running, dancing and football (see photos and Appendix 20). These participants were also given verbal persuasion to engage in physical activity in their spare time. The participants in the control school did not do any additional physical activity. Some previous physical activity studies from Western cultures have also conducted a physical activity intervention for the same duration (e.g., Boyd and Hrycaiko, 1997; Burgess et al., 2006; Duncan et al., 2009; Kang et al., 2011).
Physical Activity Intervention Programme

Physical Activity Intervention Programme
Physical Activity Intervention Programme
Table 5.2.2. Assessment Schedule of Study 3

<table>
<thead>
<tr>
<th>Time Point</th>
<th>Activity</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Screening of fitness for Physical activity</td>
<td>Health Screening Questionnaire, Weighing Scale, Frisancho (2008) Comprehensive References</td>
</tr>
<tr>
<td>2</td>
<td>Baseline Assessment</td>
<td>NL-800 pedometer, PAQ-A, Standard Progressive Matrices, Physical Self-worth questionnaire &amp; Silhouette test</td>
</tr>
<tr>
<td></td>
<td>Assessment of a Confounding factor</td>
<td>Food Frequency Questionnaire</td>
</tr>
<tr>
<td>3</td>
<td>Physical activity intervention (6 weeks)</td>
<td>Moderate to vigorous aerobic physical activities including running, skipping, football, etc., for 2 sessions a week.</td>
</tr>
<tr>
<td>4</td>
<td>Post-intervention Assessment</td>
<td>NL-800 pedometer, PAQ-A, Standard Progressive Matrices, Physical Self-worth questionnaire &amp; Silhouette test</td>
</tr>
</tbody>
</table>
5.9.4 Additional Information Based on the Pilot Study

The experimental study, Study 3, was first conducted in a single school as a pilot study in order to modify the instruments as well as the methodology in the actual research if necessary. The actual study, however, was conducted in two separate schools, one school was the experimental school and the other was the control school. Before the pilot...
study, the time allocated for the completion of the questionnaires was 1 hour 45 minutes. After the pilot study and the comments from the participants, it became necessary to increase the time for the assessment to 2 hours. Moreover, all the questionnaires were completed in English. In order to ensure that participants received similar instructions for the completion of the questionnaires, the instructions for each questionnaire was printed out and read aloud to the participants by the principal researcher only. Research assistants were around to supervise the students and also attend to participants who needed some assistance in completing the questionnaires. In each school, participants were given a 5 minutes break during the questionnaire completion time.

**Process Evaluation of Data Collection**

The data collection was successful. The school heads were grateful for the research to be conducted in their schools. The students were also co-operative. Two of the schools did not have Physical Education (PE) in their curriculum and one of the schools had PE on their curriculum but did not utilise the time for PE, therefore the physical activity intervention gave opportunity for the students to do physical activity at school. The students liked the physical activity programme and they wished that it continued as part of their curriculum.
5.10 Ethical Considerations

Ethical approval for the study was issued by Loughborough University (Appendix 21). Permission letters were sent to the school heads in order to conduct the study in the schools (Appendix 22). Moreover, informed consent was obtained from the parents and the students before data collection. To ensure confidentiality, codes were assigned to participants and these codes were used to identify participant’s responses to the questionnaires.
RESULTS

5.11 The Pilot Study

The experimental study, which was conducted in two separate schools, was initially conducted in a single school as a pilot study. The findings of the pilot study are presented in Tables 5.3.6, 5.3.7, 5.3.8, and 5.3.9. First, frequency and descriptive analyses were conducted to obtain descriptive information about participants in the experimental and control group (Table 5.3.6). Second, the one-way repeated measures ANOVA was performed to investigate the impact of the physical activity intervention on the students’ physical activity levels (Table 5.3.7). Third, the one-way repeated measures ANOVA was also performed to determine the impact of the physical activity intervention on executive functioning and mental well-being indicators of physical self-worth and body dissatisfaction (Table 5.3.8). Finally, the One-way repeated measures ANCOVA was performed to assess whether nutritional practice moderates the relationship between physical activity and cognitive functioning (Table 5.3.9) (see Appendix 4).

When assessing the impact of the physical activity intervention on the physical activity levels of the participants, the results showed that both the experimental and the control group participants had comparable levels of physical activity at baseline. At post testing however, participants in the experimental group significantly scored higher on the
PAQ-A \[F(1,54) = 590.19, p < 0.001\], and also on the pedometer \[F(1,28) = 267.03, p < 0.001\] (Table 5.3.7). When assessing the impact of the physical activity intervention on cognitive functioning, the experimental group had significantly higher scores on executive functioning than the control group \[F(1,54) = 33.89, p < 0.001\]. Moreover, the experimental group participants scored significantly higher on self-esteem than participants in the control group (Table 5.8). However, it was found that nutritional practice did not influence the impact of physical activity on cognitive functioning \[F(1, 53) = 0.00, p > 0.05\] (Table 5.3.9). Similar findings were obtained from the actual experimental study which was conducted in the two separate schools.

### 5.12 Actual Study: Sample Characteristics

In order to provide descriptive statistics for categorical and continuous variables, frequency and descriptive analyses were conducted respectively. All differences among categorical variables were analysed using Chi-square tests, and differences among continuous variables were analysed using Independent t-tests.

The demographic and anthropometric characteristics of the sample are presented in Table 5.3.1.
Table 5.3.1. Characteristics of the sample at baseline

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N= 60)</th>
<th>Intervention School (n= 30)</th>
<th>Control School (n= 30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>14.83 (1.32)</td>
<td>14.73 (1.20)</td>
<td>14.93 (1.43)</td>
<td>0.56</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>155.08 (7.06)</td>
<td>155.63 (7.58)</td>
<td>154.23 (6.51)</td>
<td>0.36</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>57.70 (9.04)</td>
<td>57.87 (8.29)</td>
<td>57.53 (9.87)</td>
<td>0.88</td>
</tr>
<tr>
<td>BMI</td>
<td>24.19 (3.14)</td>
<td>23.91 (3.16)</td>
<td>24.47 (3.15)</td>
<td>0.50</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td>F (%)</td>
<td>F (%)</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>27 (45.0%)</td>
<td>12 (40.0%)</td>
<td>15 (50.0%)</td>
<td>0.44</td>
</tr>
<tr>
<td>Females</td>
<td>33 (55.0%)</td>
<td>18 (60.0%)</td>
<td>15 (50.0%)</td>
<td>0.44</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS 1</td>
<td>19 (31.7%)</td>
<td>10 (33.3%)</td>
<td>9 (30.0%)</td>
<td>0.95</td>
</tr>
<tr>
<td>JHS 2</td>
<td>25 (41.7%)</td>
<td>12 (40.0%)</td>
<td>13 (43.3%)</td>
<td>0.95</td>
</tr>
<tr>
<td>JHS 3</td>
<td>16 (26.7%)</td>
<td>8 (26.7%)</td>
<td>8 (26.7%)</td>
<td>0.95</td>
</tr>
<tr>
<td>Height Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (≥ 5.0 percentile)</td>
<td>49 (81.7%)</td>
<td>25 (83.3%)</td>
<td>24 (80.0%)</td>
<td>0.74</td>
</tr>
<tr>
<td>Stunted (&lt; 5.0 percentile)</td>
<td>11 (18.3%)</td>
<td>5 (16.7%)</td>
<td>6 (20.0%)</td>
<td>0.74</td>
</tr>
<tr>
<td>Weight Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (&lt;25kg/m²)</td>
<td>35 (58.3%)</td>
<td>20 (66.67%)</td>
<td>15 (50.0%)</td>
<td>0.34</td>
</tr>
<tr>
<td>Overweight (&gt;25kg/m² ≤30kg/m²)</td>
<td>18 (30.0%)</td>
<td>8 (26.67%)</td>
<td>10 (33.33%)</td>
<td>0.34</td>
</tr>
<tr>
<td>Obese (&gt;30kg/m²)</td>
<td>7 (11.7%)</td>
<td>2 (6.67%)</td>
<td>5 (16.67%)</td>
<td>0.34</td>
</tr>
</tbody>
</table>

A total of 60 students who met the study’s inclusion criteria participated in the study. These students were recruited from two private schools in the city of Accra, Ghana. At baseline, the mean age of the participants...
was 14.83 (1.32) years, which ranged from 13 to 18 years. Of the entire sample 55.0% were females. With regards to stature, 18.3% of the participants were stunted. Regarding the weight of the participants, the average BMI (24.19 kg/m²) was within the normal range. However, nearly half of these participants were overweight (30.0%) or obese (11.7%). There were no significant differences between participants in the experimental and control groups at baseline ($p>0.05$). Fifty eight (97%) participants took part in the post-testing.

5.13 The Impact of Physical Activity Intervention on Physical Activity Levels

This study firstly examined whether the physical activity intervention had an influence on the participants’ physical activity levels. The hypothesis examined in accordance with this objective was as follows:

**Hypothesis One:** There will be a significant increase in physical activity levels among students in the experimental group compared with those in the control group.

**Statistical Analysis**

The one-way repeated measures ANOVA was used to examine the difference between baseline physical activity levels and post-intervention physical activity levels of both the experimental and control participants.
Results

The results of the first hypothesis are presented in Tables 5.3.2.

Table 5.3.2. One-way repeated measures ANOVA results for levels of physical activity on the PAQ-A and the pedometer

<table>
<thead>
<tr>
<th>Physical Activity Levels</th>
<th>Time point</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAQ-A</td>
<td>1</td>
<td>1.40 (0.43)</td>
<td>1.42 (0.49)</td>
<td>481.42</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.66 (0.48)</td>
<td>1.56 (0.58)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedometer</td>
<td>1</td>
<td>3187.40 (683.32)</td>
<td>3006.73 (620.50)</td>
<td>368.34</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>12001.67 (1556.68)</td>
<td>3643.07 (494.54)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

From Table 5.3.2 both the experimental and the control group had similar levels of physical activity at baseline [1.40 (0.43); 1.42 (0.49), respectively]. At post intervention, however the experimental group scored higher on self-reported physical activity (PAQ-A) than the control group [4.66(0.48); 1.56 (0.58)]. The repeated measures ANOVA showed that the observed difference in physical activity scores from baseline to post intervention was significant \[F(1, 56) = 481.42, p< 0.001\]. In addition, a subgroup (n=30) of the participants was selected to wear pedometer in order to assess the participants’ actual physical activity...
levels. From the means and standard deviations (Table 5.3.2), participants in the experimental group obtained higher scores on the pedometer at post-testing than participants in the control group. Again, the observed difference in physical activity levels between participants was statistically significant \( F(1, 28) = 368.34, p < 0.001 \). The results indicated that physical activity was significantly influenced by the physical activity intervention, thus supporting hypothesis one.

### 5.14 The Impact of Physical Activity on Executive Functioning

It has been mentioned that researchers investigating executive functioning have used tests with too many subscales to measure the construct (Tomporowski et al., 2008), due to the complex way they had operationally defined executive functioning. Therefore, the second objective of this study was to examine the impact of the physical activity intervention on performance of a standardised cognitive test.

**Hypothesis Two:** There will be a significant improvement in cognitive functioning among students who receive the physical activity intervention compared to those in the control group.

**Statistical Analysis**

To investigate the influence of the physical activity intervention on cognitive functioning, one-way repeated measures ANOVA was performed to determine whether there were significant differences in scores between
participants in the experimental group and those in the control group on the Progressive Matrices cognitive test at post-test.

**Results**

The results of hypothesis two are presented in Table 5.3.3.

**Table 5.3.3.** One-way repeated measures ANOVA results for cognitive functioning

<table>
<thead>
<tr>
<th>Group</th>
<th>Baseline M (SD)</th>
<th>Post Intervention M (SD)</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>33.83 (10.54)</td>
<td>44.52 (8.88)</td>
<td>34.77</td>
<td>0.000*</td>
</tr>
<tr>
<td>Control</td>
<td>34.03 (9.48)</td>
<td>32.62 (9.58)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

As shown in Table 5.3.3, the mean scores showed that the experimental and control group had similar performance on the matrices test at baseline. However, at post-test, the experimental group participants obtained increased scores on the cognitive test compared with those in the control group. Results from the repeated measures ANOVA showed that the increase in the matrices test scores of the experimental group participants was significant \(F(1, 56) =34.77, p< 0.001\]. The findings indicated that the physical activity intervention had an impact on participants’ reasoning capability, hence supporting the second hypothesis.
5.15 The Impact of Physical Activity on Mental Well-being

Researchers have mentioned that further studies are needed to strengthen the evidence base which indicates that physical activity would benefit adolescents with mental health difficulties (e.g. Larun et al., 2009; Martinsen, 2008). It was therefore the objective of this study to examine the causal relationship between physical activity and mental well-being in African adolescents. Self-esteem, one of the common mental health issues among adolescents (Comer, 2007) was examined. The hypothesis examined with respect to this objective was as follows:

**Hypothesis Three:** There will be a significant increase in physical self-worth among students in the intervention compared to those in the control group.

**Hypothesis Four:** There will be a significant reduction in body image dissatisfaction among students in the intervention compared to those in the control group.

**Statistical Analyses**

In order to examine whether the physical activity intervention had an influence on self-esteem, the one-way repeated measures ANOVA was performed for each of the indicators of self-esteem.

**Results**

Relevant information about hypotheses three and four are presented in Table 5.3.4.
Table 5.3.4. One-way repeated measures ANOVA results for physical self-worth and body dissatisfaction

<table>
<thead>
<tr>
<th>Self-esteem category</th>
<th>Time point</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Self-worth</td>
<td>1</td>
<td>15.66 (4.30)</td>
<td>17.86 (4.88)</td>
<td>39.75</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24.59 (4.13)</td>
<td>17.55 (2.94)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body dissatisfaction</td>
<td>1</td>
<td>2.14 (1.13)</td>
<td>2.10 (1.15)</td>
<td>21.48</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.48 (0.78)</td>
<td>2.31 (1.11)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

From Table 5.3.4, the mean scores showed that the experimental and control group were comparable at baseline on physical self-worth. The post intervention means showed that the experimental group scored higher on physical self-worth than the control group. The repeated measures ANOVA showed that the difference observed between the two groups at post intervention was significant \([F(1,56) =39.75, p<0.001]\). Therefore physical activity had a significant positive impact on physical self-worth, which supports hypothesis three.

Regarding results on the body image test, (Table 5.3.4), the mean scores at baseline revealed that the experimental and control group had similar scores on body dissatisfaction. However, the mean scores at post intervention showed that participants in the experimental group had a decrease in scores on the body image scale (which indicates less body
dissatisfaction) than the control group. The repeated measures analysis of variance showed that the observed difference between the experimental and control group at post intervention was significant $F(1, 56) =21.48, p <0.001]$. Physical activity had a significant impact on the reduction of body dissatisfaction, thus supporting hypothesis four.

5.16 The Impact of Physical Activity and Nutritional Practice on Executive Functioning

There is some evidence that physical activity is associated with executive functioning, although research has generally reported inconsistent findings. However, there is some support for findings that physical activity improves academic performance and cognitive skills such as concentration, attention and processing speed in performing cognitive tasks (Centers for Disease Control and Prevention, 2010; Ramstetter et al., 2010; Rasberry et al., 2011). On the other hand, good nutritional practice is also a health behaviour which has been linked to improved cognitive performance (e.g. Black, 2003; Hoyland et al., 2009; Kim et al., 2010). It was therefore the fifth objective of this study to explore whether the impact of physical activity on executive functioning is dependent on nutritional practice. The hypothesis investigated according to this objective was as follows:

**Hypothesis Five:** The impact of physical activity on executive functioning will show an interaction with nutritional practice.
**Statistical Analysis**

In order to investigate whether the relationship between physical activity and executive functioning is moderated by nutritional practice, the one-way repeated measures ANCOVA was performed to control for nutritional practice.

**Results of Hypothesis Five**

The relevant information about the fifth hypothesis is presented in Table 5.3.5.

**Table 5.3.5.** One-way repeated measures ANCOVA results for physical activity, nutritional practice and cognitive functioning

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time point</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
</tr>
<tr>
<td>Physical Activity</td>
<td>1</td>
<td>33.83 (10.54)</td>
<td>34.03 (9.48)</td>
<td>5.07</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>44.52 (8.88)</td>
<td>32.62 (9.58)</td>
<td></td>
</tr>
<tr>
<td>Nutritional Practice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ANCOVA: adjusted for nutritional practice.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05

As shown in Table 5.3.5, the experimental group had significantly higher scores on cognitive functioning than the control group at post intervention, even when nutritional practice was put in the model as a covariate (*p<0.05*). The results, however, showed that nutritional practice was not
significantly associated with performance on the executive functioning test \(F(1, 55) =0.20, p> 0.05\]. The findings indicated that when nutritional practice was controlled for, physical activity still had a significant positive impact on cognitive performance. Therefore hypothesis five was not supported.

### 5.17 Summary of Results

- Physical activity intervention had a significant positive impact on cognitive functioning.

- Physical activity intervention had a significant positive impact on aspects of self-esteem.

### 5.18 Discussion

The present study found that physical activity had a significant positive impact on cognitive functioning and mental health of young people. This finding is consistent with studies conducted among Western young people, which indicated that physical activity is associated with good mental health (e.g., Boyd and Hrycaiko, 1997; Burgess et al., 2006; Haugen et al., 2011; Kirkcaldy et al., 2002; Schmalz et al., 2007; Tremblay et al., 2000). Specifically, participants who took part in the physical activity intervention experienced enhancement in cognitive functioning and self-esteem compared to those who did not do physical activity. This finding
indicates that physical activity improves mental health. Research indicates that self-esteem problems are strongly associated with depression (Battle, 1980; Comer, 2007). Therefore, there is the possibility that students who participated in physical activity experienced a reduction in depression symptoms which in turn enhanced self-esteem compared to the students in the control group who did not take part in physical activity.

With regards to cognitive functioning, students who participated in the physical activity intervention significantly improved in their reasoning capabilities compared to those who did not do physical activity. This finding contributes to the physical activity literature by assisting to make the association between physical activity and executive functioning clearer. This is because there have been inconsistent findings on the association between physical activity and executive functioning (e.g., Best, 2010; Tomporowski et al., 2008). This study based on experimental design is supported by some studies from Western cultures which have also found that physical activity has a significant positive impact on executive functioning in young people (Castelli et al., 2011; Roebroeck et al., 2006; Ruiz et al., 2010). However, this finding contradicts with previous studies which have found no association between physical activity and executive functioning (e.g. Davis et al., 2007; Martinez-Gomez et al., 2011). The reason for the present finding seems to be that the present study utilised an experimental design to minimise some of the extraneous factors which are associated with non-experimental studies. This study also assessed
executive functioning simply as reasoning capabilities and therefore used a simple tool to assess executive functioning.

Moreover, the reason for the present results is possibly due to the fact that prior to the physical activity intervention, both the experimental and control group students might be experiencing some symptoms of depression which inhibited their cognitive capabilities. Research studies indicate that depression affects cognitive performance (Asare, 2003; Emerson et al., 2005; Heiligenstein and Guenther, 1996). Goldney et al. (2010) also reported that even subclinical levels of depression have a significant negative impact on productivity. After the physical activity intervention, the students who participated in physical activity (the experimental group) seem to have experienced reduction in depressive symptoms, which manifested in their improvement in cognitive functioning as well as improvement in their low self-esteem. Probably, the students in the control group, however, continued to manifest depressive symptoms which inhibited their cognitive performance as well as their self-esteem.

On the contrary, when utilising the results of the present study, it should be considered that the schools from which participants were recruited were not randomly selected to the experimental and control conditions. A specific school was used as the experimental school as a result of the
schools receptiveness to the physical activity intervention. Moreover, the test utilised to assess executive functioning was a non-verbal cognitive test, which measures spatial skills. Therefore the improvement observed on executive functioning can only be specified to spatial skills but not verbal skills. In summary, the present findings indicate that physical activity is associated with improved reasoning capabilities. This suggests that physical activity is beneficial for young people who are still developing in executive functioning (Siegler et al., 2011). More importantly, the present findings assist to make the evidence base of the association between physical activity and executive functioning clearer. This finding is helpful for schools in making decisions about school physical education programs for students. It has been clearly demonstrated that physical activity improves cognitive functioning and mental health. The finding however, is mainly generalizable to students from upper class schools in Ghana.
CHAPTER 6
OVERALL DISCUSSION

6.1 Overview

Chapter 6 provides thorough interpretation of the results obtained from the three studies conducted in this thesis. These results are explained in relation to previous research in physical activity, sedentary behaviour and well-being among young people. After the introduction, the chapter consists of the following sections:

Section 6.2: ‘Findings of the Research’ presents the findings of the studies conducted in this thesis in relation to previous studies.

Section 6.3: ‘Conclusions’ provides the summary of the main findings in the research thesis.

Section 6.4: ‘Implications of Findings’ provides the major findings that are important for public health and education.

Section 6.5: ‘Strengths and Limitations’ presents the unique attributes and the weaknesses associated with the studies conducted in this thesis.

6.6: ‘Considerations for Future Research’ outlines identified areas which need further research.
6.2 Introduction

The main purpose of this thesis was to broaden current literature showing the associations between physical activity, sedentary behaviour and well-being in 13 to 18 year olds; more specifically, in the African culture where currently research is limited. This thesis presents the first research to investigate sedentary behaviour, which seems to be an increasing problem in Africa, and its association with mental well-being among African adolescents.

6.3 Main Findings

The findings of these studies are explained in accordance with the main objectives of the entire research thesis.

Objective One: To examine the association between physical activity and cognitive functioning among African youth.

The present research found that physical activity has an impact on executive functioning. The results obtained from study 3 showed that students from the experimental school, who participated in the physical activity intervention, had significant improvement in their scores on the Progressive Matrices test at post-test than the students in the control school who did not engage in physical activity. This finding indicates that there is a significant positive association between physical activity and executive functioning. Though previous systematic reviews (e.g. Barenberg et al, 2011; Best, 2010) have reported that the relationship
between physical activity and executive functioning is not conclusive, the present finding is supported by some studies which found that physical activity is significantly associated with improvement in executive functioning (Castelli et al., 2011; Gapin et al., 2010; Roebroeck et al., 2006; Ruiz et al., 2010). In addition, the studies which did not find an entire association between physical activity and executive functioning reported findings which partially support the present research. Davis et al. (2011) reported that students who did physical activity significantly performed better on the planning subscale of a cognitive test. In addition, the brain activity of these students also changed after participation in the physical activity programme. Fisher et al. (2011) also found that students who participated in a physical activity intervention had better performance in one of the two cognitive tests.

It is important to note that the very few studies which found an association between physical activity and executive functioning (Castelli et al., 2011; Gapin et al., 2010) seem to utilise a simple test to assess executive functioning, similar to the present research. This suggests that the inconsistent associations between physical activity and executive functioning in the current literature might be due to the complex tests previous researchers have used to measure executive functioning. For example, Tomporowski et al. (2008) noted that studies investigating physical activity and executive functioning have used too many different tests to assess executive functioning. Generally, the fact that previous
studies assessing physical activity and executive functioning have reported some associations implies that there is a link between physical activity and executive functioning, which has been confirmed by this research. In comparing the present findings to physical activity studies which have examined other components of cognitive functioning, such as academic performance and cognitive skills, it establishes evidence that physical activity is associated with overall cognitive functioning. Perhaps physical activity helps to improve the capability to reason (as it has been found in the present research), and increases attention and concentration (Kang et al., 2011; Verret et al., 2012) which helps in learning and eventually leading to better academic performance among students (Balyer and Gunduz, 2012; Donnelly and Lambourne, 2011; Dwyer et al., 2001; Ruiz et al., 2010; So, 2012; Telford et al., 2012).

Moreover, because it has been established that inadequate intake of micronutrients could impair cognitive functioning (e.g., Hoyland et al., 2009), the present research investigated whether the association between physical activity and executive functioning was dependent on nutritional practice. However, the results from Study 3 showed that the positive relationship between physical activity and executive functioning was not dependent on the participants’ nutritional practice. This finding suggests that perhaps, among adolescents, physical activity influences executive functioning more than their dietary habits. The non-significant association between nutritional practice and executive functioning could be because
the present study did not examine the intake of specific micronutrients. For example, a systematic review conducted by Black (2003) concluded that deficiency in iron and Vitamin B-12 affects academic performance more than other nutrients. Kim et al. (2010) also found that frequency of fish intake is associated with students’ academic performance. However, the present research measured the quantity of nutrients intake including macronutrients. Therefore it did not show whether some of the students had deficiencies in specific micronutrient (e.g., iron) which mainly affect cognitive functioning (Black et al., 2003).

In summary, in addressing the first objective of the present thesis, it has been found that physical activity has a significant positive impact on executive functioning. This finding contributes to the physical activity literature by clarifying the unclear association between physical activity and executive functioning among young people. Moreover, it has been demonstrated that physical activity is also beneficial for the enhancement in cognitive functioning among adolescents from Africa, hence providing evidence from the African culture.

**Objective Two:** To examine the association between physical activity and mental health among African youth.

The present research found that a high level of physical activity is significantly associated with good mental well-being among adolescents,
independent of their sedentary behaviour. Specifically, the cross-sectional study (Study 2) in this thesis showed that participants who reported lower levels of physical activity were more likely to have higher depression than those who reported higher levels of physical activity. Furthermore, the results from the intervention study (Study 3) confirmed the cross-sectional findings in that students who did physical activity for 6 weeks significantly experienced enhanced self-esteem at post-testing.

The present findings are therefore consistent with previous studies which have found that physical activity is significantly associated with low depressive symptoms (e.g., Adeniyi et al., 2011; Kirkcaldy et al., 2002; Raudsepp and Neissaar, 2012; Stavrakakis et al., 2012; Sund et al., 2011) and higher self-esteem (Altintaş et al., 2008; Boyd et al., 1997; Breslin et al., 2012; Goldfield et al., 2011; Haugen et al., 2011; Kelly et al., 2011; Schmalz et al., 2007; Tremblay et al., 2000). Again, the findings in this thesis are supported by review studies which have reported that physical activity is significantly associated with lower depression (Ahn et al., 2011; Calfas et al., 1994; Craft et al., 1998; Farb et al., 2012; Johnson et al., 2011; Larun et al., 2009; North et al., 1990) and higher self-esteem (Ahn et al., 2011; Calfas et al., 1994; Ekeland et al., 2005; Farb et al., 2012; Gruber, 1986; Lubans et al., 2012; Rasberry et al., 2011; Shin et al., 2012; Trudeau et al., 2008) among young people. For example, in systematic reviews, Larun et al. (2009) reported a moderate effect size ($ES = -0.66$) for the relationship between physical activity and depression.
in young people and Ahn et al. (2011) reported an effect size of 0.57 for the relationship between physical activity and self-esteem in this age group.

As part of the research objectives, it was examined whether the association between physical activity and mental well-being in African adolescents is dependent on parenting style. This is because studies (e.g. Richter and Dawes, 2008) have indicated that authoritarian parenting style, which is associated with depression in young people, is more prevalent in the African culture. However, the present research found that there was no association between authoritarian parenting style and depression. This finding contradicts with previous studies (Goldstein et al., 2000; Kaslow et al., 1994; Xia et al., 2001). There are some possible explanations for the present findings. First, this finding in the thesis seems to be in line with some studies from non-Western cultures, which also found no association between parenting style and mental well-being in adolescents (Dwairy et al., 2006; Lavasani et al., 2011). Dwairy et al. (2006) reported that authoritarian parenting style was not associated with depression in Egyptian adolescents and therefore suggested that perhaps authoritarian parenting does not affect children living in authoritarian cultures.

Interestingly, these studies that did not find an association between parenting style and depression happen to be conducted in countries were
authoritarian parenting style is common. Based on Dwairy et al.’s (2006) suggestion, it is possible that African adolescents have become used to the controlling style of parenting, and therefore it no longer has significant negative impact on their emotions. For example, in Ghana, parents are perceived as authority figures who should take decisions for children. Therefore, adolescents from Africa might be less likely to be affected by authoritarian parenting style (Dwairy et al., 2006). A second possible explanation for the present finding is that adolescence is a stage where children detach their emotions from their parents and seek emotional support from people outside the family, especially their peers (e.g., Siegler et al., 2011). Therefore, the way their parents interact with them might be less likely to affect their mental health since these adolescents depend less on the emotional support from their parents. For example, in a meta-analysis, McLeod et al. (2007) found that the association between parenting style and mental well-being among adolescents is very small. Therefore, this might also explain why an association was not determined between parenting style and depression in the present research.

In addressing the second objective, the research from this thesis indicates that participation in physical activity improves the mental well-being of adolescents. The finding from the experimental study (Study 3) which was consistent with the cross-sectional findings (Study 2) in this thesis strengthens the evidence that physical activity is significantly associated
with good mental well-being. Therefore the present research contributes to the physical activity literature by providing evidence for the impact of physical activity on mental health among youth in the African culture. Based on this finding, it is now recognized that physical activity has a significant positive impact among Western and African youth.

**Objective Three:** To examine sedentary behaviour in Africa and a possible contributing factor of sedentary behaviour among youth in the African culture.

The present research (Study 2) found that a large proportion of Ghanaian adolescents (54%) engaged in high sedentary behaviour. This rate of sedentary behaviour identified among Ghanaian adolescents seems to be significant and becoming similar to the situation in the Western cultures (e.g., Elgar et al., 2005; Hallal et al., 2012; Vasques et al., 2012). Vasques et al. (2012) reported that about 88% of Portuguese youth are highly sedentary. It has also been found that UK youth spend about 420-460 minutes per day in sedentary activities (Department of Health, 2010).

The present research is the first to examine the prevalence of sedentary behaviour in African adolescents. It appears that in Ghana, adolescents’ sedentary behaviour is largely in the use of computer and internet. For example, the average use of computers during the weekend was 7.09 hour/day versus 6.41 hour/day for boys and girls respectively. This finding is very worrying because studies from Western and Eastern cultures (e.g., Ha et al., 2007; Odaci and Kalkan, 2010) have reported
that students who use computers or the internet for 6 hours or more per day are more likely to be suffering from internet addiction. Thus, there is the likelihood that some of these Ghanaian adolescents might be experiencing internet addiction, which is also a significant psychological problem that could interfere with their studies.

It is important to note that in the Western cultures it has been found that socio-economic status is not generally associated with high sedentary behaviour among young people (Pate et al., 2011; Van der Horst et al., 2007). However, research shows that the weather contributes to sedentary behaviours in young people (Bélanger et al., 2009; Tucker and Gilliland, 2007). Particularly, it has been found that during the cold winter season, children and adolescents do not engage in many outside activities, but are more likely to remain indoors which increases their sedentary behaviour compared to the summer season. However in Africa, the weather is hot so until quite recently, children and adolescents engaged more in outdoor activities, thus reducing the likelihood of being sedentary. However, with the introduction of screen entertainment devices from the Western culture to the African culture (e.g., Bauman et al., 2012), sedentary behaviour has now become a problem in young people in Africa, mainly because children who used to be outdoors have become fascinated with the use of screen-devices and therefore remain indoors to use them.
It is also important to mention that in Africa, and particularly in Ghana, not all the young people have access to these screen devices because they are not manufactured in Africa and therefore they are expensive to acquire. A section of young people in Ghana seems to have easy access to these screen devices. These are children and adolescents from affluent homes, whose parents buy electronic devices for them. In Ghana, the young people from affluent homes are likely to attend private schools whereas those from middle to low income families go to the public schools. Concerning, the students in public schools, their parents cannot generally afford to buy them screen devices, so they may continue with outdoor games. The research in this thesis therefore examined the prevalence of sedentary behaviour in public and private schools in Ghana. The results from the cross-sectional study (study 2) showed that students who attended the private school scored significantly higher on sedentary behaviour than students from the public school. Again, in examining the backgrounds of adolescents from the public and private school, it was confirmed that the majority of adolescents from the private school came from high socio-economic backgrounds compared to students from the public school. This finding indicates that affluence is a likely major determinant of sedentary behaviour among youth in Ghana.

Furthermore, to assess the impact of sedentary behaviour in public and private schools, the finding showed that students in the private school reported significantly higher depressive symptoms and low self-esteem
problems than students in the public school. Putting these findings together, it establishes evidence that affluence is a contributing factor for sedentary behaviours in African adolescents. The fact that mental health problems were higher among students from affluent homes, who were more sedentary, again confirms previous findings that sedentary behaviour is significantly associated with mental health problems among youth (Primack et al., 2009; Sund et al., 2011; Ussher et al., 2007).

In summary, in addressing the third objective of the research in this thesis, it has been demonstrated that affluence is a determinant of high sedentary behaviour among adolescents in Africa and as a result mental health problems are highly prevalent among these adolescents from high socioeconomic backgrounds. This finding provides new evidence to the existing sedentary behaviour literature, which would facilitate comparisons about the contributing factors of increased sedentary behaviour among adolescents in Western and African cultures. Based on the finding of this thesis, there is now an evidence that whereas the weather has been determined as a major contributing factor of sedentary behaviour among Western young people (e.g., Bélanger et al., 2009), in the African culture, affluence appears to be a key determinant of sedentary behaviour among young people. This is because in the Western culture, the cold weather makes adolescents stay indoors, therefore increasing their likelihood of being sedentary including excessive use of screen devices. Similarly in the African culture, adolescents from affluent
homes have screen devices at home which make them stay indoors to use these devices.

**Objective Four**: To examine the association between sedentary behaviour and mental health among adolescents in the African culture.

The research in this thesis (Study 2) found that sedentary behaviour was positively associated with depression independent of physical activity levels. Specifically, the finding showed that students who were more sedentary significantly reported higher depression than those who were less sedentary, irrespective of their physical activity levels. This finding is consistent with recent studies from Western cultures that have found that sedentary behaviour is significantly associated with mental health problems in children and adolescents (Cao et al., 2011; Chen et al., 2005; Dumith et al., 2010; Durkin & Barber, 2002; Ha et al., 2007; Holder et al., 2009; Katon et al., 2010; Mathers et al., 2009; Russ et al., 2009; Schmitz et al., 2002; Ybarra et al., 2005). Researchers using longitudinal designs (Primack et al., 2009; Sund et al., 2011; Van et al., 2008) have also found that sedentary behaviour was associated with higher depressive symptoms in young people. Again, this present finding is partially supported by some studies which have found a weak association between sedentary behaviour and mental well-being (e.g., Colwell and Payne, 2000; Griffiths et al., 2010) but is contradictory to a few studies (Fling et al., 1992; Selfhout et al., 2009) that did not find an association between sedentary behaviour and mental well-being. Generally, the
present result in this thesis is consistent with studies that have found that sedentary behaviour is a lifestyle that negatively affects mental health, independent of physical activity levels (Hamer et al., 2009; Iannotti, Jassen, et al., 2009; Ussher et al., 2007).

However, in examining whether the association between sedentary behaviour and depression in adolescents interacts with parenting style, it was found that parenting style was not associated with depression. This suggests that sedentary behaviour is more strongly associated with depression in Ghanaian adolescents than parenting style. In summary, in addressing the fourth objective of this thesis, the present research has found that there is a high (54%) prevalence of sedentary behaviour among African adolescents, and this behaviour is significantly associated with mental health problems among adolescents in the African culture. Based on the present finding, there is now evidence that sedentary behaviour has a significant negative impact on mental well-being among African adolescents as well as adolescents from the Western cultures. Prior to the present thesis, there was no evidence about the prevalence of sedentary behaviour among youth in Africa and its impact on their mental health.

**Objective Five:** To determine the effect size for the association between sedentary behaviour and mental health in young people.
The results from the meta-analysis shows that a high level of sedentary behaviour is significantly associated with mental health problems including depression, low self-esteem, anxiety, poor quality of life and life dissatisfaction among young people. Sedentary behaviour was more strongly associated with depression than other mental health outcomes. The results obtained from this meta-analysis, despite the small effect size, are consistent with findings of a recent systematic review by Tremblay et al. (2011), who reported that sedentary behaviour is significantly associated with poor mental health in young people. In addition, the findings from the meta-analysis is consistent with a previous meta-analysis in adults which shows that sedentary behaviour is significantly associated with mental health problems (Teychenne et al., 2010).

The small effect size determined between sedentary behaviour and mental well-being could be largely due to methodological limitations in previous studies that have examined sedentary behaviour (Pate et al., 2011). Specifically investigations into sedentary behaviour started quite recently, and therefore limited tools are available for the measurement of this behaviour (e.g., Hallal et al., 2012). For this reason, the majority of the studies in the field of sedentary behaviour have not assessed all sedentary behaviours, nor included all contexts. Most of the studies on sedentary behaviour have only examined screen-based sedentary behaviour and even with that validated tools have often not been used to measure screen use (Pate et al., 2011). Such measurement imprecision
might account for a suppression of real effects. However, the present sedentary behaviour meta-analysis in this thesis provides additional evidence to the sedentary behaviour literature, as it is the first meta-analysis on young people that examined sedentary behaviour and mental well-being.

**Additional Findings**

The present research (Study 2) discovered that a significant number of adolescents in Ghana (44%) do not do much moderate to vigorous levels of physical activity. The results obtained from the intervention study (Study 3) also confirmed the inadequate physical activity levels among Ghanaian adolescents. Specifically, prior to the physical activity intervention, findings from the baseline assessment showed that these adolescents were doing an average of 3,000 steps a day which was significantly below the recommended 10,000 steps a day specified in guidelines. Therefore, it was not surprising that a significant number of these adolescents who participated in the intervention study (42%) were overweight. This finding seems to be consistent with the pattern of physical activity participation identified among adolescents in Western cultures. Studies show that about half of adolescents do not meet the recommended physical activity levels (Iannotti and Wang, 2013; Pearson et al., 2009; Saxena et al., 2002). More recently, Iannotti and Wang (2013) found that 47% of adolescents in the United States do not do adequate physical activity.
6.4 Conclusion

The present research shows that physical activity has a significant positive impact on executive functioning and mental well-being. To date, the association between physical activity and executive functioning is unclear. Therefore, the current findings clarify the benefits of physical activity on executive functioning. Moreover, the present research has found that sedentary behaviour is highly prevalent among African adolescents especially among adolescents from affluent homes. Sedentary behaviour is significantly associated with mental health problems among African youth, which is consistent with reports from studies among Western young people. The present research, therefore, contributes new information to the existing literature. Firstly, this research clarifies the association between physical activity and executive functioning which was unclear in the existing literature.

Secondly, the research in this thesis is the first to investigate the impact of sedentary behaviour among youth in the African culture. Actually, sedentary behaviour is a new lifestyle among adolescents in Africa, however, there was no information about its impact on their well-being as well as the main contributing factors to sedentary behaviour among youth in Africa. This research is the first to determine that affluence is a key determinant of sedentary behaviour among youth in the African culture. Therefore, with this finding, the new evidence now has comparable information that shows that whereas the weather is a contributing factor
of increased sedentary behaviour among youth in the Western cultures (e.g., Bélanger et al., 2009), affluence is a key contributing factor of sedentary behaviour in African youth. Finally the present research, in analysing the findings from previous studies, found that sedentary behaviour is significantly associated with mental health problems in young people. This is the first meta-analysis on sedentary behaviour and mental well-being that focused on young people.

6.5 Implications for Healthcare

The findings from the present research contribute to the existing evidence which indicates that physical activity and sedentary behaviour are associated with mental health in young people. The following are some key issues arising from the research findings which are relevant for policy makers and centres promoting young people’s well-being:

1. Low physical activity and increasing sedentary behaviour now seems to be a significant problem in Africa. The research in this thesis shows that a large proportion of adolescents do not do moderate to high levels of physical activity. There is also a high prevalence of sedentary behaviour among youth in Africa. Therefore, the government and public health agencies need to include physical activity and sedentary behaviours in their agenda when promoting health among young people. School physical education, which is an important subject that would expose students to physical activity,
should be well structured. However, it has been found that there is a lack of trained teachers in Ghana to teach physical education (Pühse & Gerber, 2005). Specifically, physical education teachers in Ghana do not have adequate expertise to teach the theoretical aspect of physical education which would broaden the students’ knowledge about the importance of engaging in sufficient physical activity levels for their health (Pühse and Gerber, 2005).

Based on the findings of the research in this thesis, which indicate that physical activity enhances learning, the Ghanaian government needs to invest more in physical education in schools. This can be achieved by organising professional training for the physical education teachers to equip them with adequate knowledge. Again trained teachers with physical activity and health qualifications should be employed to teach effectively. When these adolescents are given adequate knowledge about the importance of active lifestyles, they may not for example perceive walking to school as an activity for poor people.

2. The findings of the present research indicate that participants who did physical activity had significant improvement in their self-esteem. Perhaps self-esteem was lower as a result of depression (Battle, 1980; Comer, 2007; Siegler et al., 2011) prior to the physical activity intervention. The improvement in self-esteem after the physical activity intervention again suggests that the physical
activity intervention was helpful in reducing depression among students who did physical activity. This resulted to improvement in self-esteem among these students. This finding confirms research which indicates that physical activity reduces the impact of stress on well-being (Sigfusdottir et al., 2011; Sund et al., 2011). It is important to note that in 2011, a new definition of health was introduced in which well-being is described as the ‘ability to cope with illness or stress’ (Huber et al., 2011), instead of the prevailing WHO definition of health which described health as ‘being free from physical, psychological and social stresses’ (WHO, 1948). Based on the new definition of health, which states that a healthy person is one who is ‘able to cope with illnesses or stresses’ (Huber et al., 2011), and the results of this research which indicate that physical activity might reduce depression (e.g., Sund et al., 2011), it has been demonstrated that adolescents who incorporate physical activity into their lifestyle may be better able to cope with inevitable life stressors.

3. Sedentary behaviour is significantly associated with high level of depression among adolescents in the African culture, which is similar to findings in the Western culture. In the Western cultures, it has been found that a number of adolescents have been experiencing mental health problems including internet addiction due to excessive use of computer and internet. Therefore, in
countries like the U.S, Canada, South Korea and those in Europe, health centres have been established to treat adolescents’ internet addition problems (e.g., Witt et al., 2011). Since the finding from the present thesis indicates that sedentary behaviour also has negative impact among youth in African culture, it draws attention that the proportion of adolescents who are sedentary mainly due to excessive use of screen devices may develop increased mental health problems including worries, clinical depression and internet addiction as it has been occurring in the Western cultures.

Notably, some Clinical Psychologists in Ghana have even started treating internet addiction problems among youth (PLC, 2011). Recently, many organisations from the Western countries have been donating computers to Africa (Ghana News Agency, 2012), which are supplied to the schools. Based on the findings from the present research, the Ghana government should be aware that since these students who would be using these computers might overuse them and eventually lead to mental health problems, they should ensure that these donors who are donating computers to Africa add some additional money which could be used to set up mental health centres to treat future psychological problems including internet addiction among these students who would use them in Africa.

4. Affluence is a key contributing factor of sedentary behaviour in African youth. So far, the sedentary behaviour problem in Ghana is
mainly among private school students who come from affluent homes. However, recently the Ghanaian government has developed a plan to increase information and communication technology (ICT) in the secondary schools (Ghana News Agency, 2012). Therefore, the government has started supplying computers to the public schools in Ghana (Ghana News Agency, 2012). Considering the increasing supply of computers and internet to the public schools in Ghana (Ghana News Agency, 2012), by the next decade, students from low to middle socio-economic backgrounds who do not have screen devices at home would be having easy access to computers and internet at school, which could double the existing sedentary behaviour problem in Ghanaian youth.

Mental health problems associated with excessive sedentary behaviour may increase among students in public schools, similarly to the current situation among students in private schools, who have easy access to screen devices. Eventually, there is bound to be an increase in the prevalence of mental health problems in Ghanaian adolescents. Based on the findings of this research which show that sedentary behaviour is significantly associated with mental health problems, the government should have in mind that whilst embarking on establishing internet and communication technology to the public schools, they should also set aside some money which would be used to treat the future mental health
problems of these students who are going to use the computers and the internet due to the possibility of these students overusing the provided screen devices.

5. The present research indicates that participation in physical activity is associated with good cognitive functioning and mental well-being. This suggests that it is even more beneficial for adolescents, especially girls, who may want to lose weight to conform to societal pressures regarding appearance (Grogan, 2008; Labre, 2002), to do regular physical activity. This is because regular physical activity is also effective for weight loss (e.g., Thompson and Manore, 2012) and safer than consuming less food which could cause these adolescents to have inadequate nutrients and reduce their muscle mass (Malina et al., 2004). Overall, the present research in this thesis has given an indication that there is a significant prevalence of low physical activity and high sedentary behaviour in African youth. These trends seem to continue, particularly with the adoption of new technologies. This has implications for behaviour change at both the individual and population level. For example, measures might be undertaken to provide national guidelines on physical activity and sedentary behaviour, similar to other countries. Following this, actual changes in behaviour will require a multifaceted approach, including changes to social and physical environments. It therefore provides the basis for future research
into the trend of sedentary behaviour and their impact on mental health in other African countries.

6.6 **Strengths and Limitations**

The research in this thesis was designed to address methodological problems in previous research. Therefore, some strengths can be identified in the entire research thesis. First, the present research assessed baseline and post-intervention physical activity levels when conducting the experimental study, to examine the impact of physical activity on well-being. Therefore, the findings in the present research strongly suggest that the improvement in well-being after the physical activity intervention was associated with increase in physical activity levels over the intervention period. Moreover, the findings reported in this thesis seem to be reliable, because the association between physical activity and mental well-being were examined with both cross-sectional and experimental study. The experimental study confirmed the cross-sectional findings, which indicate that physical activity is significantly associated with mental well-being. The consistency of the results across the two studies reported in this thesis confirms the findings in the previous literature which indicate that participation in sufficient levels of physical activity is associated with good mental well-being.
Again, the experimental study in this thesis, which examined the impact of physical activity on well-being, utilised a true control group. Participants in the intervention study were recruited from schools which did not pay attention to physical education. Also, students who were allocated to the control group condition were selected from a school which did not have physical education in their curriculum time. The use of a true control group in the present research strengthens the findings that the physical activity intervention had a significant positive impact on participants’ well-being. In addition, the participants of the present intervention study were carefully recruited in order to include students who generally might have low physical activity levels. To achieve this, participants were selected from schools mostly attended by students from high-income families. Thus, for example, the baseline physical activity levels of the selected participants were 3,000 steps per day. These physical activity levels were far below the recommended physical activity levels for their age group. However, at post-testing it was found that the experimental participants had increased their physical activity levels from 3,000 steps a day to 11,000 steps per day whereas the control group participants remained at 3,000 steps per day at post-testing. The large increment in physical activity levels of the experimental participants to 11,000 steps a day, which was even beyond the recommended 10,000 steps per day, might have reflected in the significant improvement in well-being identified among the experimental participants.
Though, the present research made efforts to address methodological issues in previous research, there are still some limitations associated with the present findings in this thesis. Particularly, in this research, executive functioning was measured simply as reasoning. Therefore, findings only demonstrate that physical activity has significant impact on students’ reasoning rather than their entire executive functioning. Moreover, there was no follow-up to find out whether the significant improvement in well-being among the experimental participants maintained over time. Again, the research was conducted in specific schools in Ghana and therefore cannot be strongly generalised to other populations. Another limitation in the current research is that the actual experimental study was a non-randomised controlled trial. This limitation however, did not seem to affect the study findings because the pilot study, which was a randomised controlled trial, had findings which were consistent with the actual experimental study conducted in two separate schools.

6.7 Considerations for Future Research

The following issues were identified from the present research which future researchers could consider:

1. Future researchers should examine how physical activity and nutritional practice interact to influence cognitive functioning. This is because in the present finding there was no association between
nutritional practice and cognitive functioning. However, it has been well established that good nutritional practice can be associated with cognitive functioning.

2. This research should be a platform for further research into sedentary behaviour and mental well-being in African youth. The present findings provide ideas that there is a high prevalence of sedentary behaviour among adolescents in the African culture. Future researchers should examine the impact of sedentary behaviour in the African countries where little literature exists.

3. Future researchers should investigate why parenting style, and especially authoritarian parenting style does not seem to have an association with depression among African youth. This is because the present research found that physical activity was more associated with depression among Ghanaian adolescents than parenting style.
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Physical activity and mental health in children and adolescents: a review of reviews

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ABSTRACT

Objective To synthesise reviews investigating physical activity and depression, anxiety, self-esteem and cognitive functioning in children and adolescents and to assess the association between sedentary behaviour and mental health by performing a brief review.

Methods Searches were performed in 2010. Inclusion criteria specified review articles reporting chronic physical activity and at least one mental health outcome that included depression, anxiety/stress, self-esteem and cognitive functioning in children or adolescents.

Results Four review articles reported evidence concerning depression, four for anxiety, three for self-esteem and seven for cognitive functioning. Nine primary studies assessed associations between sedentary behaviour and mental health. Physical activity has potentially beneficial effects for reduced depression, but the evidence base is limited. Intervention designs are low in quality, and many reviews include cross-sectional studies. Physical activity interventions have been shown to have a small beneficial effect for reduced anxiety, but the evidence base is limited. Physical activity can lead to improvements in self-esteem, at least in the short term. However, there is a paucity of good quality research. Reviews on physical activity and cognitive functioning have provided evidence that routine physical activity can be associated with improved cognitive performance and academic achievement, but these associations are usually small and inconsistent. Primary studies showed consistent negative associations between mental health and sedentary behaviour.

Conclusions Association between physical activity and mental health in young people is evident, but research designs are often weak and effects are small to moderate. Evidence shows small but consistent associations between sedentary screen time and poorer mental health.

Mental illnes is a serious public health issue. It is expected to account for 15% of the global burden of disease by 2020, which would make it the leading disease burden.1 Suicide, depression, eating disorders and anxiety are some of the conditions that affect young people in disproportionate rates in comparison to many other population groups.2 Moreover, there is widespread belief that physical activity is inherently good for young people in respect of varied psychosocial outcomes, such as self-esteem and cognitive functioning. The majority of studies in this area, however, are cross-sectional and therefore causality cannot be established because the temporal relationship between exposure (physical activity) and outcome (mental health) has not been tested or shown with any consistency. Thus, although there is evidence that physical activity can enhance psychological well-being, such an outcome may not be inevitable3 or may be dependent on certain conditions existing.

The effect of physical activity on mental health in children and adolescents has received significantly less attention than in adult populations.4 Where it has been investigated, the work has primarily focused on depression, anxiety and self-esteem. In addition researchers and education professionals are showing increasing interest in the effects of physical activity on cognitive functioning. For these reasons, and space restrictions, our review is delimited to the outcomes of depression, anxiety, self-esteem and cognitive functioning.

The purpose of this article, therefore, is to synthesise evidence on chronic physical activity participation and mental health in children and adolescents mainly through a review of reviews. Such a method has been adopted to optimise the ability to cover four areas of mental health and to synthesise 18 reviews. It would have been unwieldy to attempt individual systematic reviews of the literature in each of the four mental health domains. Moreover, a review of reviews is accepted practice in the medical and health behaviour literatures.5 In addition a brief analysis will also be provided on relationships between sedentary behaviour and mental health from primary research studies.

METHOD

To find reviews of studies on chronic physical activity and mental health in young people, the following electronic databases were searched up to October 2010: PubMed, SPORTDiscus, PsychINFO, Web of Science, Medline, Cochrane Library and ISI Science Citation Index. We searched using terms that reflected exposure variables of interest (eg, sport, exercise, physical activity), mental health outcome variables (eg, depression, anxiety, self-esteem, cognitive functioning) and methods (only reviews, systematic reviews, meta-analyses). Only review articles were included. Additional searches of personal files supplemented the electronic sources.

Articles were selected for detailed analysis if they met the following inclusion criteria (1) were review articles (narrative, systematic or meta-analytic); (2) reported the relationship between physical activity and at least one mental health outcome that included depression, anxiety/stress, self-esteem or physical self-worth and...
cognitive functioning; (3) reported chronic physical activity studies, including interventions (reviews of acute studies were excluded); (4) were on school-aged children or adolescents up to and including 18 years with no known physical health limitations. If a review contained some data on young people, but the primary emphasis was on adults, the data were scrutinised and reported where appropriate.

To balance the work on physical activity, a brief narrative review was conducted on sedentary behaviour and mental health. This is not meant to be a comprehensive systematic review but rather a commentary on recent articles.

RESULTS
Five review articles were retrieved that reviewed evidence concerning physical activity and depression, four for anxiety, three for self-esteem and seven for cognitive functioning. Two articles covered more than one mental health outcome variable, with Larun et al addressing anxiety and depression, and Calfas and Taylor reviewing depression, anxiety and self-esteem.

Depression
Evidence from adult studies demonstrates that physical activity is inversely associated with symptoms of depression, and there is some evidence that this relationship is causal. There is, however, much less evidence for this relationship in children and adolescents. We found five reviews that synthesised data for young people, although the article by Dunn and Weintraub primarily provides a methodological critique of articles used in the review by Larun et al. Reviews of depression are summarised in table 1, excluding the critique by Dunn and Weintraub, leaving four reviews.

The study by North et al was the first meta-analysis investigating associations between physical activity and depression and included all research designs. An overall effect size (ES) of −0.53 was reported, with five studies involving only young people reflecting a similar value (ES = −0.49). However, acute and chronic studies were included as well as non-intervention designs.

The first systematic review concerning physical activity and mental health in adolescents was published as part of the American physical activity guidelines process, although the authors used a wide age range of 11–21 years. All research designs were eligible for analysis but ES was calculated only for experimental designs. From only four intervention studies, ES = −0.38 favouring physical activity over a control group. By using all research designs, Calfas and Taylor reported that of 11 studies showed a negative association between physical activity and depression.

Craft and Landers conducted a meta-analysis on exercise and depression for those with clinical depression. Only three studies provided data for those aged 12–18 years, showing a small non-significant ES of −0.15, much smaller than that for adults and in all studies (−0.72).

Larun et al conducted a systematic review of exercise interventions on depression in young people up to the age of

<table>
<thead>
<tr>
<th>Author, date and years covered</th>
<th>Type of review number of studies (K)</th>
<th>Sample for current analyses</th>
<th>Exposure variables</th>
<th>Types of research design</th>
<th>Main findings</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Larun et al (1965–2005)</td>
<td>Meta-analysis K=5</td>
<td>11–19 years</td>
<td>Vigorous</td>
<td>RCTs</td>
<td>The review assessed vigorous exercise (VIG) vs no intervention in a general population. VIG had a significant negative effect on depression; ES = −0.66. VIG v. no exercise for children in treatment: no difference. VIG v. low intensity exercise for depressed children in treatment: no difference. Exercise v. psychosocial intervention for depressed children in treatment: no difference. Exercise significantly reduced depression among participants with clinical depression and depression resulting from mental illness (including adults). Effect size for young people was small (ES = −0.15).</td>
<td>Few studies included.</td>
</tr>
<tr>
<td>Craft and Landers (Up to 1996)</td>
<td>Meta-analysis and systematic review K=3</td>
<td>12–18 years</td>
<td>PA: aerobic and anaerobic</td>
<td>Quasi-experimental</td>
<td>Exercise significantly reduced depression among participants with clinical depression and depression resulting from mental illness (including adults). Effect size for young people was small (ES = −0.15).</td>
<td>The review is one of the few that examined the effects of chronic exercise on clinically diagnosed depression. Review includes varied age groups. Only 3 studies were on young people.</td>
</tr>
<tr>
<td>Calfas and Taylor (Up to 1982)</td>
<td>Meta-analysis K=11</td>
<td>11–21 years</td>
<td>PA: flexibility training; running; vigorous activity</td>
<td>Quasi-experimental and cross-sectional observational</td>
<td>34 trials available for meta-analysis. Significant negative relationship between PA and depression (ES = −0.38). 9 of 11 studies showed negative association.</td>
<td>Only 4 effect sizes available for calculation of overall ES.</td>
</tr>
<tr>
<td>North, et al (Up to 1989)</td>
<td>Meta-analysis K=5</td>
<td>&lt;18 years</td>
<td>PA: aerobic; and muscular strength endurance</td>
<td>Various</td>
<td>Higher levels of exercise significantly associated with lower depression (ES = −0.49) among young people.</td>
<td>Only 5 studies involved young people. It was not possible to identify research designs used, intensity or duration of exercise, or type of depression assessed.</td>
</tr>
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</table>

ES, effect size; PA, physical activity; RCT, randomised controlled trial.
20 years. Five trials were found that investigated whether vigorous exercise (fitness training and weight training) conferred benefits over no intervention. They found a significant moderate effect (ES = −0.66; CI, −1.25 to −0.08) but noted that the trials were of low quality and highly varied in respect of methodological characteristics, such as sampling and measurement. When comparing vigorous with low-intensity exercise, only two trials were found, and these showed no significant effect, a result repeated for two trials investigating children receiving psychological treatment. This might suggest that lower levels of physical activity intensity may also be effective for anxiety reduction.

When comparing exercise with psychosocial interventions, Larun et al found only two trials, and no significant effect was evident. This was also the case for one trial involving children receiving psychological treatment, suggesting that physical activity may be equally effective as psychosocial interventions. There was no evidence for intervention effectiveness after 8 weeks.

Limitations of findings include the use of broad inclusion criteria that allows participants in some interventions to have rather mild depression over a short time frame (ie, they may not be particularly depressed at all). Studies also fail to specify the exact nature of the physical activity interventions in respect of frequency, intensity, duration and type of activity. Group-based physical activity interventions often fail to control for the effects of social interaction.

In summary, physical activity over no intervention seems to be potentially beneficial for reduced depression, but the evidence base is limited. Intervention designs are low in quality, and many reviews include cross-sectional studies that may distort associations or fail to rule out reverse causality.

### Anxiety

Active adults report fewer symptoms of anxiety than inactive adults. However, the amount of evidence for young people is considerably less. Our search revealed four reviews (see table 2). The meta-analysis of exercise and anxiety reduction conducted by Petruzzello et al also reported ESs for those younger than 18 years. Results showed a small-to-moderate effect for physical activity programmes when assessing trait anxiety (ES = −0.47), although only three studies were available for review. The review by Calfas and Taylor found only three intervention studies on anxiety and reported an ES of −0.15. This review does not completely map onto the studies reviewed by Petruzzello et al and lacks methodological detail.

Larun et al conducted a systematic review of exercise interventions on anxiety in young people up to the age of 20 years. Six trials were found that investigated whether vigorous exercise conferred benefits over no intervention. They found a non-significant, although small to moderate, trend (ES = −0.48). Studies were of low quality and highly varied in respect of methodological characteristics. When comparing vigorous with low-intensity exercise, only three trials were found, and these showed no significant effect. When comparing exercise with psychosocial interventions, Larun et al found only two trials, and no significant difference was evident.

Wipfli et al claimed to address the methodological weaknesses of previous reviews by conducting a meta-analysis of just randomised controlled trials, although this was also performed by Larun et al. Three trials were reviewed for those younger than 18 years, revealing a non-significant effect (ES = −0.18). It is not clear why Wipfli et al only found three interventions 2 years after Larun et al analysed six.

In summary, physical activity interventions for young people have been shown to have a small beneficial effect for

### Table 2 Reviews of physical activity and anxiety in young people

<table>
<thead>
<tr>
<th>Author, date and years covered</th>
<th>Type of review; number of studies (K)</th>
<th>Sample for current analyses</th>
<th>Exposure variables</th>
<th>Types of research design</th>
<th>Main findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larun et al&lt;sup&gt;6&lt;/sup&gt; 1965–2005</td>
<td>Meta-analysis K=6 11–19 years</td>
<td>VIG</td>
<td>RCTs</td>
<td>VIG had a small-to-moderate effect on anxiety (ES=−0.48). There was no statistically significant difference between VIG and low intensity exercise on anxiety. There was no statistically significant difference between exercise and psychosocial interventions on anxiety. Exercise group showed small reductions in anxiety v. other forms of anxiety treatment (ES = −0.19).</td>
<td>Few studies and many with methodological weaknesses.</td>
<td></td>
</tr>
<tr>
<td>Wipfli et al&lt;sup&gt;13&lt;/sup&gt; Up to Jan 2006</td>
<td>Meta-analysis K=3 &lt;18 years</td>
<td>PA: aerobic; anaerobic; combined</td>
<td>RCTs</td>
<td>Exercise group showed small reductions in anxiety v. other forms of anxiety treatment (ES = −0.19).</td>
<td>8 studies were included in the full meta-analysis (all ages) that were acute studies. It was not possible to tell if the 3 studies on those &lt;18 years included those in acute exercise RCTs. Unclear why only three interventions were found two years after Larun et al analysed six. Duration of PA was not mentioned; moderate PA was not adequately explained.</td>
<td></td>
</tr>
<tr>
<td>Calfas and Taylor&lt;sup&gt;7&lt;/sup&gt; Up to 1982</td>
<td>Meta-analysis and systematic review K=20 11–21 years</td>
<td>PA: (Fitness training): flexibility training; running; vigorous activity</td>
<td>Quasi-experimental and cross-sectional observational</td>
<td>3 trials available for meta-analysis. Small relationship between PA and anxiety (ES = −0.15).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Petruzzello, et al&lt;sup&gt;14&lt;/sup&gt; 1980–1989</td>
<td>Meta-analysis K=3 &lt; 18 years</td>
<td>PA: programmes (aerobic, anaerobic)</td>
<td>Longitudinal design</td>
<td>Chronic exercise significantly associated with less trait anxiety (ES=−0.47).</td>
<td>Not clear on methods for studies with young people.</td>
<td></td>
</tr>
</tbody>
</table>

ES, effect size; PA, physical activity; RCT, randomised controlled trial; VIG, vigorous exercise.
reduced anxiety. However, the evidence base is limited and in need of development.

Self-esteem

Self-esteem reflects the degree to which an individual values himself or herself and is widely viewed as a key indicator of positive mental health and well-being. The belief that physical activity, including sport, is associated with the development of self-esteem in young people is a commonly held view. Typically, global self-esteem is seen as the apex of a hierarchical and multidimensional framework, underpinned by different domains of the self, including the perceptions of physical self-worth.

We found three systematic reviews addressing physical activity and self-esteem in young people (see table 3). One of the first meta-analyses in exercise psychology was that by Gruber (1986). He meta-analysed 27 experimental designs, mainly on children, but gave limited detail on methodology.

Gruber reported an overall effect for physical activity on self-esteem of 0.41, representing a small effect. Larger effects were found for children with perceptual, emotional and learning disabilities (ES = 0.57), for better controlled experiments assessing only one dependent variable (ES = 0.65) and for aerobic fitness activities (ES = 0.89). Three studies analysed by Calfas and Taylor showed a small effect (ES = 0.12).

A recent Cochrane meta-analysis by Ekeland et al examined whether exercise interventions improved global self-esteem among children and young people aged 3–20 years. This was later published as a journal article. The results showed that in the eight trials available for meta-analysis and testing an exercise-alone intervention versus a no-intervention control, there was a small-to-moderate effect in favour of the intervention group (ES = 0.49).

Most of the trials analysed by Ekeland et al were small scale and of short duration. No follow-up results were given so the sustainability of changes could not be assessed. Only one of the trials was considered to be of high methodological quality and demonstrated the strongest effects. A further four trials compared the effects of exercise as part of a comprehensive intervention package against no-intervention control groups and showed a moderate positive effect on self-esteem in favour of the intervention (ES = 0.51).

In summary, physical activity can lead to improvements in self-esteem, at least in the short term. However, there is a paucity of good quality research. Moreover, global measures of self-esteem can be affected by many factors beyond physical activity. Hence, measures of physical aspects of the self, such as body image or physical self-worth, important indices of psychological health in their own right, might be better targets for intervention.

Cognitive functioning

A link between physical activity and cognitive functioning has been believed to exist for many years. Blakemore reported that the brain is activated during physical activity by increasing blood flow to essential areas that may stimulate learning. Moreover, research has suggested that integrating physical activity in the classroom will enhance student learning. However, further studies are needed to make school authorities confident that encouraging school physical activity will improve learning rather than disrupt academic time. Cognitive functioning is best defined as a) intelligence, which is the ability to reason quickly and abstractly; b) cognitive skills of concentration and attention; c) academic achievement, usually assessed by overall school grades and performance.

Seven review articles were found (see table 4). More than a decade ago, Shephard reported a systematic review to investigate links between physical activity and cognitive functioning using cross-sectional and longitudinal studies. It was found that increasing physical education (PE) time in schools by 14–26% did not have a significant negative effect on academic performance. However, only three studies on routine physical activity were involved, and evidence was not established concerning additional time for physical activity and intellectual enhancement; students who had extra PE time performed better.
### Table 4  Reviews of physical activity and cognitive functioning in young people

<table>
<thead>
<tr>
<th>Author, date and years covered</th>
<th>Type of review; number of studies (K)</th>
<th>Sample for current analyses</th>
<th>Exposure variables</th>
<th>Types of research design</th>
<th>Main findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Best</strong>&lt;sup&gt;30&lt;/sup&gt; Dates covered not stated</td>
<td>Systematic review K=3</td>
<td>7–11 years</td>
<td>PA (aerobic): running; walking</td>
<td>Experimental</td>
<td>Exercise (specifically aerobic) had significant positive relationship with creativity- specifically flexible and divergent thinking but not with perceptual-motor skills or visual-motor coordination.</td>
<td>Some studies analysed included ‘attitude’ and ‘mood’ outcomes, not cognitive functioning.</td>
</tr>
<tr>
<td><strong>Centres for Disease Control and Prevention</strong>&lt;sup&gt;29&lt;/sup&gt; Dates covered not stated</td>
<td>Systematic review K=50</td>
<td>Children; exact ages not stated</td>
<td>School PE; Recess (break); classroom physical activity breaks; extra-curricular physical activity</td>
<td>All</td>
<td>School-based PE (k=14): weak or no association between increased PE time and academic achievement. Recess studies (k=8): weak or no association between recess activity and cognitive outcomes. Classroom physical activity studies (k=9): Consistent association between classroom activity breaks and cognitive outcomes. Extra-curricular physical activity studies (k=19): Consistent association between extra-curricular physical activity and cognitive outcomes.</td>
<td></td>
</tr>
<tr>
<td><strong>Keeley and Fox</strong>&lt;sup&gt;28&lt;/sup&gt; Up to Feb 2009</td>
<td>Systematic review N=18</td>
<td>4–18 years</td>
<td>PA (break-time play; active travel; sport and physical education; informal play and sports; and dance clubs outside school)</td>
<td>RCTs; quasi experimental; longitudinal; cross sectional</td>
<td>A weak positive relationship was found between increased school physical activity and cognitive functioning. Cross-sectional studies indicated that more physical activity was associated with better performance in some subjects (eg, mathematics) but not in others (eg, English). Intervention Studies indicated that introduction of more curricular time to PE did not have a detrimental effects on children’s academic performance. A weak but positive association was found between physical fitness and cognitive functioning in young people with the strongest correlations being with cardiovascular fitness.</td>
<td></td>
</tr>
<tr>
<td><strong>Tomporowski et al</strong>&lt;sup&gt;27&lt;/sup&gt; Dates covered not stated</td>
<td>Systematic review K=15</td>
<td>8–16 years</td>
<td>PA (chronic exercise): Strength training; aerobic; running</td>
<td>Cross-sectional, prospective and experimental</td>
<td>Prospective and experimental designs: 2 of 4 studies showed improvements in intelligence 3 of 6 for cognition 1 of 6 for academic achievement. Cross-sectional designs: 3 of 4 studies showed association with academic achievement.</td>
<td>Executive functioning tasks seem most positively affected.</td>
</tr>
<tr>
<td><strong>Trudeau and Shephard</strong>&lt;sup&gt;26&lt;/sup&gt; 1966–2007</td>
<td>Systematic review K=17</td>
<td>5–16 years</td>
<td>PA: PE activities; school sport</td>
<td>Quasi experimental; longitudinal; cross-sectional</td>
<td>PA and academic achievement: Allocating up to an additional hour per day of curricular time to PA programmes did not affect academic performance of primary school students. Children, in the experimental group, whose academic tuition was reduced achieved equally as the control group. PA and classroom behaviour: PA significantly improved concentration and classroom behaviour. Fitness and academic achievement: A positive but weak relationship.</td>
<td>The context of PA was not clearly defined. Limited studies were used to assess the effect of fitness on academic achievement.</td>
</tr>
</tbody>
</table>
equally well as students who had intact classroom curricular time.

Sibley and Etnier\textsuperscript{25} conducted a meta-analysis to investigate the effects of different types of physical activity on cognitive functioning across varied age groups of young people. All research designs were included. The findings revealed that physical activity was associated with better cognitive functioning across all age groups. A small effect for chronic studies was found (ES = 0.29).

Trudeau and Shephard\textsuperscript{26} conducted a systematic review on physical activity, physical fitness and academic performance. Seventeen studies of varied research designs were involved. Findings indicated that allocating up to an additional hour per day of curricular time to physical activity programmes in school does not affect academic performance of primary school students. Furthermore, physical activity improved classroom behaviour, attention and concentration. A positive but weak relationship was established between physical fitness and academic achievement. However, for experimental studies, the authors did not find strong evidence for an effect of school physical activity on academic performance because children in the experimental group, whose academic tuition was reduced, did not perform better than the control group; that is, children exposed to additional school physical activity achieved equally well as students who had regular academic tuition.

Tomporowski \textit{et al.}\textsuperscript{27} in a systematic review of 15 studies, examined the relationship between physical activity and cognitive functioning among children aged 6–16 years. For prospective and experimental designs, two of four studies showed improvements in intelligence, three of six for cognition and one of six for academic achievement. In contrast, three of four cross-sectional studies on academic achievement showed positive associations. They concluded that children's cognitive functioning can be enhanced through physical activity, but this is mainly in respect of executive functioning tasks (ie, “goal-directed actions in complex stimulus environments, especially novel ones, in which elements are constantly changing”\textsuperscript{27}, p. 126).

To update previous reviews, Keeley and Fox\textsuperscript{28} conducted a systematic review to investigate the relationship between physical activity, physical fitness and cognitive functioning among 4- to 18-year-old students. Eighteen studies with varied research designs were included. Generally studies involved exposing experimental participants to increased school-based physical activities at the expense of academic work time. A weak positive relationship was found between increased school physical activity and cognitive functioning. Specifically, cross-sectional studies indicated that more physical activity was associated with better performance in some subjects (eg, mathematics) but not in others (eg, English). One intervention study reported that increased physical activity significantly improved cognitive functioning; two intervention studies found no association between increased physical activity and academic performance. A weak but positive association was found between physical fitness and cognitive functioning in young people, with the strongest correlations being with cardiovascular fitness.

Although a strong association has not been established between increased school physical activity and cognitive functioning, Keeley and Fox (2009) found that the introduction of more physical activity, at the expense of academic subject time, did not have a detrimental effect on children's academic performance. This reflects conclusions from other reviews.

The Centres for Disease Control and Prevention\textsuperscript{29} in the United States has also examined the effect of routine physical activity on the cognitive functioning of young people. The review involved 50 studies with cross-sectional (K = 11) and longitudinal (K = 38) research designs, with 32 classified as interventions. It was found that increased PE time in schools had a positive but weak relationship with academic achievement in 11 of 14 studies. Time spent in increased break (recess) play had a small positive relationship with classroom behaviour, including children's attention and concentration (all eight studies found one or more positive associations between recess and indicators of cognitive skills). In addition classroom-based physical activity (5-20 min break during lessons) improved children's academic behaviour and achievement (eight of the nine studies found positive associations). Extracurricular physical activities (participation in school sports) also had a positive association with academic performance (all 19 studies examining after-school sport found one or more positive associations with cognitive performance). Finally the review

### Table 4

<table>
<thead>
<tr>
<th>Author, date and years covered</th>
<th>Type of review; number of studies (K)</th>
<th>Sample for current analyses</th>
<th>Exposure variables</th>
<th>Types of research design</th>
<th>Main findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sibley and Etnier\textsuperscript{25} Up to 2001</td>
<td>Meta-analysis K=16</td>
<td>4–18 years</td>
<td>PA: aerobic; resistance training; perceptual motor; PE programs</td>
<td>True experiment; quasi experiment; cross-sectional</td>
<td>PA significantly associated with better cognitive functioning (ES=0.32). No effect for memory tests and only a small effect for verbal tests. Results were similar for healthy subjects, subjects with mental impairments and subjects with physical disabilities. The influence of PA on cognitive functioning was not moderated by the type of research design, participant health and PA type.</td>
<td>Narrative review only.</td>
</tr>
<tr>
<td>Shephard\textsuperscript{26} Dates covered not stated</td>
<td>Narrative review K=3 longitudinal studies highlighted</td>
<td>&lt;20 years</td>
<td>PA: PE activities</td>
<td>Cross-sectional; longitudinal</td>
<td>Academic performance is maintained or even enhanced by an increased level of PA.</td>
<td>Narrative review only.</td>
</tr>
</tbody>
</table>

ES, effect size; PA, physical activity; PE, physical education.
### Table 5  Primary studies investigating sedentary behaviour and mental health in young people

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample characteristics</th>
<th>Design/method</th>
<th>Sedentary behaviour exposure variables</th>
<th>Mental health outcome variables</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murdey et al(^{17})</td>
<td>N=119 UK youth. 64 boys and 55 girls across three school year cohorts: Year 6 (10.0–10.9 years); Year 8 (12.0–12.9 years); Year 10 (14.0–14.9 years).</td>
<td>Cross-sectional phase of longitudinal study. Free-time sedentary behaviour assessed by momentary time sampling paper diary.</td>
<td>Body image (body attractiveness subscale of Physical Self-Perception Profile for Children; PSPP-C)</td>
<td>Small negative association only for girls between sedentary behaviour and body image: r=-0.23, p=0.05</td>
<td>PA not accounted for in analyses. Only study to assess and aggregate multiple sedentary behaviours.</td>
<td></td>
</tr>
<tr>
<td>Mathers et al(^{38})</td>
<td>N=925 Australian adolescents (mean age = 16.1 years)</td>
<td>Cross-sectional data from the third (2005) wave of the longitudinal Health of Young Victorians Study. Electronic media use (EMU) assessed with MARCA – Multimedia Activity Recall for Children and Adolescents, a computerised time-use diary.</td>
<td>Health-related quality of life (HRQoL; KIDSCREEN); health status (Pediatric Quality of Life Inventory 4.0; PedsQL); depression/ anxiety (Kessler-10); behaviour problems (Strengths and Difficulties Questionnaire - SDQ).</td>
<td>Higher EMU associated with poorer HRQoL and more behaviour problems. High video game use associated with worse HRQoL.</td>
<td>PA not accounted for in analyses.</td>
<td></td>
</tr>
<tr>
<td>Iannotti, Janssen, et al(^{39})</td>
<td>N=49 124 Young people aged 11, 13 and 15 years from countries participating in the Health Behaviour in School-Aged Children (HBSC) study: 10 countries selected to represent 5 regions: North America, North Europe, South Europe, West Europe, East Europe.</td>
<td>Cross-sectional self-report survey of health behaviours, including physical activity and screen time. Screen-based media sedentary behaviour (SBM) in h/day.</td>
<td>Physical Self-Image: Perception (of body size); Life Satisfaction; Quality of Family Relationships; Quality of Peer Relationships.</td>
<td>Higher levels of SBM associated with poorer self-image. More frequent SBM associated with poorer Life Satisfaction in four regions and poorer perceived health status and family relationships in three regions.</td>
<td>PA accounted for as a confounder.</td>
<td></td>
</tr>
</tbody>
</table>
Table 5  Continued

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample characteristics</th>
<th>Design/method</th>
<th>Sedentary behaviour exposure variables</th>
<th>Mental health outcome variables</th>
<th>Results</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamer et al[1]</td>
<td>N=1486 Scottish children aged 4–12 years (mean age=8.5 years)</td>
<td>Cross-sectional assessment of psychological well-being, sedentary behaviour and physical activity</td>
<td>Parent reported TV and screen entertainment (TVSE).</td>
<td>Psychological well-being (Strengths and Difficulties Questionnaire)</td>
<td>Higher SDQ scores associated with greater TVSE time independently of PA and after controlling for confounders.</td>
<td>PA accounted for as a confounder.</td>
</tr>
<tr>
<td>Russ et al[2]</td>
<td>N=54,863 American youth aged 6–17 years.</td>
<td>Cross-sectional assessment of media use and parent reported child psycho-social well-being</td>
<td>Parent reported media use (TV, computers, screen time)</td>
<td>Parent reported social-emotional problems of the child, concerns about child’s self-esteem, and social competence</td>
<td>TVSE and PA interact to be associated with higher levels of psychological distress.</td>
<td>Parental proxy reports likely to have poor validity.</td>
</tr>
<tr>
<td>Holder et al[3]</td>
<td>N=514 Canadian children aged 9–11 years.</td>
<td>Cross-sectional assessment of screen time and phone used, self-concept and happiness</td>
<td>Self and parent reported sedentary behaviour (TV, computer, computer games, phone)</td>
<td>Piers-Harris Children's Self-Concept Scale 2 Happiness/satisfaction (from Piers-Harris) Self-reported happiness using a faces scale</td>
<td>Screen time (but not phone) had small but significant association with both child and parent reported happiness (faces scale) No associations with self-concept.</td>
<td>Markers of PA assessed but not used as covariates.</td>
</tr>
<tr>
<td>Primack et al[4]</td>
<td>N=4142 American adolescents (Grades 7-12; aged 12–17 years at baseline)</td>
<td>Longitudinal cohort study with 7 year follow-up. Analyses included only those not depressed at baseline.</td>
<td>Self-report of 'last week’ exposure to 4 types of electronic media: TV, video, computer games, radio</td>
<td>Centers for Epidemiologic Studies – Depression Scale (CES-D)</td>
<td>Significantly increased odds of depression at follow up for each additional hour of TV viewing (OR=1.08). No effect for other media.</td>
<td>PA not accounted for in analyses.</td>
</tr>
<tr>
<td>Page et al[5]</td>
<td>N=1013 UK youth (mean age=10.95 years)</td>
<td>Cross-sectional assessment of psychological well-being, sedentary behaviour and physical activity</td>
<td>Self-reported daily TV hours and computer use. Total sedentary time also assessed with accelerometer.</td>
<td>Psychological well-being (Strengths and Difficulties Questionnaire)</td>
<td>Children who spent more than 2 h/day watching TV or using a computer were at increased risk of high levels of psychological difficulties.</td>
<td>PA accounted for as a confounder.</td>
</tr>
</tbody>
</table>
concluded that school physical activity programmes have a positive impact on academic performance. However, effects are inconsistent and often small.

In a recent systematic review, Best30 examined the relationship between aerobic physical activity and cognitive functioning in young people. Studies used experimental designs; however, only three studies assessed the effects of chronic aerobic exercise on cognitive functioning. Aerobic exercise did not influence children’s tasks requiring visual-motor coordination, but it did improve tasks requiring flexible and divergent thinking.

In summary, systematic reviews on physical activity and cognitive functioning have provided evidence that routine physical activity can be associated with improved cognitive performance, classroom behaviour and academic achievement in young people, but these associations are usually small and not entirely consistent.

The major implication arising from these reviews is that integrating physical activity in the school system may help young people to learn better and reduce the likelihood of negative classroom behaviours. However, strong evidence has not yet been established between chronic physical activity and students’ cognitive functioning, and this could be due to methodological shortcomings of studies. These include expectancy effects and unblinded intervention designs. Thus, available evidence does not contribute strongly to the proposition that increasing school physical activity time to the detriment of classroom curricular time is beneficial for school children. Studies with more rigorous designs are needed on physical activity, including non-aerobic exercise, and its effect on cognitive functioning.

Sedentary behaviour and mental health

Sedentary behaviour in young people and adults is a rapidly developing area of research. Operationally defined as “sitting time”, sedentary behaviour can be high in the contexts of leisure time (eg, screen time), school and travel (ie, car use). Most of the evidence with young people has centred on screen time, and TV viewing in particular. Although TV viewing remains the most prevalent sedentary behaviour for youth, it is only one behaviour and may not reflect wider patterns of excessive sitting.31 However, the development of attractive home-based or even mobile electronic entertainment has led to concerns about excessive sitting time in young people.

Most of the evidence linking sedentary behaviour to health outcomes has focused on TV viewing and weight status,32 with more recent studies looking at screen time (ie, TV and computers) and aspects of metabolic health more broadly.33 34 Less has been written about sedentary behaviour and mental health in young people. For this brief section of the article, we review recent articles addressing links between sedentary behaviour and mental health, with a summary shown in table 5.

Results from the nine primary studies show consistent negative mental health associations with sedentary behaviour, primarily screen viewing. This mirrors a growing literature showing adverse physical health outcomes of high sitting time.35 The one longitudinal study did show that TV viewing, but not computer games, was associated with increased odds of depression after 7-year follow-up.56 The associations across the studies, however, are small and, all but one, are derived from cross-sectional designs. It is plausible that those with poorer mental health choose to be more sedentary at screens—a reverse causality hypothesis. Only half the cross-sectional studies controlled for physical activity in their analyses. Most of the studies are large, with some being very large, and one assessing across multiple countries. Sedentary behaviour needs to be considered alongside physical activity in the study of mental health.

OVERALL CONCLUSIONS

In summarising physical activity and mental health in young people, physical activity is likely to have positive psychosocial outcomes. The review of reviews method adopted allows us to see the wider field of several mental health outcomes associated with physical activity in young people. It also allows a view of the gaps and inconsistencies across different outcomes.

The effects seem strongest for self-esteem (at least in the short term), and those who are physically active seem less likely to suffer from mental health problems and may have enhanced cognitive functioning. Evidence on depression is also promising but remains an underdeveloped area of enquiry. Although all participants are likely to gain significant benefits, such effects are likely to be greater in those who have poorer mental health at baseline; however, the evidence is not extensive. Studies are largely cross-sectional (thus unable to rule out reverse causality) and small scale and lack measurement consistency. In addition although physical activity may enhance psychological well-being, it is possible that the prevailing psychological climate and social interactions inherent in such settings will also be crucial. Unfortunately, such factors are rarely accounted for. Higher levels of sedentary (sitting) behaviour are associated with worse mental health.

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Physical activity and mental health in children and adolescents: a review of reviews

Stuart J H Biddle and Mavis Asare

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Appendix 2. Summary Table of Systematic Reviews of Physical Activity and Mental Well-Being

### Physical Activity and Cognitive Functioning

<table>
<thead>
<tr>
<th>S/N</th>
<th>Author and Year</th>
<th>Years Covered</th>
<th>Type of Review</th>
<th>No. of Studies</th>
<th>Type of Sample</th>
<th>Exposure Variables</th>
<th>Type of Research Design</th>
<th>Main Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shephard (1997)</td>
<td>Not stated</td>
<td>Non-meta-analysis</td>
<td>3</td>
<td>Boys and girls &lt;20 years</td>
<td>School physical education</td>
<td>Cross-sectional; longitudinal</td>
<td>School physical activities significantly improve academic performance despite about 14-26% reduction in curricular time.</td>
<td>No experimental study was included.</td>
</tr>
<tr>
<td>2</td>
<td>Sibley and Etnier (2003)</td>
<td>2002-2003</td>
<td>Meta-analysis</td>
<td>44</td>
<td>Boys and girls 4-18 years</td>
<td>Physical activity (aerobic, resistance, perceptual motor, and school physical education)</td>
<td>Cross-sectional; experimental</td>
<td>Physical activity is significantly associated with improved cognitive functioning ($ES=0.32$). <strong>Moderators:</strong> Older students (e.g. middle school age) benefited more from physical activity than elementary school age students. Type of physical activity was not a significant moderator. Research design was not a significant moderator.</td>
<td>Participants also included those with disabilities, though the type of disability was not mentioned. Seven unpublished experimental studies were included.</td>
</tr>
<tr>
<td></td>
<td>Authors</td>
<td>Year Range</td>
<td>Analysis Type</td>
<td>Participants</td>
<td>Study Design</td>
<td>Findings</td>
<td>Methodological Issues</td>
<td></td>
<td></td>
</tr>
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<td>--------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Trudeau and Shephard</td>
<td>1966-2007</td>
<td>Non meta-analysis</td>
<td>Boys and girls 5-16 years</td>
<td>School physical activities (e.g. physical education, school sports)</td>
<td>Cross-sectional; longitudinal; experimental</td>
<td>School physical activities do not affect academic performance of students. Children in the experimental group whose curricular time was reduced for physical activities performed equally to the control group. Physical activity significantly improved concentration and classroom behaviour.</td>
<td>Some of the studies did not use true control groups.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Tomporowski et al.</td>
<td>Not Stated</td>
<td>Non meta-analysis</td>
<td>Boys and girls 8-16 years</td>
<td>Physical activity (aerobic e.g. running, and strength)</td>
<td>Cross-sectional; randomised controlled trials</td>
<td>Physical activity did not have a consistent impact on executive functioning. A significant positive association was found between physical activity and academic achievement. A significant positive association was found between physical activity and cognitive skills. Experimental studies had a larger effect than cross-sectional studies.</td>
<td>Studies included used too many different tests to assess executive functioning.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Keeley and Fox</td>
<td>Up to February 2009</td>
<td>Non meta-analysis</td>
<td>Boys and girls 4-18 years</td>
<td>Physical activities (active travel; school)</td>
<td>Cross-sectional; longitudinal; randomised</td>
<td>School physical activities had a significant positive association with academic achievement. The</td>
<td>Studies included assessed only school physical activities.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Study Description</td>
<td>Study Type</td>
<td>Sample Size</td>
<td>Participants</td>
<td>Operational Definitions of Variables</td>
<td>Study Design</td>
<td>Findings</td>
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<td>6</td>
<td>Ramstetter et al. (2010)</td>
<td>Systematic Review</td>
<td>15</td>
<td>Boys and girls; school children</td>
<td>Physical activity (school physical education; recess, etc.)</td>
<td>Cross-sectional; longitudinal; experimental</td>
<td>Almost all the studies found significant and consistent associations between physical activity and cognitive skills such as attention, concentration and cooperative classroom behaviours. Studies did not include adolescents. Included participants from the U.S. only.</td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>Centers for Disease Control and Prevention (2010)</td>
<td>Non meta-analysis</td>
<td>50</td>
<td>Primary school children. Specific ages not specified.</td>
<td>Physical activity (School physical education; classroom based physical activity; extra-curricular physical activity)</td>
<td>Longitudinal; intervention</td>
<td>Increased time in physical education class had a significant positive association with academic achievement. All the 19 studies examining the association between physical activity and academic performance found significant positive associations. Consistent associations were</td>
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<td></td>
<td>Measures of academic performance and cognitive skills were not stated. Studies involved were mostly cross-sectional designs which do not establish causal relationships.</td>
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</tr>
<tr>
<td></td>
<td>Study Details</td>
<td>Year of Publication</td>
<td>Study Type</td>
<td>Participants</td>
<td>Intervention</td>
<td>Findings</td>
<td>Notes</td>
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<tr>
<td>8</td>
<td>Best (2010)</td>
<td>Not stated</td>
<td>Systematic Review</td>
<td>Not stated</td>
<td>Boys &amp; girls 7-11 years</td>
<td>Aerobic physical activity</td>
<td>Experimental</td>
<td>Physical activity had significant improvement on cognitive functioning. Complex physical activities had stronger impact on cognitive functioning than simpler physical activities such as walking.</td>
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<td></td>
<td>Only 3 of the included studies examined executive functioning.</td>
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<td>Moderators: Older children significantly benefited from complex physical activities than younger children.</td>
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<tr>
<td>9</td>
<td>Rasberry et al. (2011)</td>
<td>1985-2008</td>
<td>Systematic Review</td>
<td>50</td>
<td>Boys and girls 6 to 18 years</td>
<td>Physical activity (physical education; recess; classroom physical activity; extra-curricular physical activity)</td>
<td>Cross-sectional; longitudinal; intervention</td>
<td>Significant and consistent associations were found between physical activity and academic achievement. Eight of 10 intervention studies found an association between physical activity and academic achievement. Significant and consistent associations were found between physical activity and cognitive skills.</td>
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<td></td>
<td></td>
<td></td>
<td>Focused only on school physical activities. None of the studies reported that physical education has a negative impact on academic performance.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Barenberg et al. (2011)</td>
<td>Not stated</td>
<td>Systematic Review</td>
<td>23</td>
<td>Boys and girls. From 7 years and</td>
<td>Physical activity (aerobic); physical</td>
<td>Interventions</td>
<td>Physical activity has a significant impact on executive functioning.</td>
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<td></td>
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<td></td>
<td></td>
<td>Only 9 intervention studies were found. The</td>
<td></td>
</tr>
</tbody>
</table>
above. fitness

remaining studies reported on acute physical activity.

|   | Farb and Matjasko (2012) | 2004-2009 | Systematic Review | 24 | Boys and girls 12-19 years | Physical activity (school physical education; recess; classroom physical activity, etc.) | Cross-sectional; longitudinal | Physical activity was significantly associated with academic achievement. | Studies involve only US and Canadian young people. |
## Physical Activity and Depression

<table>
<thead>
<tr>
<th>S/N</th>
<th>Author (year)</th>
<th>Years Covered</th>
<th>Type of Review</th>
<th>No. of Studies</th>
<th>Type of Sample</th>
<th>Exposure Variables</th>
<th>Type of Research Design</th>
<th>Main Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>North et al. (1990)</td>
<td>Up to 1989</td>
<td>Meta-analysis</td>
<td>5</td>
<td>Males and females 11 to 55 years</td>
<td>Physical activity (aerobic, strength; endurance)</td>
<td>experiment</td>
<td>Physical activity was significantly associated with reduced depression (ES= -0.60). Length of physical activity and gender did not moderate the impact of physical activity on depression.</td>
<td>Only 5 studies involved young people.</td>
</tr>
<tr>
<td>2</td>
<td>Calfas and Taylor (1994)</td>
<td>Up to 1982</td>
<td>Meta-analysis</td>
<td>20</td>
<td>Boys and girls 11-21 years</td>
<td>Physical activity (aerobic; flexibility)</td>
<td>Cross-sectional; experimental</td>
<td>Physical activity was significantly associated with reduced depression (ES=0.38). There was no comparison between aerobic and other types of physical activity on depression.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Craft and Landers (1998)</td>
<td>Up to 1996</td>
<td>Meta-analysis</td>
<td>3</td>
<td>Boys and girls 12-18 years</td>
<td>Physical activity (aerobic; anaerobic)</td>
<td>Quasi-experiments</td>
<td>Physical activity significantly reduced depression among participants with clinical depression and depression resulting from mental illness (ES= -0.15)</td>
<td>The review included only studies involving participants with clinically diagnosed depression.</td>
</tr>
<tr>
<td>No.</td>
<td>Authors and Year</td>
<td>Date Range</td>
<td>Study Design</td>
<td>Sample Size</td>
<td>Dependent Variables</td>
<td>Study Description</td>
<td>Notes</td>
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<tr>
<td>4</td>
<td>Larun et al. (2009)</td>
<td>1965-2005</td>
<td>Meta-analysis</td>
<td>5</td>
<td>Boys and girls 11-19 years</td>
<td>Physical activity (school physical education; aerobic; strength)</td>
<td>Experiments</td>
<td>Physical activity had a significant impact in reducing depression (ES = -0.66)</td>
<td>Only 3 studies were on young people.</td>
</tr>
<tr>
<td>5</td>
<td>Ahn and Fedewa (2011)</td>
<td>Not stated</td>
<td>Meta-analysis</td>
<td>73</td>
<td>Boys and girls 3-18 years</td>
<td>Physical activity (aerobic; strength; flexibility)</td>
<td>Cross-sectional; experimental</td>
<td>Physical activity had a significant negative association with depression (ES = -0.14)</td>
<td>Some of the studies were unpublished. Only one study was from Africa.</td>
</tr>
<tr>
<td>6</td>
<td>Johnson and Taliaferro (2011)</td>
<td>1997-2010</td>
<td>Systematic Review</td>
<td>19</td>
<td>Boys and girls mean age 14 and 19 years</td>
<td>Physical activity (aerobic; sports)</td>
<td>Cross-sectional; longitudinal; experimental</td>
<td>Physical activity had a significant negative relationship with depression.</td>
<td>Some of the studies did not use clinical diagnostic tools to assess depression.</td>
</tr>
<tr>
<td>7</td>
<td>Farb and Matjasko (2012)</td>
<td>2004-2009</td>
<td>Systematic Review</td>
<td>24</td>
<td>Boys and girls 12-19 years</td>
<td>Physical activity (school physical education; school sports, etc.)</td>
<td>Cross-sectional; longitudinal</td>
<td>Physical activity was associated with reduced depression.</td>
<td>Studies involved mostly adolescents.</td>
</tr>
</tbody>
</table>
# Physical Activity and Self-esteem

<table>
<thead>
<tr>
<th>S/N</th>
<th>Author (year)</th>
<th>Years Covered</th>
<th>Type of Review</th>
<th>No. of Studies</th>
<th>Type of Sample</th>
<th>Exposure Variables</th>
<th>Type of Research Design</th>
<th>Main Findings</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gruber (1986)</td>
<td>Up to 1966</td>
<td>Meta-analysis</td>
<td>27</td>
<td>Boys and girls &lt;18 years</td>
<td>Physical activity (school physical education; aerobic, strength)</td>
<td>experiment</td>
<td>Physical activity had a significant positive impact on self-esteem (ES=0.41).</td>
<td>Included studies involving young people with disabilities.</td>
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<td></td>
<td>The effect size was greater for young people with disabilities than those without disabilities.</td>
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</tr>
<tr>
<td>2</td>
<td>Calfas and Taylor (1994)</td>
<td>Up to 1982</td>
<td>Meta-analysis</td>
<td>20</td>
<td>Boys and girls 11-21 years</td>
<td>Physical activity (aerobic; strength; flexibility)</td>
<td>Cross-sectional; quasi experimental</td>
<td>Physical activity was significantly associated with reduced depression (ES= - 0.12)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ekeland et al. (2009)</td>
<td>1965-2002</td>
<td>Meta-analysis</td>
<td>25</td>
<td>Boys and girls 3-20 years</td>
<td>Physical activity (running; swimming; ball games; out-door play; energetic activities)</td>
<td>Quasi-experiments</td>
<td>Physical activity significantly improved self-esteem (ES= 0.49).</td>
<td>Only 4 studies were included in the meta-analysis.</td>
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<td></td>
<td>Physical activity as part of other interventions significantly improved depression (ES= 0.51)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ahn and Fedewa (2011)</td>
<td>Not stated</td>
<td>Meta-analysis</td>
<td>73</td>
<td>Boys and girls 3-18 years</td>
<td>Physical activity (aerobic; strength; flexibility )</td>
<td>Cross-sectional; experimental</td>
<td>Physical activity was significantly associated with enhanced self-esteem (ES= 0.57)</td>
<td>Some of the studies were unpublished. Only one study was from</td>
</tr>
<tr>
<td></td>
<td>Study</td>
<td>Year</td>
<td>Design</td>
<td>Sample Size</td>
<td>Age Range</td>
<td>Activities</td>
<td>Study Type</td>
<td>Findings</td>
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<tr>
<td>7</td>
<td>Farb and Matjasko (2012)</td>
<td>2004-2009</td>
<td>Systematic Review</td>
<td>24</td>
<td>Boys and girls 12-19 years</td>
<td>Physical activity (school physical education; school sports, etc.)</td>
<td>Cross-sectional; longitudinal</td>
<td>Physical activity was significantly associated with improved self-esteem.</td>
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<td></td>
<td>The number of studies that assessed self-esteem was not mentioned.</td>
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<tr>
<td>8</td>
<td>Shin and Park (2012)</td>
<td>Up to 2010</td>
<td>Meta-analysis</td>
<td>14</td>
<td>Boys and girls Ages not specified.</td>
<td>Physical activity (aerobic; endurance; balance)</td>
<td>Interventions</td>
<td>Physical activity had a significant positive impact on self-esteem (ES= 0.90).</td>
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<td></td>
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<td></td>
<td>A large effect size was determined.</td>
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</tr>
<tr>
<td>9</td>
<td>Lubans et al. (2012)</td>
<td>Up to 2010</td>
<td>Systematic Review</td>
<td>15</td>
<td>Boys and girls 4-18 years</td>
<td>Physical activity (aerobic; endurance; balance)</td>
<td>Experimental</td>
<td>Physical activity was significantly associated with improved self-esteem.</td>
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<td>Some of the studies assessed self-concept.</td>
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</tr>
</tbody>
</table>
### Appendix 3. Summary Table of Studies Included in the Meta-analysis and Study Quality Ratings

<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Characteristics</th>
<th>Design/ method</th>
<th>Sedentary behaviour exposure variable</th>
<th>Mental Well-being outcome variable</th>
<th>Results</th>
<th>Study quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fling et al (1992)</td>
<td>N= 153 children and adolescents from middle and junior high schools. Boys and girls of 11 to 18 years old.</td>
<td>Cross-sectional</td>
<td>Video game playing</td>
<td>Self-esteem</td>
<td>There was a significant but small positive association between sedentary behaviour and self-esteem.</td>
<td>5</td>
</tr>
<tr>
<td>Colwell et al (1995)</td>
<td>N= 120 English school children and adolescents. Boys and girls aged 11 to 17 years.</td>
<td>Cross-sectional</td>
<td>Television viewing and computer game playing</td>
<td>Self-esteem</td>
<td>Sedentary behaviour was significantly associated with low self-esteem in girls. A moderate association was determined.</td>
<td>4</td>
</tr>
<tr>
<td>Durkin &amp; Barber (2002)</td>
<td>N= 1304 adolescents in the U.S. Boys and girls aged 16 years.</td>
<td>Cross-sectional</td>
<td>Computer game playing</td>
<td>Depression and Self-esteem</td>
<td>Low use of computer games was significantly associated with lower depression and higher self-esteem than high use and non-use of computer games.</td>
<td>4</td>
</tr>
<tr>
<td>Schmitz et al (2002)</td>
<td>N= 3798 students from sixteen schools in the U.S. Boys and girls of 11 to 15 years.</td>
<td>Cross-sectional</td>
<td>Television viewing and video game playing</td>
<td>Depression</td>
<td>Sedentary behaviour was positively associated with depression.</td>
<td>7</td>
</tr>
<tr>
<td>Study</td>
<td>Sample Size</td>
<td>Study Design</td>
<td>Sedentary Behavior</td>
<td>Outcome</td>
<td>Findings</td>
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<tr>
<td>Chen et al (2005)</td>
<td>N= 7887</td>
<td>Cross-sectional</td>
<td>Television viewing</td>
<td>Quality of life</td>
<td>Longer duration of television viewing was significantly associated with poor quality of life.</td>
<td></td>
</tr>
<tr>
<td>Lohaus et al (2005)</td>
<td>N= 357</td>
<td>Cross-sectional</td>
<td>Television viewing and computer use</td>
<td>Anxiety</td>
<td>A significant but small positive association between media use and anxiety.</td>
<td></td>
</tr>
<tr>
<td>Ybarra et al (2005)</td>
<td>N= 1501</td>
<td>Cross-sectional</td>
<td>Internet use</td>
<td>Depression</td>
<td>Internet use for ≥3 hours a day was significantly associated with higher depression.</td>
<td></td>
</tr>
<tr>
<td>Ha et al (2007)</td>
<td>N= 452</td>
<td>Cross-sectional</td>
<td>Internet use</td>
<td>Depression</td>
<td>A significant and strong positive relationship between excessive</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Sample Description</td>
<td>Study Design</td>
<td>Screen Use (Media Type)</td>
<td>Psychological Outcome</td>
<td>Association</td>
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</tr>
<tr>
<td>Ussher et al (2007)</td>
<td>N= 2623 adolescents from ten schools in the U.K. Boys and girls of 13 to 16 years.</td>
<td>Cross-sectional</td>
<td>Screen use (TV, Computer, Video game)</td>
<td>Psychological distress</td>
<td>A significant and strong positive association between higher sedentary behaviour and psychological difficulties.</td>
<td></td>
</tr>
<tr>
<td>Selfhout et al (2009)</td>
<td>N= 307 Dutch adolescents. Boys and girls.</td>
<td>Longitudinal</td>
<td>Internet use</td>
<td>Depression and anxiety</td>
<td>Use of internet was not significantly associated with depression or anxiety over time.</td>
<td></td>
</tr>
<tr>
<td>Hamer et al (2009)</td>
<td>N= 1486 Scottish children aged 4 to 12 years.</td>
<td>Cross-sectional</td>
<td>Television</td>
<td>Psychological distress</td>
<td>Higher screen use was significantly associated with higher psychological difficulties.</td>
<td></td>
</tr>
<tr>
<td>Study Reference</td>
<td>Sample Size and Characteristics</td>
<td>Study Design</td>
<td>Screen Use (Medium/Devices)</td>
<td>Mental Health Outcome</td>
<td>Findings</td>
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<tr>
<td>Mathers et al (2009)</td>
<td>N= 925 adolescents. Boys and girls of 13 to 20 years.</td>
<td>Cross-sectional</td>
<td>Screen use (Television, computer, video games)</td>
<td>Psychological distress</td>
<td>Longer use of screen was significantly associated with higher psychological difficulties.</td>
<td></td>
</tr>
<tr>
<td>Primack et al (2009)</td>
<td>N= 4142 adolescents from multi-ethnic cultures including Europe, America and Asia. Boys and girls.</td>
<td>Longitudinal</td>
<td>Screen use (Television, computer and video games)</td>
<td>Depression</td>
<td>Longer television viewing was significantly associated with the likelihood of higher depression at follow-up.</td>
<td></td>
</tr>
<tr>
<td>Choo et al (2010)</td>
<td>N= 2998 children and adolescents from Singapore. Boys and girls from primary and secondary schools.</td>
<td>Cross-sectional</td>
<td>Video game playing</td>
<td>Anxiety</td>
<td>Excessive video game playing was significantly associated with higher anxiety symptoms.</td>
<td></td>
</tr>
</tbody>
</table>

Note: The table entries include study references, sample sizes, study designs, screen use characteristics, mental health outcomes, and findings. The study references are as follows:
- Mathers et al (2009)
- Primack et al (2009)
- Russ et al (2009)
- Choo et al (2010)
- Dumith et al (2010)
<table>
<thead>
<tr>
<th>Study</th>
<th>N</th>
<th>Design</th>
<th>Variables Measures</th>
<th>Outcomes</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffiths et al (2010)</td>
<td>N= 13470 children in the U.K. Boys and girls of 3 to 5 years.</td>
<td>Cross-sectional</td>
<td>Screen use (Television, computer and video games)</td>
<td>Psychological distress</td>
<td>Longer hours of screen use were not associated with psychological difficulties in very young children.</td>
</tr>
<tr>
<td>Katon et al (2010)</td>
<td>N= 2291 adolescents in the U.S. Boys and girls aged 13 to 17 years.</td>
<td>Cross-sectional</td>
<td>Television viewing and computer use</td>
<td>Depression</td>
<td>Excessive computer use was significantly associated with higher depression.</td>
</tr>
<tr>
<td>Page et al (2010)</td>
<td>N= 1013 school children from twenty-three primary schools in the U.K. Boys and girls of 10 to 11 years.</td>
<td>Cross-sectional</td>
<td>Television viewing, computer use and total sedentary behaviour.</td>
<td>Psychological distress</td>
<td>Greater television and computer use was significantly associated with higher psychological difficulties. However, overall sedentary time, assessed with accelerometer, was significantly associated with better psychological well-being.</td>
</tr>
<tr>
<td>Cao et al (2011)</td>
<td>N= 5003 Chinese children and adolescents. Boys and girls aged 11 to 16 years.</td>
<td>Cross-sectional</td>
<td>Screen use (TV, and computer)</td>
<td>Depression, anxiety and quality of life.</td>
<td>There was a significant positive relationship between sedentary behaviour and depression, anxiety. Sedentary behaviour was also associated with life dissatisfaction.</td>
</tr>
<tr>
<td>Deyreh (2011)</td>
<td>N= 231 elementary students in Iran. Boys and girls.</td>
<td>Cross-sectional</td>
<td>Computer use and video game playing.</td>
<td>Psychological distress</td>
<td>There was a significant positive association between sedentary behaviour and psychological difficulties.</td>
</tr>
<tr>
<td>Study Authors</td>
<td>N</td>
<td>Setting</td>
<td>Study Type</td>
<td>Primary Outcome Variables</td>
<td>Findings</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------</td>
<td>------------------------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Holtz et al (2011)</td>
<td>205 students from Austria. Boys and girls of 10 to 14 years.</td>
<td>Cross-sectional</td>
<td>Internet use and video game playing.</td>
<td>Anxiety</td>
<td>Excessive internet use was significantly associated with anxiety symptoms.</td>
</tr>
<tr>
<td>Jackson et al (2011)</td>
<td>482 school children from the U.S. Boys and girls.</td>
<td>Cross-sectional</td>
<td>Screen use (internet and video games)</td>
<td>Self-esteem (social self-esteem and overall self-esteem)</td>
<td>Only internet use was significantly associated with low social and overall self-esteem.</td>
</tr>
<tr>
<td>Lemola et al (2011)</td>
<td>190 students from Switzerland. Boys and girls aged 13 to 17 years.</td>
<td>Cross-sectional</td>
<td>Computer use</td>
<td>depression</td>
<td>Longer duration of computer use especially at night was significantly associated with depression.</td>
</tr>
<tr>
<td>Messias et al (2011)</td>
<td>2 separate samples. N= 30451 U.S students. Boys and girls of 14 to 18 years.</td>
<td>Cross-sectional</td>
<td>Internet use and video game playing.</td>
<td>Depression (suicidal ideas)</td>
<td>Students who used the internet or play video games for 5 hours or more per day had higher risk of sadness and suicidal ideas.</td>
</tr>
<tr>
<td>Sund et al (2011)</td>
<td>2464 school children and adolescents in Norway. Boys and girls aged 12 to 15 years.</td>
<td>Longitudinal</td>
<td>TV viewing, video game playing and reading.</td>
<td>Depression</td>
<td>Higher amount of time spent in sedentary activities significantly predicted depression a year later.</td>
</tr>
</tbody>
</table>

Note: Study quality was scored over 11 points for cross-sectional studies and 13 for longitudinal studies.
Appendix 4. Results of the Pilot Intervention Study

Table 5.3.6. Sample characteristics at baseline (pilot study)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Overall (N= 60)</th>
<th>Intervention School (n= 30)</th>
<th>Control School (n= 30)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>14.45 (0.89)</td>
<td>14.50 (0.82)</td>
<td>14.40 (0.97)</td>
<td>0.67</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>156.07 (5.48)</td>
<td>156.10 (5.60)</td>
<td>156.03 (5.46)</td>
<td>0.96</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>58.57 (8.04)</td>
<td>59.83 (8.29)</td>
<td>57.30 (7.71)</td>
<td>0.23</td>
</tr>
<tr>
<td>BMI</td>
<td>24.03 (2.93)</td>
<td>24.54 (2.98)</td>
<td>23.52 (2.84)</td>
<td>0.18</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>F (%)</td>
<td>F (%)</td>
<td>F (%)</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>24 (40.0%)</td>
<td>13 (43.3%)</td>
<td>11 (36.7%)</td>
<td>0.60</td>
</tr>
<tr>
<td>Females</td>
<td>36 (60.0%)</td>
<td>17 (56.7%)</td>
<td>19 (63.3%)</td>
<td>0.60</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>JHS 1</td>
<td>22 (36.7%)</td>
<td>11 (36.7%)</td>
<td>11 (36.7%)</td>
<td>1.00</td>
</tr>
<tr>
<td>JHS 2</td>
<td>24 (40.0%)</td>
<td>12 (40.0%)</td>
<td>12 (40.0%)</td>
<td>1.00</td>
</tr>
<tr>
<td>JHS 3</td>
<td>14 (23.3%)</td>
<td>7 (23.3%)</td>
<td>7 (23.3%)</td>
<td>1.00</td>
</tr>
<tr>
<td>Height Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (≥ 5.0 percentile)</td>
<td>55 (91.7%)</td>
<td>27 (90.0%)</td>
<td>28 (93.3%)</td>
<td>0.64</td>
</tr>
<tr>
<td>Stunted (&lt; 5.0 percentile)</td>
<td>5 (8.3%)</td>
<td>3 (10.0%)</td>
<td>2 (6.7%)</td>
<td>0.64</td>
</tr>
<tr>
<td>Weight Classification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (&lt;25kg/m²)</td>
<td>31 (51.7%)</td>
<td>14 (46.7%)</td>
<td>17 (56.7%)</td>
<td>0.71</td>
</tr>
<tr>
<td>Overweight (&gt;25kg/m² ≤30kg/m²)</td>
<td>23 (38.3%)</td>
<td>13 (43.3%)</td>
<td>10 (33.3%)</td>
<td>0.71</td>
</tr>
<tr>
<td>Obese (&gt;30kg/m²)</td>
<td>6 (10.0%)</td>
<td>3 (10.0%)</td>
<td>3 (10.0%)</td>
<td>0.71</td>
</tr>
</tbody>
</table>
Table 5.3.7. One-way repeated measures ANOVA of the impact of physical activity intervention on scores of the PAQ-A and the pedometer

<table>
<thead>
<tr>
<th>Physical Activity levels</th>
<th>Time point</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PAQ-A</td>
<td>1</td>
<td>1.47 (0.45)</td>
<td>1.49 (0.42)</td>
<td>590.19</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.67 (0.45)</td>
<td>4.60 (0.46)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedometer</td>
<td>1</td>
<td>4140.07 (484.83)</td>
<td>4181.73 (310.99)</td>
<td>267.03</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>11973.80 (1868.68)</td>
<td>4563.00 (277.46)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001

Table 5.3.8. One-way repeated measures ANOVA of physical activity and well-being indicators

<table>
<thead>
<tr>
<th>Well-being Category</th>
<th>Time point</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M (SD)</td>
<td>M (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive functioning</td>
<td>1</td>
<td>31.41 (8.69)</td>
<td>33.48 (9.33)</td>
<td>33.89</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>41.34 (9.74)</td>
<td>31.59 (8.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Self-worth</td>
<td>1</td>
<td>16.45 (5.04)</td>
<td>16.74 (5.08)</td>
<td>41.11</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24.76 (4.18)</td>
<td>16.59 (4.36)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body dissatisfaction</td>
<td>1</td>
<td>2.28 (0.88)</td>
<td>2.11 (0.93)</td>
<td>51.19</td>
<td>0.000*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>0.62 (0.56)</td>
<td>1.96 (1.16)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.001
Table 5.3.9. One-way repeated measures ANCOVA results for physical activity, nutritional practice and cognitive functioning

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time point</th>
<th>Experimental Group $M (SD)$</th>
<th>Control Group $M (SD)$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical Activity</td>
<td>1</td>
<td>31.41 (8.69)</td>
<td>33.48 (9.33)</td>
<td>4.43</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>41.34 (9.74)</td>
<td>31.59 (8.93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nutritional Practice</td>
<td></td>
<td></td>
<td>0.00</td>
<td>0.99</td>
<td></td>
</tr>
</tbody>
</table>

ANCOVA: adjusted for nutritional practice.

*$p<0.05$
## Appendix 5. Meta-analysis Search Terms

The following search terms were used to search for the Studies:

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Populations</th>
<th>Mental Health Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sedentary</td>
<td>‘Young people’</td>
<td>‘Mental health’</td>
</tr>
<tr>
<td>Television</td>
<td>‘Children’</td>
<td>‘Psychological well-being’</td>
</tr>
<tr>
<td>Video</td>
<td>‘Adolescents’</td>
<td>‘Depression’</td>
</tr>
<tr>
<td>DVDs</td>
<td>‘Teenagers’</td>
<td>‘Stress’</td>
</tr>
<tr>
<td>Computers</td>
<td></td>
<td>‘Self-esteem’</td>
</tr>
<tr>
<td>Screen-time</td>
<td></td>
<td>‘Anxiety’</td>
</tr>
<tr>
<td>Sitting</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 6. Meta-analysis In-Out Form

**META-ANALYSIS– SEDENTARY BEHAVIOUR AND MENTAL WELL-BEING**

**In/Out Form**

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes</th>
<th>Not Clear</th>
<th>No</th>
<th>Further information:</th>
</tr>
</thead>
</table>
| Does the study provide statistical data on sedentary behaviour?  
State the measure of sedentary behaviour: | | | | State the main purpose of the study (including population and intervention focus): |

| Design: |

| Is the age group studied **aged 5-18 yrs**? | | | | |
| Is an outcome reported on mental **health**? | | | | State the measure of mental health reported: |

| Peer reviewed journal?  
Is this assessment reported as statistical data? | | | | |

**IF THE ANSWER TO ANY OF THE ABOVE IS SHADED BOX, EXCLUDE THE STUDY (FROM THIS INITIAL SCREENING)**

<table>
<thead>
<tr>
<th>This study is:</th>
<th>Included</th>
<th>Excluded</th>
<th>Not sure</th>
</tr>
</thead>
</table>

Other information

---

**Notes:**

1. The form is designed to screen studies for inclusion in a meta-analysis of sedentary behaviour and mental well-being.
2. The form includes questions to determine if a study meets the inclusion criteria.
3. Studies that do not meet the criteria are shaded and excluded from the initial screening.
4. The form is part of the methodology section of the meta-analysis document.
## Appendix 7. Data Extraction Form

<table>
<thead>
<tr>
<th>Author, date</th>
<th>Country of study</th>
<th>Study type (e.g. cross-sectional)</th>
<th>Population (e.g. children or adolescents)</th>
<th>Target population (e.g. girls only or low SES)</th>
<th>Number and mean age of sample</th>
<th>Response rate</th>
<th>Sedentary behaviour assessed</th>
<th>Assessment of sedentary behaviour (e.g. Self-report or objective)</th>
<th>Measure of sedentary behaviour (e.g. Accelerometer or questionnaire)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reliability of measure of sedentary behaviour</th>
<th>Validity of measure of sedentary behaviour</th>
<th>Type of mental health assessed (e.g. Depression)</th>
<th>Assessment of mental health</th>
<th>Measure of mental health</th>
<th>Reliability of measure of mental health</th>
<th>Validity of measure of mental health</th>
<th>Analyses used for association between SB and mental health (e.g. Regression or correlation)</th>
<th>Were analyses adjusted for potential confounders?</th>
<th>Results (data reported separately for each outcome)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Positive or negative association (significant or not)</th>
</tr>
</thead>
</table>


### Appendix 8. Physical Activity and Sedentary Behaviours Review – Quality Appraisal

#### QUALITY OF REPORTING

<table>
<thead>
<tr>
<th>item</th>
<th>Adequate* description of sampling population, methods of recruitment, and place of recruitment</th>
<th>+</th>
<th>-</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Adequate description of the characteristics of the baseline sample (number of participants, sex, age)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Presentation of descriptive data on SB and mental health outcomes – including point estimates / prevalence and measures of variability (SD, SE, 95% CI)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Additional items for prospective studies

| item | Description of follow-up duration (month / year of each assessment or age of participants at each assessment), the number and characteristics of participants assessed at each time point |   |   |   |

#### Comments

#### QUALITY SCORE: %

Response options: ‘+’ yes, criteria met; ‘-’ no, criteria not met; ‘?’ unclear or not sufficiently described

To calculate a quality of reporting score – calculate proportion of items scored ‘+’ (denominator is 3 for cross-sectional studies, 4 for prospective studies).
## Appendix 8. Physical Activity and Sedentary Behaviours Review – Quality Appraisal

### QUALITY OF STUDY (VALIDITY / PRECISION)

<table>
<thead>
<tr>
<th>Methods for selecting participants</th>
<th>+</th>
<th>-</th>
<th>?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Response rate at baseline at least 70% or if the non-response was not selective (attrition analysis indicates study sample is not different (sex, age, BMI, SES) from population of eligible participants)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Sampling procedure (No procedure reported/narrow procedure (-); diverse (+))</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Methods for measuring sedentary behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Reliable† tool used to assess sedentary behaviour</td>
</tr>
<tr>
<td>4 Valid‡ tool used to assess sedentary behaviour</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Methods for measuring mental health outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Reliable† tool used to assess mental health outcomes</td>
</tr>
<tr>
<td>6 Valid‡ tool used to assess mental health outcomes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistical analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Clear and appropriate method of analysis used</td>
</tr>
<tr>
<td>8 Analysis included attempts to control for confounding</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional items for prospective studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 Response rate at follow-up was at least 70% or if the non-response was not selective (attrition analysis indicates study sample is not different (sex, age, BMI, SES) from baseline sample)</td>
</tr>
</tbody>
</table>

### Comments

**QUALITY SCORE:** %

Response options: ‘+’ yes, criteria met; ‘-’ no, criteria not met; ‘?’ unclear or not sufficiently described

To calculate a quality of reporting score – calculate proportion of items scored ‘+’ (denominator is 9 for cross-sectional studies, 10 for prospective studies).
Appendix 8. Physical Activity and Sedentary Behaviours Review – Quality Appraisal

NOTES

* ‘Adequate’ – defined as sufficient information to be able to replicate the study

Sampling procedure – narrow sample (e.g. used only one class or one school for data collection); diverse sample (e.g. community based sample or used multiple schools for data collection).

† Reliability: ‘+’ only if sedentary behaviour or mental health was assessed objectively or if subjective instrument had test-retest reliability ≥0.70 or Kappa / ICC ≥0.70.

# Validity: ‘+’ only if sedentary behaviour or mental health was assessed objectively or if validated subjective instrument with correlations ≥0.70 or Kappa / ICC ≥0.70, or a combination of objective and subjective measures.
Appendix 9. Health Screening Questionnaire

HEALTH SCREEN  Name of child .................................................

It is important that volunteers participating in research studies are currently in good health and have had no significant medical problems in the past. This is to ensure (i) their own continuing well-being and (ii) to avoid the possibility of individual health issues confounding study outcomes.

Please complete this brief questionnaire to confirm fitness to participate:

1. At present, does your child have any health problem for which they are:
   (a) on medication, prescribed or otherwise .................... Yes ☐ No ☐
   (b) attending your general practitioner ......................... Yes ☐ No ☐
   (c) on a hospital waiting list ........................................ Yes ☐ No ☐

2. In the past two years, has your child had any illness which required them to:
   (a) consult your GP .................................................. Yes ☐ No ☐
   (b) attend a hospital outpatient department ................. Yes ☐ No ☐
   (c) be admitted to hospital ....................................... Yes ☐ No ☐

3. Has your child ever had any of the following:
   (a) Convulsions/epilepsy ......................................... Yes ☐ No ☐
   (b) Asthma ......................................................... Yes ☐ No ☐
   (c) Eczema ......................................................... Yes ☐ No ☐
   (d) Diabetes ......................................................... Yes ☐ No ☐
   (e) A blood disorder ............................................. Yes ☐ No ☐
   (f) Head injury ..................................................... Yes ☐ No ☐
   (g) Digestive problems ......................................... Yes ☐ No ☐
   (h) Heart problems ............................................... Yes ☐ No ☐
   (i) Problems with bones or joints ............................ Yes ☐ No ☐
   (j) Disturbance of balance/coordination .................... Yes ☐ No ☐
   (k) Numbness in hands or feet ............................... Yes ☐ No ☐
   (l) Disturbance of vision ....................................... Yes ☐ No ☐
   (m) Ear / hearing problems .................................... Yes ☐ No ☐
   (n) Thyroid problems .......................................... Yes ☐ No ☐
   (o) Kidney or liver problems ................................ Yes ☐ No ☐
   (p) Allergy to nuts ............................................... Yes ☐ No ☐

4. Has any, otherwise healthy, member of your family under the age of 35 died suddenly during or soon after exercise? ..Yes ☐ No ☐

If the response was YES to any of the questions above, please describe in more detail, as briefly as possible, the nature of the problem (e.g. to confirm the problem was / is short-lived, insignificant or well controlled.)

...........................................................................................................................................................
...........................................................................................................................................................
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............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
............................................................................................................................................................
5. What is your child’s ethnic group?
(Ethnic origin questions are not about nationality, place of birth or citizenship. They are about colour and broad ethnic group).

African

Other

(please specify).....................................................................

Thank you for your cooperation!

Loughborough University
<table>
<thead>
<tr>
<th>Overweight</th>
<th>Healthy Range</th>
<th>Below the Mean</th>
<th>Stunting</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Obesity</td>
<td>(not reliable)</td>
<td>Tall</td>
<td>Z &gt; 1.645</td>
<td>95.1 - 1.100 percentile</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1.036 &lt; Z &lt; 1.640</td>
<td>85.1 - 99 percentile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Above the Mean</td>
<td>Healthy Range</td>
<td>1.036 &lt; Z &lt; 1.030</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Healthy Range</td>
<td>Healthy Range</td>
<td>1.5 - 85 percentile</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Below the Mean</td>
<td>Healthy Range</td>
<td>1.045 &lt; Z &lt; 1.040</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Healthy Range</td>
<td>5.0 - 15 percentile</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Weighting</td>
<td>Underweight</td>
<td>Z &gt; 1.650</td>
<td>&gt; 5.0 percentile</td>
</tr>
</tbody>
</table>

(Adapted from Frischman, 2008: www.cdc.gov/growthcharts, www.who.org)

Appendix 10: Anthropometric Classification Table
Physical Activity Questionnaire (High School)

Code: _________________________   Age: _________________
Sex: __________________    Grade: _______________

Please indicate the highest level of education of either parent
<high school ____          high school ____          tertiary ____

We are trying to find out about your level of physical activity from the last 7 days (in the last week). These include sports or dance that make you sweat or make your legs feel tired, or games that make you breathe hard, like tag, skipping, running, climbing, and others. Please answer the following questions:

1. Physical activity in your spare time: Have you done any of the following activities in the past 7 days (last week)? If yes, how many times? (Mark only one circle per row)

<table>
<thead>
<tr>
<th>Activity</th>
<th>No</th>
<th>1-2 times</th>
<th>3-4 times</th>
<th>5-6 times</th>
<th>7 times or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skipping</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tug of war</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking for exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bicycling</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Jogging or running</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Aerobics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swimming</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Softball</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Dance</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Football</td>
<td></td>
<td></td>
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<tr>
<td>Ampe</td>
<td></td>
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<tr>
<td>Tumatu</td>
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<td></td>
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</tr>
<tr>
<td>Table tennis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volleyball</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Floor hockey</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basketball</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Other: 1.</td>
<td></td>
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</tr>
</tbody>
</table>
2. In the last 7 days, during your physical education (PE) classes, how often were you very active (playing hard, running, jumping, throwing)? (Check one only.)

- I don’t do PE .....................................................
- Hardly ever ..............................................................
- Sometimes ...............................................................
- Quite often ............................................................
- Always .................................................................

3. In the last 7 days, what did you normally do at lunch (besides eating lunch)? (Check one only.)

- Sat down (talking, reading, doing schoolwork)……
- Stood around or walked around ...............................
- Ran or played a little bit ..........................................
- Ran around and played quite a bit ...............................
- Ran and played hard most of the time .....................

4. In the last 7 days, on how many days right after school, did you do sports, dance, or play games in which you were very active? (Check one only.)

- None .................................................................
- 1 time last week ....................................................
- 2 or 3 times last week ...........................................
- 4 times last week ...................................................
- 5 times last week ....................................................

5. In the last 7 days, on how many evenings did you do sports, dance, or play games in which you were very active? (Check one only.)

- None .................................................................
- 1 time last week ....................................................
- 2 or 3 times last week ...........................................
- 4 or 5 last week ....................................................
- 6 or 7 times last week ............................................

6. On the last weekend, how many times did you do sports, dance, or play games in which you were very active? (Check one only.)

- None .................................................................
- 1 time .................................................................
- 2 — 3 times ...........................................................
- 4 — 5 times ...........................................................
- 6 or more times ...................................................
7. Which one of the following describes you best for the last 7 days? Read all five statements before deciding on the one answer that describes you.

F. All or most of my free time was spent doing things that involve little physical effort .................................................................

G. I sometimes (1 — 2 times last week) did physical things in my free time (e.g. played sports, went running, swimming, bike riding, did aerobics) ...........

H. I often (3 — 4 times last week) did physical things in my free time ..........

I. I quite often (5 — 6 times last week) did physical things in my free time ........

J. I very often (7 or more times last week) did physical things in my free time .....

8. Mark how often you did physical activity (like playing sports, games, doing dance, or any other physical activity) for each day last week.

<table>
<thead>
<tr>
<th>Day</th>
<th>None</th>
<th>Little bit</th>
<th>Medium</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. Were you sick last week, or did anything prevent you from doing your normal physical activities? (Check one.)

Yes ..............................................................................

No ..............................................................................

If Yes, what prevented you? ___________________________________________
Appendix 12. Physical Activity Log

Pedometer Recording Log and Activity Diary

Participant number__________________
**Pedometer recording log**

**Instructions**

- Please put your pedometer on as soon as you get out of bed in the morning and wear it all day, until you get back into bed in the evening. The pedometer should be worn continuously throughout waking hours, and only removed when bathing, showering and/or swimming.

- Please record what time you put the pedometer on in the morning, and the time you removed it each night in the table opposite.

If you have any questions, or problems, over the next 7 days, please contact Mavis Asare (0277 293438).

*Thank you for your participation!*

<table>
<thead>
<tr>
<th>Date</th>
<th>Please note the time the pedometer was put on &amp; taken off</th>
<th>Please give a brief account of any physical activity including approximate duration of the activity (e.g., walk, 30 minutes; gym, 60 minutes; run, 30 minutes etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>On:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>On:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>On:</td>
<td></td>
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<tr>
<td></td>
<td>Off:</td>
<td></td>
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<td></td>
<td>On:</td>
<td></td>
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<td></td>
<td>Off:</td>
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<td></td>
<td>On:</td>
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<td></td>
<td>Off:</td>
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<td>On:</td>
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<td></td>
<td>Off:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>On:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Off:</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 13. ADOLESCENT SEDENTARY ACTIVITY QUESTIONNAIRE (ASAQ)

Question 1. Think about a normal school week, and write down how long you spend doing the following activities before and after school each day.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours</td>
<td>Minutes</td>
<td>Hours</td>
<td>Minutes</td>
<td>Hours</td>
</tr>
<tr>
<td>Watching TV?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching videos/DVDs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the computer for fun?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the computer for doing homework?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing homework not on the computer?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading for fun?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being tutored?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel (car/bus/train)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing crafts or hobbies?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting around (chatting with friends/on the phone/chilling)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing/practicing a musical instrument?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Question 2. Think about a normal **weekend**, and write down how long you spend doing the following activities on the **weekend**.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Saturday</th>
<th></th>
<th>Sunday</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hours</td>
<td>Minutes</td>
<td>Hours</td>
<td>Minutes</td>
</tr>
<tr>
<td>Watching TV?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching videos/DVDs?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the computer for fun?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using the computer for doing homework?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing homework <strong>not</strong> on the computer?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading for fun?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being tutored?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Travel (car/bus/train)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing crafts or hobbies?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting around (chatting with friends/on the phone/chilling)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Playing/practicing a musical instrument?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Going to church or Saturday school?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 14. Children Depression Inventory

Name: __________________________
Age: _______  Birthdate: ____________
Grade in school: _______  Sex: _______
Today's date: ____________________

Kids sometimes have different feelings and ideas.

This form lists the feelings and ideas in groups. From each group of three sentences, pick one sentence that describes you best for the past two weeks. After you pick a sentence from the first group, go on to the next group.

There is no right or wrong answer. Just pick the sentence that best describes the way you have been recently. Put a mark like this □ next to your answer. Put the mark in the box next to the sentence that you pick.

Here is an example of how this form works. Try it. Put a mark next to the sentence that describes you best.

Example:

- □ I read books all the time.
- □ I read books once in a while.
- □ I never read books.

Remember, pick out the sentences that describe you best in the PAST TWO WEEKS.

<table>
<thead>
<tr>
<th>Item 1</th>
<th>Item 2</th>
<th>Item 6</th>
<th>Item 7</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ I am sad once in a while.</td>
<td>□ Nothing will ever work out for me.</td>
<td>□ I think about bad things happening to me once in a while.</td>
<td>□ I hate myself.</td>
</tr>
<tr>
<td>□ I am sad many times.</td>
<td>□ I am not sure if things will work out for me.</td>
<td>□ I worry that bad things will happen to me.</td>
<td>□ I do not like myself.</td>
</tr>
<tr>
<td>□ I am sad all the time.</td>
<td>□ Things will work out for me O.K.</td>
<td>□ I am sure that terrible things will happen to me.</td>
<td>□ I like myself.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 3</th>
<th>Item 4</th>
<th>Item 5</th>
<th>Item 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ I do most things O.K.</td>
<td>□ I have fun in many things.</td>
<td>□ I am bad all the time.</td>
<td>□ All bad things are my fault.</td>
</tr>
<tr>
<td>□ I do many things wrong.</td>
<td>□ I have fun in some things.</td>
<td>□ I am bad many times.</td>
<td>□ Many bad things are my fault.</td>
</tr>
<tr>
<td>□ I do everything wrong.</td>
<td>□ Nothing is fun at all.</td>
<td>□ I am bad once in a while.</td>
<td>□ Bad things are not usually my fault.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 9</th>
<th>Turn over and fill out the other side.</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ I do not think about killing myself.</td>
<td></td>
</tr>
<tr>
<td>□ I think about killing myself but I would not do it.</td>
<td></td>
</tr>
<tr>
<td>□ I want to kill myself.</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>Item 10</td>
<td>I feel like crying every day.</td>
</tr>
<tr>
<td></td>
<td>I feel like crying many days.</td>
</tr>
<tr>
<td></td>
<td>I feel like crying once in a while.</td>
</tr>
<tr>
<td>Item 11</td>
<td>Things bother me all the time.</td>
</tr>
<tr>
<td></td>
<td>Things bother me many times.</td>
</tr>
<tr>
<td></td>
<td>Things bother me once in a while.</td>
</tr>
<tr>
<td>Item 12</td>
<td>I like being with people.</td>
</tr>
<tr>
<td></td>
<td>I do not like being with people many times.</td>
</tr>
<tr>
<td></td>
<td>I do not want to be with people at all.</td>
</tr>
<tr>
<td>Item 13</td>
<td>I cannot make up my mind about things.</td>
</tr>
<tr>
<td></td>
<td>It is hard to make up my mind about things.</td>
</tr>
<tr>
<td></td>
<td>I make up my mind about things easily.</td>
</tr>
<tr>
<td>Item 14</td>
<td>I look O.K.</td>
</tr>
<tr>
<td></td>
<td>There are some bad things about my looks.</td>
</tr>
<tr>
<td></td>
<td>I look ugly.</td>
</tr>
<tr>
<td>Item 15</td>
<td>I have to push myself all the time to do my schoolwork.</td>
</tr>
<tr>
<td></td>
<td>I have to push myself many times to do my schoolwork.</td>
</tr>
<tr>
<td></td>
<td>Doing schoolwork is not a big problem.</td>
</tr>
<tr>
<td>Item 16</td>
<td>I have trouble sleeping every night.</td>
</tr>
<tr>
<td></td>
<td>I have trouble sleeping many nights.</td>
</tr>
<tr>
<td></td>
<td>I sleep pretty well.</td>
</tr>
<tr>
<td>Item 17</td>
<td>I am tired once in a while.</td>
</tr>
<tr>
<td></td>
<td>I am tired many days.</td>
</tr>
<tr>
<td></td>
<td>I am tired all the time.</td>
</tr>
<tr>
<td>Item 18</td>
<td>Most days I do not feel like eating.</td>
</tr>
<tr>
<td></td>
<td>Many days I do not feel like eating.</td>
</tr>
<tr>
<td></td>
<td>I eat pretty well.</td>
</tr>
<tr>
<td>Item 19</td>
<td>I do not worry about aches and pains.</td>
</tr>
<tr>
<td></td>
<td>I worry about aches and pains many times.</td>
</tr>
<tr>
<td></td>
<td>I worry about aches and pains all the time.</td>
</tr>
<tr>
<td>Item 20</td>
<td>I do not feel alone.</td>
</tr>
<tr>
<td></td>
<td>I feel alone many times.</td>
</tr>
<tr>
<td></td>
<td>I feel alone all the time.</td>
</tr>
<tr>
<td>Item 21</td>
<td>I never have fun at school.</td>
</tr>
<tr>
<td></td>
<td>I have fun at school only once in a while.</td>
</tr>
<tr>
<td></td>
<td>I have fun at school many times.</td>
</tr>
<tr>
<td>Item 22</td>
<td>I have plenty of friends.</td>
</tr>
<tr>
<td></td>
<td>I have some friends but I wish I had more.</td>
</tr>
<tr>
<td></td>
<td>I do not have any friends.</td>
</tr>
<tr>
<td>Item 23</td>
<td>My schoolwork is alright.</td>
</tr>
<tr>
<td></td>
<td>My schoolwork is not as good as before.</td>
</tr>
<tr>
<td></td>
<td>I do very badly in subjects I used to be good in.</td>
</tr>
<tr>
<td>Item 24</td>
<td>I can never be as good as other kids.</td>
</tr>
<tr>
<td></td>
<td>I can be as good as other kids if I want to.</td>
</tr>
<tr>
<td></td>
<td>I am just as good as other kids.</td>
</tr>
<tr>
<td>Item 25</td>
<td>Nobody really loves me.</td>
</tr>
<tr>
<td></td>
<td>I am not sure if anybody loves me.</td>
</tr>
<tr>
<td></td>
<td>I am sure that somebody loves me.</td>
</tr>
<tr>
<td>Item 26</td>
<td>I usually do what I am told.</td>
</tr>
<tr>
<td></td>
<td>I do not do what I am told most times.</td>
</tr>
<tr>
<td></td>
<td>I never do what I am told.</td>
</tr>
<tr>
<td>Item 27</td>
<td>I get along with people.</td>
</tr>
<tr>
<td></td>
<td>I get into fights many times.</td>
</tr>
<tr>
<td></td>
<td>I get into fights all the time.</td>
</tr>
</tbody>
</table>
Appendix 15

PHYSICAL SELF-WORTH QUESTIONNAIRE - MODIFIED

Code: _______________  Gender: ____________   Age: _________

What Are You Like?

Please rate each statement as it applies to you. Tick one number on each line.

<table>
<thead>
<tr>
<th>Statement</th>
<th>1 Not at all like me</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 Very much like me</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Some kids are proud of themselves physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2 Some kids don’t feel very confident about themselves physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3 Some kids are very satisfied with themselves physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4 Some kids are unhappy with how they are and what they can do physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5 Some kids have a positive feeling about themselves physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6 Some kids wish that they could feel better about themselves physically</td>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Statement</td>
<td>Strongly disagree</td>
<td>Disagree</td>
<td>Neither agree nor disagree</td>
<td>Agree</td>
<td>Strongly agree</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-------------------</td>
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<td>---------------------------</td>
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<td>----------------</td>
</tr>
<tr>
<td>1. When I come home or leave the house, I have to tell my parents</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2. When I have a bad results at school, my parents encourage me to do better.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>3. I can count on my father when I have any problems.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>4. My mother helps me with homework if I do not understand something.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>5. I find it very easy to talk to my mother openly. She is very involved in my life.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>6. If I have a bad result in school my parents offer to help me.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. My parents really know what I do in my leisure time.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>8. My father helps me with homework if I do not understand something.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>9. My parents really know where I go in the evenings.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>10. My parents know exactly where I am after school.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>11. My parents make time to talk to me.</td>
<td></td>
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<tr>
<td>12. My parents really know where I am after school.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>13. If I get a good result at school my parents show admiration.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>14. Me and my parents regularly do something fun together.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>15. I can count on my mother when I have any problems.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

16. What time are you usually allowed to stay out until on a school night (Sunday-Thursday)? (please circle)

- I am not allowed to go out during the week
- Before 8 o’clock
- Between 8 and 10 o’clock
- Between 10 and 11 o’clock
- After 11/at anytime I want to

17. What time are you usually allowed to stay out until on a Friday-evening or Saturday-evening? (please circle)

- I am not allowed to go out during the weekend
- Before 8 o’clock
- Between 8 and 10 o’clock
- Between 10 and 11 o’clock
- After 11/at anytime I want to
Appendix 19. FOOD FREQUENCY QUESTIONNAIRE (FFQ)

How often have you eaten the following foods in the last week? Using the response options provided, please tick (✓) the box to indicate how often you eat each food item.

<table>
<thead>
<tr>
<th>Food</th>
<th>4 or more times/day</th>
<th>3 times/day</th>
<th>twice/day</th>
<th>once/day</th>
<th>4–6 times/week</th>
<th>2–3 times/week</th>
<th>once/week</th>
<th>not eaten</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cereals</td>
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<tr>
<td>Rice</td>
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<td>Wheat</td>
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<td>Millet</td>
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<td>Root/Tubers</td>
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<td>Plantain</td>
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<td>Yam</td>
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<td>Beans</td>
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<td>Peanuts</td>
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<td>Groundnuts</td>
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<td>Vegetables</td>
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<td>Cabbage</td>
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<td>Tomato</td>
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<td>Fruits</td>
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<tr>
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<td>Orange</td>
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<tr>
<td>Pineapple</td>
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<td></td>
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<tr>
<td>Item</td>
<td>4 or more times/day</td>
<td>3 times/day</td>
<td>twice/day</td>
<td>once/day</td>
<td>4–6 times/week</td>
<td>2–3 times/week</td>
<td>once/week</td>
<td>not eaten</td>
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<tr>
<td>Watermelon</td>
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<td>Fish products</td>
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<td>Fish</td>
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<td>Meat and egg</td>
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<td>Beef</td>
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<tr>
<td>Eggs</td>
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<td></td>
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<tr>
<td>Milk Products</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ice-cream</td>
<td></td>
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</tr>
</tbody>
</table>
The intervention study involves after-school physical activities, for two times a week for a period of 6 weeks. Each session of physical activity lasts for 45 minutes. Both boys and girls participate in the same kind of physical activity.

Venue: School playground

Total Number of Sessions: 12

<table>
<thead>
<tr>
<th>Week</th>
<th>Type of Physical Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Skipping</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Break</td>
<td>3 minutes</td>
</tr>
<tr>
<td></td>
<td>Running</td>
<td>20 minutes</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack</td>
<td>2 minutes</td>
</tr>
<tr>
<td>2</td>
<td>Football</td>
<td>40 minutes</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack (in between talk)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Vigorous dance (with music)</td>
<td>40 minutes</td>
</tr>
<tr>
<td></td>
<td>Break (in between PA)</td>
<td>(3 minutes)</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Skipping</td>
<td>15 minutes</td>
</tr>
<tr>
<td></td>
<td>Break</td>
<td>3 minutes</td>
</tr>
<tr>
<td></td>
<td>Running</td>
<td>20 minutes</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack</td>
<td>2 minutes</td>
</tr>
<tr>
<td>5</td>
<td>Football</td>
<td>40 minutes</td>
</tr>
<tr>
<td></td>
<td>Break (in between PA)</td>
<td>(3 minutes)</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Vigorous dance (with music)</td>
<td>40 minutes</td>
</tr>
<tr>
<td></td>
<td>Break (in between PA)</td>
<td>(3 minutes)</td>
</tr>
<tr>
<td></td>
<td>Talk (PA persuasion)</td>
<td>5 minutes</td>
</tr>
<tr>
<td></td>
<td>Snack</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 20
Ms Mavis Asare  
School of Sport, Health and Exercise Sciences  
Loughborough University  
Loughborough  
Leicestershire  
United Kingdom  
LE11 3TU  

10 August 2011  

Dear Ms Asare,  

R11-P114 – Physical Activity, Sedentary Behaviour and Adolescents’ well-being.  

I can confirm that the Loughborough University Ethical Advisory Committee has agreed to issue full ethical approval to the above study.  

Please note that any amendments to the approved study would require separate approval.  

Yours Sincerely,  

[Signature]  

Mrs Zoe Stockdale  
Secretary to the Ethical Advisory Committee
Dear Sir/Madam,

PERMISSION TO CONDUCT RESEARCH
PHYSICAL ACTIVITY AND SCHOOL WORK

Loughborough University is conducting a research on Physical Activity and School work. The aim of the study is to provide insight into the benefits of school physical activity programmes. The study will help to explore ways of improving children’s classroom performance.

The research is carried out by Ms. Mavis Asare, with the supervision of Prof Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University, UK.

We would need junior high school students to participate in this study and your school has been chosen as one of the sites we would like to use for data collection.

The selected students will be requested to do 40 minutes of supervised physical activity two times a week for a period of 6 weeks after which they will respond to paper pencil questionnaires on school work. It will take 7 weeks to complete the study. The study does not involve the taking of body samples nor any other procedures that would harm the students.

In the unlikely event of adverse incident, the study is covered by the Loughborough University Insurance.

All information obtained from the research is strictly confidential and would be handled according to the UK Data Protection Act 1998 and stored securely at Loughborough University. Any written information about the study will be made anonymous without making particular reference to any school.
Appendix 22

If you have any questions about any aspect of the study, please do not hesitate to contact the research team using the address below.

In the unlikely event that you are unsatisfied about the procedures of the study, please contact the Loughborough University’s Research Ethical Committee: [http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm](http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm).

Hoping to hear favourably from you.

______________________________________________________________

Mavis Asare
P.O.Box KN 4213
Kaneshie-Accra
Ghana

Contact Person
Prof Stuart Biddle
School of Sport, Exercise and Health Sciences
[s.j.h.biddle@lboro.ac.uk](mailto:s.j.h.biddle@lboro.ac.uk)
Dear Sir/Madam,

PERMISSION TO CONDUCT RESEARCH
PHYSICAL ACTIVITY AND WELL-BEING

Loughborough University is conducting a research on Physical Activity, Sitting Time and Well-being. The aim of the study is to provide insight into the benefits of school physical activity programmes. The study will help to explore ways of improving children’s well being.

The research is carried out by Ms. Mavis Asare, with the supervision of Prof Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University, UK.

We would need junior high school students to participate in this study and your school has been chosen as one of the sites we would like to use for data collection.

The research will involve the administration of psychological tests and does not involve procedures that would harm the students. The students will be involved in this study during one day only.

In the unlikely event of any negative incident, this study is covered by the Loughborough University Insurance.

All information obtained from the research is strictly confidential and would be handled according to the UK Data Protection Act 1998 and stored securely at Loughborough University. Any written information about the study will be made anonymous without making particular reference to any school.

If you have any questions about any aspect of the study, please do not hesitate to contact the research team using the address below.

In the unlikely event that you are unsatisfied about the procedures of the study, please contact the Loughborough University’s Research Ethical Committee : http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.
Appendix 22

Hoping to hear favourably from you.

_________________________
Mavis Asare
P.O.Box KN 4213
Kaneshie-Accra
Ghana

Contact Person
Prof Stuart Biddle
School of Sport, Exercise and Health Sciences
s.j.h.biddle@lboro.ac.uk
PHYSICAL ACTIVITY, SITTING TIME AND WELL-BEING
PARTICIPANT INFORMATION SHEET

We would like to invite your child to take part in a research study by Loughborough University. The research is part of a PhD project.

Please read this sheet carefully. If you have any questions or comments please do not hesitate to contact the researchers (contact details are provided at the end of this sheet).

The Purpose of the Study
The aim of the study is to see how physical activity and sitting affect adolescents’ feelings of well-being. The study will provide valuable insight into the usefulness of physical activity in managing young people’s feelings.

The study is led by Prof. Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University.

Your Child’s Involvement:

1. If you do NOT wish your child to participate in the study, please let us know by the following week, by indicating below. Your child will be requested to sign a Consent form.
2. Your child will be asked to complete questionnaires on physical activity levels, sitting time, and feelings of well-being.
3. Your child will be involved in this study during one day.
4. If you or your child change your mind you can always withdraw from the study by contacting the researcher, Mavis Asare (contact details below).

Confidentiality
All information given will remain strictly confidential and will be accessible only to the research team. The team will ensure that any information you provide will be made anonymous by the allocation of a unique code to each child. All data will be stored in a confidential manner according to the UK Data Protection Act 1998 and stored securely at Loughborough University. Please be assured that this research is purely
for academic purposes. All reported data, and any written information about the study, will be made anonymous and your child’s identity will not be revealed.

**The Results of the Study**

The data collected during this study will be summarised into a research report. The report will be published to be used to guide school decisions and parents in raising their children.

**Any Queries**

If you have any concerns about any aspect of the study do not hesitate to contact the research team. Use the following contact details.

Prof Stuart Biddle  
School of Sport, Exercise and Health Sciences  
Loughborough University  
s.j.h.biddle@lboro.ac.uk

Or contact: [http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm](http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm).

Researcher’s Address: Mavis Asare, P.O. Box KN 4213, Kaneshie-Accra, Ghana.  
You can email the researcher by [ahemahr@yahoo.com](mailto:ahemahr@yahoo.com).  
Cell Phone 277 29 34 38

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**Physical Activity, Sitting time and Well-being**

I do **not** wish my child to participate.

Name of child ___________________________

Signed by parent ________________________

There is no need to reply if you are happy for your child to participate.
PHYSICAL ACTIVITY, SITTING TIME AND WELL-BEING
CHILD INFORMATION SHEET

We would like to invite you to take part in a research study by Loughborough University. The research is part of an academic project.

Please read this sheet carefully. If you have any questions or comments tell your parents to contact the researchers (contact details are provided at the end of this sheet).

What is the purpose of the study?
The aim of the study is to see how physical activity and sitting affect adolescents’ feelings of well-being. The study will provide valuable information about the role of physical activity in managing young people’s feelings.

The study is led by Prof. Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University.

What will I be asked to do?

1. Before you participate in the study, you will be requested to sign the attached Consent Form.
2. You will be asked to complete questionnaires on physical activity levels, sitting time, and feelings of well-being.
3. You will be involved in this study during one day.

Once I take part, can I change my mind?

Even after signing the Consent form, if you decide not to take part again at any point in time, just tell your parents or tell the researcher (Mavis Asare) straightaway. You do not need to give any reason why you do not want to continue.

Will my taking part in this study be kept confidential (private)?

All information given will remain strictly confidential and will be handled only by the research team. The team will ensure that your names are not attached to any information you provide. To ensure this, each student will be given a unique code. All information will be stored in a confidential manner according to the UK Data
Protection Act 1998 and stored securely at Loughborough University. Please be assured that this research is purely for academic purposes. All reported data, and any written information about the study, will not include your name or identity.

What will the results of the study be used for?

The information from this study will be summarised into a research report. The report will be published to be used to guide school decisions and young people in improving their health.

If I have some more questions who should I contact?

If you have any questions about any aspect of the study, tell your parents to contact the research team. Use the following contact details.

Prof Stuart Biddle
School of Sport, Exercise and Health Sciences
Loughborough University
s.j.h.biddle@lboro.ac.uk
Or contact http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

Researcher’s Address: Mavis Asare, P.O. Box KN 4213, Kaneshie-Accra, Ghana.
You can email the researcher by ahemahr@yahoo.com.
Cell Phone 277 29 34 38
PHYSICAL ACTIVITY, SITTING TIME AND WELL-BEING
INFORMED CONSENT FORM

The purpose and details of this study have been explained to me. I understand that this study is purely for research purposes. The data obtained from the study will be used to enhance academic and health knowledge.

I have understood that all the steps involved in the study will not cause harm to me and that all the procedures have been approved by the Loughborough University Ethical Advisory Committee.

I have sufficiently understood the Information Sheet and this Consent Form.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers, unless it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in the study.
Yes _____    No_____

Kindly sign this form if you agree to participate.

Name _______________________________________

Signature     __________________________________

Date             __________________________________

Signature of investigator _____________________________

Date _____________________________
We would like to invite your child to take part in a research study by Loughborough University. The research is part of a PhD project.

Please read this sheet carefully. If you have any questions or comments please do not hesitate to contact the researchers (contact details are provided at the end of this sheet).

The Purpose of the Study
The aim of the study is to see how physical activity affects school work. The study will provide valuable insight into the effectiveness of physical activity programmes in schools. Findings from the study will also help to explore ways of improving academic work in school.

The study is led by Prof. Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University.

Your Child’s Involvement:

1. If you do NOT wish your child to participate in the study, please let us know by the following week, by indicating below. Your child will be requested to sign a Consent form.
2. Before your child participates in the study, you will be requested to give some health information about your child.
3. Your child will be measured on height and weight. Your child will complete a questionnaire on physical activity levels and food habits.
4. Your child will be given a small object to wear for one week. This object will measure his/her body posture; it will not disrupt the child’s daily activity, it has no side effects.
5. Your child will take part in an after school exercise programme. The exercise programme will involve a mixture of different types of physical activity mainly in the moderate to vigorous zone of exercise intensity suitable for health benefits.
6. After the whole exercise programme is over, your child will be asked to respond to some questionnaires related to school work. It will take one hour to complete the questionnaires.
7. If you or your child change your mind you can always withdraw from the study by contacting the researcher, Mavis Asare (contact details below).
Confidentiality

All information given will remain strictly confidential and will be accessible only to the research team. The team will ensure that any information you provide will be made anonymous by the allocation of a unique code to each child. All data will be stored in a confidential manner according to the UK Data Protection Act 1998 and stored securely at Loughborough University. Please be assured that this research is purely for academic purposes. All reported data, and any written information about the study, will be made anonymous and your child’s identity will not be revealed.

The Results of the Study

The data collected during this study will be summarised into a research report. The report will be published to be used to guide school decisions and parents in raising their children.

Any Queries

If you have any concerns about any aspect of the study do not hesitate to contact the research team. Use the following contact details.

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School of Sport, Exercise and Health Sciences
Loughborough University
s.j.h.biddle@lboro.ac.uk
Or contact http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

Researcher’s Address: Mavis Asare, P.O. Box KN 4213, Kaneshie-Accra, Ghana.
You can email the researcher by ahemahr@yahoo.com.
Cell Phone 277 29 34 38

Physical Activity and School Work

I do not wish my child to participate.

Name of child ____________________________________________

Signed by parent __________________________________________

There is no need to reply if you are happy for your child to participate.
We would like to invite you to take part in a research study by Loughborough University. The research is part of an academic project.

Please read this sheet carefully. If you have any questions or comments tell your parents to contact the researchers (contact details are provided at the end of this sheet).

**What is the purpose of the study?**
The aim of the study is to see how physical activity affects school work. The study will find out the importance of physical activity programmes in schools. Findings from the study will also help to explore ways of improving academic work in school.

The study is led by Prof. Stuart Biddle in the School of Sport, Exercise and Health Sciences at Loughborough University.

**What will I be asked to do?**
1. Before you participate in the study, your parent will be requested to give some health information about you.
2. You will be measured on height and weight. You will complete a questionnaire on physical activity levels and food habits.
3. You will be given a small object to wear for one week. This object will measure your body posture; it will not disrupt your daily activity, it has no side effects.
4. You will take part in an after school exercise programme. The exercise programme will involve a mixture of different types of physical activity mainly in the moderate to vigorous zone of exercise intensity suitable for health benefits.
5. After the whole exercise programme is over, you will be asked to respond to some questionnaires related to school work. It will take one hour to complete the questionnaires.

**What type of clothing should I wear?**
If you are selected to participate in the after-school physical activity programme you will need to bring along P.E clothes (shorts and T-shirt) for the exercise activities.
Once I take part, can I change my mind?

Even after signing the Consent form, if you decide not to take part again at any point in time, just tell your parents or tell the researcher (Mavis Asare) straightaway. You do not need to give any reason why you do not want to continue.

Will my taking part in this study be kept confidential (private)?

All information given will remain strictly confidential and will be handled only by the research team. The team will ensure that your names are not attached to any information you provide. To ensure this, each student will be given a unique code. All information will be stored in a confidential manner according to the UK Data Protection Act 1998 and stored securely at Loughborough University. Please be assured that this research is purely for academic purposes. All reported data, and any written information about the study, will not include your name or identity.

What will the results of the study be used for?

The information from this study will be summarised into a research report. The report will be published to be used to guide school decisions and young people in improving their health.

If I have some more questions who should I contact?

If you have any questions about any aspect of the study, tell your parents to contact the research team. Use the following contact details.

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Researcher’s Address:  Mavis Asare ,  P.O. Box KN 4213, Kaneshie-Accra, Ghana. You can email the researcher by  [ahemahr@yahoo.com](mailto:ahemahr@yahoo.com).
Cell  Phone 277 29 34 38
PHYSICAL ACTIVITY, SITTING TIME AND WELL-BEING  
INFORMED CONSENT FORM

The purpose and details of this study have been explained to me. I understand that this study is purely for research purposes. The data obtained from the study will be used to enhance academic and health knowledge.

I have understood that all the steps involved in the study will not cause harm to me and that all the procedures have been approved by the Loughborough University Ethical Advisory Committee.

I have sufficiently understood the Information Sheet and this Consent Form.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers, unless it is judged that confidentiality will have to be breached for the safety of the participant or others.

I agree to participate in the study.
Yes _____    No_____

Kindly sign this form if you agree to participate.

Name _______________________________________

Signature   ________________________________

Date             ____________________________

Signature of investigator ________________________________

Date
____________________________
PHYSICAL ACTIVITY, SITTING TIME AND WELL-BEING
INFORMED CONSENT FORM

The purpose and details of this study have been explained to me. I understand that this study is purely for research purposes. The data obtained from the study will be used to enhance academic and health knowledge.

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I agree to participate in the study.
Yes _____ No_____

Kindly sign this form if you agree to participate.

Name ________________________________
Signature ____________________________
Date ________________________________

Signature of investigator ________________________________
Date ____________________________________