Physical activity and sedentary behaviour in a school sample of Kuwaiti adolescents: Sociodemographic correlates and associations with adiposity and blood pressure: The Study of Health and Activity among Adolescents in Kuwait (SHAAK)

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STUDENT DECLARATION

I, Rawan Hashem, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Signed:

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ABSTRACT

Background Epidemiological studies of both physical activity and sedentary behaviour in Kuwait and Middle East are scarce and rely almost entirely on self-reported measures. Levels of physical activity and sedentary behaviour patterns have not been described using objective measures. Research on sociodemographic correlates of physical activity and sedentary behaviour are limited and the links between physical activity, sedentary behaviour with adiposity and blood pressure are unclear and inconsistent.

Aims The main aim of this PhD was to describe the levels of physical activity, sedentary behaviour and their socio-demographic correlates among adolescents in Kuwait using self-reported and accelerometer based measures and to examine the associations of physical activity and sedentary behaviour with two sets of key cardiometabolic outcomes (adiposity and blood pressure).

Methods Participants (279 male and 310 female) in school grades 6-12 were recruited. Physical activity and sedentary behaviour were assessed using a self-administered questionnaire and a GT1M Actigraph accelerometer worn for 7 consecutive days.

Results Very few adolescents met the physical activity recommendations, 14% using self-report and 2% using objective physical activity measure. Results revealed that 93% of the adolescents in this study did not limit screen time to less than two hours per day. Accelerometer based physical activity was lower among girls and declined with age, while sedentary behaviour was higher among girls and increased with age. The study revealed that accelerometer based physical activity and sedentary behaviour was not associated with adiposity or blood pressure.

Conclusion These data will provide baseline information to enable governmental authorities to steer physical activity promotion programmes to key target populations. The low physical activity levels documented in this study call for action to promote physical activity and reduce sedentary behaviour among Kuwaiti adolescents.

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LIST OF ABBREVIATIONS

BMI	Body mass index
BP	Blood pressure
CDC	Centres for Disease Control and Prevention
CMO	Chief Medical Officer
C.I.	Confidence Interval
DEXA	Dual-energy X-ray absorptiometry
EE	Energy expenditure
GDP	Gross Domestic Product
HTN	Hypertension
IOTF	International Obesity Task Force
MET	Metabolic equivalent
MVPA	Moderate-to-vigorous physical activity
PA	Physical activity
SB	Sedentary behaviour
SES	Socio-economic status
SHAAK	Study of Health and Activity among Adolescents in Kuwait
TV	Television
WC	Waist circumference
WHO	World Health Organization

Chapter 1: Introduction

"If we could give every individual the right amount of nourishment and exercise, not too little and not too much, we would have found the safest way to health."

Hippocrates, 460-377B.C.

"Lack of activity destroys the good condition of every human being while movement and methodical physical exercise save it and preserve it."

Plato, 380B.C.

As indicated by the quotations above, the link between health and physical activity (PA) has been speculated about for more than 2000 years. The scientific evidence regarding this dates back to the mid-20th century (1, 2). Since then, a large volume of observational and experimental studies has documented the positive health gains of PA (3). Insufficient PA has been speculated to be the largest public health problem of our time (4, 5).

The worldwide prevalence of overweight and obesity among adolescents is high (6). This is also true for the rate of prevalence of overweight and obesity among children and adolescents in Arab countries (7). The negative impacts of obesity on insulin sensitivity and disturbances in the pathogenesis of glucose metabolism are evident early in childhood (8). Obesity in children appears to be a major risk factor for type 2 diabetes (8, 9). Obesity is also linked to several chronic conditions including hypertension, non-alcoholic liver disease, insulin resistance, dyslipidaemia, pulmonary disorders and psychological problems (10, 11). Over the past decade evidence of a rising worldwide epidemic of childhood obesity suggests that the life expectancy of children may be lower than that of their parents due to the adverse health effects of obesity (12, 13).

Adolescence is a stage where individuals leave the influences of their family and start to develop their own behaviours and lifestyle (14), thus a key period for obesity development (15). Obesity is a multifaceted problem that is not wholly understood. Improving our culture specific understanding on the factors that contribute to obesity during adolescence may assist policy makers to develop initiatives aimed at improving young and adult health and well being (16). Weight gain may be predisposed by genetic factors (17), but the lifestyle behaviours of children and adolescents have the largest effect on energy balance (18). Lifestyle factors such as nutrition, PA, and sedentary behaviour (SB) contribute to adolescent obesity (7, 19).

The benefits of establishing physically active lifestyles during childhood include improved mental health, self esteem and social interaction. Understanding the factors influencing PA can aid in the design of more effective intervention programmes. There is an emerging body of evidence suggesting that SB (as characterised by activities involving sitting) is linked to cardiometabolic disease in young people (20, 21). Technological progress in recent decades has created less demand for PA, and this may have a profound impact on the behaviour of children and young people (22). Available evidence from prospective observational studies suggests that increased PA and decreased SB protect people against relative weight and fatness gains over childhood and adolescence (23), although the evidence about SB is less conclusive.

A recent survey conducted in Kuwait indicated that the (self-reported) PA levels of adolescents are low (24). Technological advances have made it possible to objectively quantify the time spent in sedentary, light-intensity, and moderate-to-vigorous physical activity (MVPA) behaviours. This has improved the methodology for measuring activity patterns, which previously relied mainly on self-reports (25). Improved methods of measuring PA would help to establish important prevention and intervention targets, identify subgroups or develop periods where interventions would be likely to take effect. PA and SB research is, however, limited in volume in Arab countries. In addition, the research available presents methodological limitations, such as reliance on a self-reported questionnaire for data on PA and SB (26).

There are no studies to date that report accelerometer-based PA and SB levels among adolescents in Kuwait or the Middle East. To address gaps in our knowledge of PA and obesity amongst Kuwaiti adolescents, the **S**tudy of **H**ealth and **A**ctivity among **A**dolescents in **K**uwait (**SHAAK**) was designed to generate comprehensive data about the levels and patterns of PA, SB and adiposity among adolescents in Kuwait. These data will provide baseline information for the governmental authorities, in particular the Ministry of Health's National Programme to control obesity, which has funded the present research. The broad aim of this thesis is to describe the prevalence and the demographic and socioeconomic correlates of PA and SB as well as the associations of these behaviours with key cardiometabolic outcomes among a sample of school age adolescents in Kuwait. **SHAAK** will be the first study to report objectively measured PA and SB data in a school sample of Kuwaiti adolescents. The remainder of this chapter will describe operational definitions of the key concepts in general and give a brief overview of the socioeconomic, cultural, health, and environmental context of Kuwait.

1.1 Operational definitions of key concepts

1.1.1 Physical activity

PA is defined as ‘any bodily movement produced by skeletal muscles resulting in energy expenditure above the basal level’ (27). PA is a broad term covering any bodily movement, including such subtle movements as fidgeting, competitive sport, daily exercise, and non-competitive activities such as cycling and walking. A subcategory of PA, exercise, refers to bodily movement which aims to sustain physical fitness and is structured, intentional and repetitive (27).

PA can be described in terms of the following dimensions :

- Frequency of participation, often expressed as a number of sessions per day, week, month, etc.
- Duration refers to the time spent on a single bout of activity, expressed in minutes or hours.
- Type or mode refers to qualitative descriptions, such as walking, dancing or weight lifting (28).
- Intensity indicates how strenuous a given activity is and can be linked to the rate of energy expenditure (EE) required. Intensity is classified as sedentary, light, moderate or vigorous and is often expressed in relative EE units, e.g. metabolic equivalent (MET).

A product of two PA dimensions, volume, refers to the total quantity of PA through a specific period; it is calculated as frequency x duration. One MET corresponds to the rate of EE during rest. Assuming a 40- year-old male who weighs 70 kilograms (kg), one MET corresponds to 3.5 millilitres of oxygen per kg of body weight per minute. METs are used to estimate the energy cost of an activity (29).

Commonly used MET standards of intensity are (29):

- Light corresponds to <3 METs
- Moderate lies in the range of 3-6 METs
- Vigorous corresponds to >6 METs

The Compendium of Physical Activities codes PA by intensity (29). In the Compendium, all the physical activities are reported as multiples of the resting MET level; these range from 0.9 (sleeping) to 18 METs (running at 17.5 km per hour) (see Table 1.1 for examples of PA intensities with corresponding MET values) (29).

Table 1.1 Common physical activities classified as light, moderate or vigorous in intensity with corresponding MET values (29)

Light <3 METs[a]	Moderate 3-6 METs	Vigorous >6 METs
Walking slowly – light effort = 2.9	Walking moderate speed 3.0 km/h[b] = 5.7	Jogging at 8 km/h = 8.5 Running at 11 km/h = 9.3
Standing performing light work such as making lunch, putting away groceries= 2.0–2.5	Bicycling: light effort = 4.7	Soccer — casual = 8.8 competitive = 11.0
Playing most musical instruments = 2.0–2.5	Table tennis = 4.0	Basketball game = 8.2

[a]MET: Metabolic equivalent [b]km/h: kilometres per hour

Physical activity and sedentary behaviour guidelines:

Several countries have devised PA guidelines for children and adolescents corresponding to the minimum levels of PA required to achieve health benefits. For example, the UK Chief Medical Officer's (CMO) 2011 guidelines below refer to all children and young people between 5 and 18 years old, regardless of gender or ethnicity (30):

1. Children and young people should engage in MVPA for at least 60 minutes and up to several hours every day.

2. Vigorous intensity activities, including those that strengthen muscle and bone, should be incorporated at least three days a week. Such activities include: resistance-type exercise typical of high intensity sportive activities such as dancing, water-based activities or weight (resistance) training.

3. Children and young people should minimise the amount of time spent being sedentary (sitting) for extended periods.

The World Health Organization (WHO) globally recommends the same guidelines to 5-18 year olds as are mentioned above, as well as recommending that amounts of PA greater than 60 minutes provide additional health benefits (31). The USA Centre for Disease Control (CDC) (32) has the same guidelines as the UK CMO and the WHO. The UK CMO guidelines also include recommendation to minimise sedentary time. Guidelines suggest minimising SB by reducing time spent watching television (TV), using the computer or playing video games and breaking up sedentary time such as shortening a long bus or car journey by walking part of the way (30).

In a conference held in January 2010 (33), a strategy prepared by the Arab Taskforce for Obesity and PA (based in Bahrain) to combat obesity and promote PA in Arab countries presented the following objectives for elementary and secondary school students:

1. Increasing the proportion of children who are physically active for one hour or more on five or more days of the week by 25%.
2. Reducing by 20% the percentage of students who watch television daily for more than two hours.
3. Increasing the awareness of parents of schoolchildren by 50% of the importance of physical activity and healthy nutrition for these children.

The evaluation of the strategy will depend on the availability of baseline PA and SB data in each Arab country. Due to lack of comprehensive PA and SB studies in most Arab countries, the suggested percentage changes of PA and SB are based on the available WHO statistics through the Global School-based Student Health Survey (GSHS) (24). To fulfil the above objectives in Kuwait by the year 2015, as suggested by the strategy, comprehensive data (self-reported and objectively measured) on existing patterns of PA and SB among adolescents in Kuwait would provide baseline information for comparative purposes or follow up studies (33)

1.1.2 Sedentary Behaviour

SB refers to any waking activities that are characterized by an EE equal to or less than 1.5 MET and a sitting or reclining posture (34, 35). SB is considered a distinct class among low energy expenditure behaviours. TV viewing and screen time in particular are the most commonly reported sedentary behaviours (36). The average sedentary time (TV viewing) for children and adolescents in the UK is approximately three hours on weekdays and four hours daily at weekends (37). Indoor entertainment includes computer games, television viewing and internet use (38).

SB can be estimated by self-reporting (questionnaires), or objective methods (e.g. accelerometers and inclinometers). Questionnaires can estimate sedentary time by inquiring about hours spent on TV viewing, playing computer games, reading and using a computer.

Accelerometers can estimate sedentary time based on lack of movement, while inclinometers can provide postural information, such as whether the subject is sitting, lying down or standing upright (34, 39).

1.1.3 Adiposity indices

Adiposity is defined as the body fat deposit at a site or an organ in the body (40). There are direct and indirect methods of estimating the level of fat in the human body. Direct methods include, measuring total body water using isotope dilution. Criterion methods include dual-energy X-ray absorptiometry (DEXA) and computed tomography (41). Indirect methods, such as the body mass index (BMI) and waist to hip ratio, can be used in clinical practice to estimate adiposity (41).

To date there is no universally accepted classification system for childhood obesity. The lack of a universally accepted definition for childhood obesity makes it difficult to monitor the growth of the obesity epidemic and to compare the results of different studies. Various attempts have been made to develop BMI-based classification systems (42), although such systems are inherently difficult to develop because adiposity in youth cannot be linked to chronic disease risk (43).

Body mass index

Calculated as weight (kg) divided by height squared (m^2), body mass index (BMI) has been closely correlated with directly assessed adiposity in children and adults (44-46). BMI is considered a reasonable measure for classifying obesity in children, and it is recommended by the International Obesity Task Force (IOTF) (42), the CDC (47) and the WHO (48). In order to develop a definition of child overweight and obesity which is internationally recognisable and acceptable, Cole et al (42) proposed cut off points which are age- and sex-specific. The suggested cut off points are less arbitrary than any currently available and offer (49) a classification system for international comparisons of the prevalence of overweight and obesity in children (42). These cut off points cover children and adolescents aged 2-18 years and are based on international reference data which are statistically linked to a BMI of

25 (overweight) and 30 (obese) kg/m2 (42) (see Table 1.2 for the international cut off points for BMI for overweight and obesity by sex between 12 and 18 years).

Table 1.2 International cut off points for body mass index for overweight and obesity by sex between 12 and 18 years (42)

Age (years)	**Body mass index 25 kg/m2**		**Body mass index 30 kg/m2**	
	Males	Females	Males	Females
12	21.22	21.68	26.02	26.67
13	21.91	22.58	26.84	27.76
14	22.62	23.34	27.63	28.57
15	23.29	23.94	28.30	29.11
16	23.90	24.37	28.88	29.43
17	24.46	24.70	29.41	29.69
18	25	25	30	30

Waist Circumference

Waist circumference (WC) is an adiposity proxy that reflects body fat distribution and is linked to central obesity. WC is usually measured midway between the lower thoracic margin and the iliac crest (50). The WC is particularly useful owing to the relevance of abdominal fatness and its association with metabolic dysregulation and chronic disease risk (51). This association is already established in adults, and emerging new evidence testifies to the importance of abdominal fatness as a risk factor in children and adolescents (52, 53). Variation in WC does track variation in fatness to a reasonable extent, but normative data for children and adolescents are limited (53) and more work is needed to better define the relationship between WC, intra-abdominal and subcutaneous fatness and chronic disease risk factors in children and adolescents (54).

Bioelectrical impedance

Another measure of adiposity is bioimpedance which is used to estimate body fat. Bioimpedance works by measuring the body's resistance to an electrical current. Adipose tissue resists the flow of electricity through the body; therefore, the less fat people have, the easier it is for electricity to flow through their bodies. A number of body composition prediction equations using bioimpedance have been developed for use in child and adolescent populations (55-57). Most equations incorporate bioimpedance with height and weight to predict fat-free mass (muscle, bones, organs, body water and other body tissues) assuming a constant hydration status (58). Still, bioimpedance has limitations, including the fact that the equations employed to convert resistance to body fat must be population specific and may not always be available. Hydration status, regional blood flow and body temperature may also affect the results of bioimpedance (54). The US Preventive Services Task Force has indicated that indirect measures of body fat, including bioelectrical impedance analysis, waist-hip circumference and skin fold thickness, all have potential in clinical practice, research and health surveillance (59, 60).

Strengths and limitations of adiposity assessment methods

The four-compartment model which incorporates independent measurements of body density, body water and bone mass to calculate adiposity in children and adolescents is a gold standard method that is not feasible in large epidemiological studies (61, 62). DEXA, which has performed very well against the gold standard, is also not readily available or feasible (63). Furthermore, DEXA emits radiation (although in small amounts), which may discourage children from participating in studies (63). Identifying feasible alternative methods which are closely correlated with the gold standard measures is crucial to correctly assessing adiposity in children and adolescents; see Table 1.3 for the strengths and limitations of the common tools used to assess adiposity in young people.

Table 1.3 Strengths and limitations of adiposity assessment methods (41, 63, 64)

Adiposity Measure	Strengths	Limitations	Spearman correlation of adiposity measure with DEXA* r
Body mass index	Measures overall adiposity Simple, feasible technique Inexpensive Minimal training required Established international cut offs to define overweight and obesity Increased sensitivity with increasing adiposity	Not able to differentiate between fat mass and lean mass Measures nutritional status and not body composition Norms may need to be ethnicity-specific Less sensitive in thinner children	0.83
Bioimpedance	Predicts body fat composition Fairly simple technique Non-invasive Minimal training required	Relies on predication equations to predict total body water and fat free mass Difficult to ensure that participants are fasted and adequately hydrated Need for standardisation of techniques, e.g. placement of electrodes Underestimates total body fat in leaner children Overestimates total body fat in obese children	0.84

		Developed prediction equations are population specific and perform poorly in healthly individuals May be relatively expensive depending on choice of machine	
Waist circumference	Robust measure of central adiposity Simple, quick and feasible technique Inexpensive Minimal training required Centile charts available	Not accurate in measuring internal visceral fat No standard cut-off recommendations for waist circumference since it depends on age, gender, ethnicity and height	0.79

*DEXA: Dual energy x-ray absorptiometry

1.1.4 Blood pressure

High blood pressure (BP) is a major health problem in developing countries and around the world, due to its increasing prevalence as a result of the epidemiological transition and for its strong association with cardiovascular disease in adults (65, 66). A systematic review and meta-regression analysis study tracking BP has suggested that elevated levels during childhood may lead to hypertension in adulthood (67). Normative BP ranges differ according to age, gender and height. It has been suggested that BP in children and adolescents is associated with similar lifestyle factors as in adults, namely, low levels of PA (49, 68), high SB patterns (69), poor diet (70) and obesity (71).

1.2 Kuwait environmental, cultural and socioeconomic context

Lifestyle factors, cultural norms and familial circumstances in Kuwaiti society may have played a crucial role in the current levels of PA and SB among adolescents. This section summarises the environmental, cultural and socioeconomic context in Kuwait that may be relevant to the key concepts of this thesis, namely PA, SB and obesity.

1.2.1 Environmental and geographical characteristics

In 1961, a decree was issued to separate Kuwait into three governorates. The first three governorates are Asimah, Hawalli and Ahmadi. Three more governorates were added in later years (Jahra in 1979, Farwaniya in 1988 and Mubarak al Kabeer in 1999), bringing the total number of governorates to six. The capital of Kuwait (Asimah governorate) is the political, cultural and economical center of the country. Asimah includes the Kuwaiti parliament and most governmental offices and corporations. The more privileged of Kuwaiti society reside in the Asimah governorate. The Hawalli governorate is a densely populated by various segments of the society. Many Arab (non-Kuwaiti) communities reside in the commercial areas of Hawalli. The Ahmadi governorate has the highest number of oil refineries. The Ahmadi governorate is predominantly peopled by employees of the Kuwait Oil Company. Regarded as an agricultural area, the Jahra governorate is inhabited mainly by Kuwaiti citizens of 'Bedouin' origin.

Each governorate in Kuwait is divided into districts, which include residential or commercial areas (72). Each governorate is served by a number of state-run schools, in proportion to its population density. The state-run schools only permit Kuwaiti nationals (non-Kuwaiti students attain their education via private schools). Services in each residential area include governmental schools for all educational levels for each gender (schools are segregated), a primary health care centre, a supermarket (co-op), fast food chains (sometimes exceeding ten restaurants), banks, post offices, etc. Some residential areas, have a public sports club, while others may have a park or a walkway (a paved path about two to three km long located along the perimeter of an area). Sports clubs are funded by the government; only young boys or men are permitted to participate in a variety of sports. The only public sports club for females in Kuwait is located in Asimah (the capital). It may take an hour's journey by car to reach it, depending on where a family lives. The sports clubs offer training in a variety of sports to boys of five years and above, for example in soccer (very popular), tennis, volleyball, etc. However, some parents in Kuwait do not allow their children to join the residential clubs. Parental concerns include the risk of injury during sports, unsuitable weather conditions and the loss of time for schoolwork (73).

The weather may play a part in the levels of PA and SB among young people and people in general. Kuwait boasts a generally very dry, hot climate with frequent sand storms in the summer, between April and October in particular; temperatures exceed 51°C during the months of June, July and August. Humidity in the atmosphere often rises to 90% and gradually decreases by mid September (73-75).

1.2.2 Cultural characteristics

Some cultural norms in Kuwaiti society may have played a crucial role in discouraging the levels of PA and encouraging SB among adolescents. This section highlights some of the norms that may have done so (75). The 'dewaniyah,' meaning a room in the house secluded from the main family living space, allows only the presence of men who sit on cushions, chat informally, smoke, eat snacks and relax in the evening. This cultural characteristic is very popular today and has come to include male adolescents as well. Typically the young men gather at a friend's dewaniyah and watch TV, snack, or play computer games (76, 77).

Kuwaiti women have the freedom to dress in Western clothes or the traditional garment called the 'aba', a head to toe black cloak which covers the clothing and is worn in public (73, 76). The Islamic headscarf which conceals the hair is not compulsory in Kuwait; however, in keeping with Islamic tradition most Kuwaiti women begin to wear it in their teenage years. It is not considered 'appropriate' behaviour for girls to engage in sports outside designated areas such as schools or the girls' sports club. Therefore walking in a park or along a walkway is the chosen exercise for girls. Most Kuwaiti adolescent girls would be embarrassed to be seen running or taking part in sports in public.

1.2.3 Social and health policy

Kuwaiti citizens have several privileges, granted by the government as part of social policy. These privileges include free health care, free education (including university), a financial grant upon marriage, monthly food supplies and free housing has enabled Kuwaitis to afford additional personal luxuries such as domestic workers and multiple cars per household.

Thanks to its oil revenues, Kuwait has built an extensive educational system. Government policy on education yields a literacy rate of 90%. Education is compulsory from the age of 5 to 18. Undergraduate studies are provided publicly by Kuwait University and a number of private universities as well. Governmental schools in Kuwait are of four levels, pre-school, preparatory, intermediate and secondary (74).

The Kuwaiti government provides equitable and high level quality health services for all its citizens. In 2006, Kuwait had 78 primary health care centres, which cover the six governorates in Kuwait . The six general hospitals provide secondary health care. Tertiary care provides services, including maternal care and oncology care (74).

1.2.4 Demographic, epidemiologic and nutrition transition in Kuwait

Economic development in a country is closely associated with demographic, epidemiologic and nutrition transitions. This section elaborates further on these transitions.

The demographic situation in Kuwait is quite unique, since it contains a high number of expatriates in relation to the number of Kuwaiti citizens. The expatriate population in Kuwait is approximately 55% that of the whole population (74). The age structure of Kuwaiti nationals is typical of high fertility societies. In 2006, 11.4% of the population was aged under five years, 40% aged under 15 years, while those aged 65 and over comprised less than three percent (74). The demographic transition, namely, lifestyle factors, the obesity epidemic and population ageing, has shifted the burden of diseases from communicable to non-communicable (74). Cardiovascular diseases (e.g. Hypertension, stroke and coronary heart disease) and metabolic disease (e.g. type 2 diabetes, metabolic syndrome) make up a high proportion of the disease burden in the Kuwaiti population. Cardiovascular diseases account for 39.5% of all deaths in 2006 (74). However, infectious diseases were responsible for only 2.3% of all deaths in 2006 (74).

Kuwait has gone through a nutrition transition during the past four decades. Increased revenue from the discovery of oil increased the availability of food in the country (78). An increase in the consumption of animal products and a decline in the intake of fruit and vegetables and complex carbohydrates registered for the period 1970-2005 (78). Kuwait has the highest energy consumption per capita per day of all Gulf countries. Energy from macronutrients in Kuwait, Saudi Arabia and United Arab Emirates are 3108, 3073 and 2923 kcal/capita/day, respectively (78). Several factors have contributed to this change in food consumption patterns. Among these factors are changes in lifestyle, income, urbanization, the decrease in food price and improvements in food processing (78).

1.2.5 Macroeconomic context

Kuwait has a rich and relatively open economy; its crude oil reserves include 96 billion barrels, which make up approximately 10% of the world's reserves. Nearly half of Kuwait's gross domestic product (GDP) consists of petroleum. Due to the harsh climate, agricultural development is limited. As a result, Kuwait relies mostly on food imports, the only exception being fish. According to the International Monetary Fund, Kuwait currently ranks 17th among world economies in relation to GDP. The GDP and GDP per capita are $94.13 billion and $32,530 respectively (74, 79).

1.2.6 Summary

The present chapter described the operational definitions of the key concepts in the thesis, namely PA, SB, adiposity and BP. The chapter gave an overview of certain lifestyle factors and cultural norms specific to Kuwaiti society that may have played an important role in current PA levels, SB patterns and adiposity among adolescents. It also describes the main international PA and SB guidelines for young people. The present introductory chapter is followed by the literature review and the thesis aims and objectives.

Chapter 2: Literature review

2.1 Literature review objectives and methodology

The general aim of the literature review is to provide a critical synopsis of the existing evidence that correspond to the research objectives of SHAAK.
The objective of this chapter was to review the literature on the following areas:

- Levels of physical activity and sedentary behaviour in the Middle East amongst children and adolescents.
- The sociodemographic correlates of physical activity and sedentary behaviour amongst children and adolescents.
- The prevalence of overweight and obesity amongst children and adolescents in the Middle East.
- The associations between physical activity and sedentary behaviour with adiposity indices amongst children and adolescents.
- The association between physical activity and sedentary behaviour and blood pressure amongst children and adolescents.

For details on sections of the review methodology, please refer to Appendix 1.

The general inclusion and exclusion criteria for the core parts of this review were the following:

- Only children and adolescents of 3-19 years of age were considered for inclusion in the review.
- When no studies in the Middle East or Arab countries were identified, studies from other countries were considered. A search without the term ‘Middle East’ (or equivalent) was carried out (refer to Appendix 1).
- Where possible, priority was given to meta-analysis and systematic review articles.
- Grey literature (local WHO reports) was reviewed as well for relevant studies in Middle Eastern or Arab countries, by contacting experts in the field of physical activity in Kuwait.

- Only evidence from within the last 10 years was included in the main parts of the review, meaning that studies published before 2003 were excluded

2.2 Review results

2.2.1 Levels of physical activity and sedentary behaviour amongst children and adolescents in the Middle East

A Pubmed search for literature that corresponds to the first literature review objective resulted in 335 studies, 29 of which were conducted in the Middle East or Arab countries. After applying the inclusion and exclusion criteria, a total of six studies were included in this section to provide an overview of existing PA and SB studies in the Middle East. Table 2.1 summarizes the findings of the selected studies.

A 34 country comparison studied patterns of PA and SB in school children from mainly developing countries (80). The study used a self-administered questionnaire developed by the WHO to assess health behaviours among adolescents (13-15 year olds) as part of the Global School Health Survey (81). Meeting the PA recommendations was defined as spending at least 60 minutes per day, at least five days per week (80). Among the Eastern Mediterranean Region countries, the prevalence of meeting the PA recommendations was lowest for Egypt (3.7%) and highest for Oman (34%) (80). The prevalence of SB, defined in the study as sitting for more than three hours per day, was highest in the United Arab Emirates (43%) and lowest in Egypt (24%) (80). Although the study used representative sample populations from each country, PA was assessed through self-reported answers to three questions, all having multiple choice response options (80). A systematic review concluded that subjective measures of PA through self-report in paediatric populations may overestimate PA levels among young people in comparison to objective measures e.g. accelerometry (82). In addition, when developing the questionnaire used in the Global School Health Survey, the children expressed difficulty in differentiating between the intensity levels of PA (80). Furthermore, the questions used to assess overall PA were developed and evaluated in the US and not tested for suitability in developing countries (80). SB was assessed through one question inquiring about the time spent watching TV, playing video games, talking with friends (not including homework and sitting in school) during a typical day (80). The main limitation of assessing SB through one question is the recall and social desirability bias that is often associated with self-reporting (83). In addition, when quantifying SB hours, the questionnaire did not differentiate between active and non-active video games, which may have resulted in a proportion of the time being classified as sedentary when in fact, as previous research has suggested, the children may have been engaged in light or moderate PA (84). The SB and transport questions were also not tested among children for reliability and validity (80).

The first Global School Health Survey study was conducted in Kuwait by the Ministry of Health in the academic year 2010-2011 (24). The timeframe of the survey was seven days preceding the assessment (24). In Kuwait, 20.7% of students aged 13-15 years reported being physically active (intensity not specified) for a total of at least 60 minutes per day on five or more days during the previous seven days (24). Overall, 15.4% of students were physically active for a total of at least 60 minutes on all seven days (24). In addition, 69.8% of students reported that they did not walk or ride a bicycle to or from school (24). The study found that 53.2% of students spent three or more hours per day seated, engaged in such activities as watching TV, playing video games or surfing the internet (24). In terms of limitations, the study included only students from the eighth to tenth grades, thus presenting PA and SB data from a narrow age range (13-15 years) (24). The investigated PA levels and SB patterns were based on three questions (two for PA and one for SB). The questionnaire assessed PA through multiple choice question without specifying the type, intensity or duration of the PA level attained, which may have subjected the participant to difficulties in recall and question misinterpretation (83). The question assessing SB inquired about activities while seated during a typical day, such as watching TV, or playing video games – without differentiating the types of video gaming (active or non-active video games), which may have resulted in unintended misclassification bias (83), and without including other types of SB such as reading for leisure, doing homework or listening to music.

Results from a Saudi survey using self-reported PA assessment methods, primarily designed to examine overweight and obesity among a sample of male adolescents in Riyadh and assessing PA levels, showed that the rate of adolescents exercising for one day or less per week was approximately 50% (85). The study was not representative of the Saudi male population and did not include females. The questionnaire failed to provide a definition of the term ‘exercise’ for the participants, who often find difficulty in interpreting PA intensities through self-reports (83) or inquire about the volume of exercise in the questionnaire (85). A specific question on SB, moreover, was not included in the questionnaire. These limitations, as well as the documented pitfalls of self-reporting, apply to this study (83).

A study conducted in Iran designed to examine prevalence of overweight and obesity and their association with PA activity patterns among adolescents, suggested that high, moderate and low leisure-time levels of PA overall were approximately 3%, 79% and 18% respectively (86). PA was determined through self-reports using the Baecke questionnaire and formula (87). The formula was based on the average energy expenditure cut offs to classify participants into high energy expenditure (average consumption 420 kilocalories per hour), moderate energy expenditure (average 330 kilocalories per hour) and low energy expenditure (average 180 kilocalories per hour) levels. The proportion of adolescents with high, moderate and low levels of sport-related PA were approximately 17%, 75% and 7% respectively (86). The proportion of adolescents reporting more than three hours of TV viewing was about 60% (86). The results of the PA of the adolescents was not reported in terms of meeting the MVPA recommendations and the question on SB inquired only about TV viewing time, which may have been less than the total of sedentary time. The study was conducted in Northern Iran and therefore is not representative of the Iranian adolescent population (86). The use of the Baecke questionnaire, designed primarily for adults, may be inappropriate for use in adolescents (87).

A Saudi study examining self-reported PA, SB and dietary habits among Saudi adolescents suggested that around 56% of males and 22% of females met the MVPA recommendations of at least 60 minutes daily activity (88). SB of more than two hours of screen time daily was 84% for males and 91% for females (88). The study included a representative sample of Saudi adolescents and used the validated Arab Teen Lifestyle Study questionnaire, but the questionnaire was validated against an electronic pedometer. Therefore, the limitations of self-reporting in this study included but were not limited to recall, social desirability and misclassification bias. Although the questionnaire did inquire about total screen time during a typical day, it did not inquire about other types of SB or differentiate active and non-active video games, which may have affected the SB results (84).

An objective measure to assess PA was identified in merely one study in the Middle East. The study, which used pedometers to examine the levels of PA among Saudi boys, revealed that, on the basis of pedometer counts, more than 47% of the surveyed boys aged 8-12 years accumulated fewer than 13000 steps per day (the daily recommended amount of PA) (89). In addition to the exclusion of females in the study, pedometers have several limitations including the over-counting of steps while driving motor vehicles, double counting of steps during brisk walking or running and the under-counting of steps in obese individuals (90).

In summary, the available data on the patterns of PA and SB among children and adolescents in the Middle East come mainly from WHO initiated surveys. Other identified studies do not assess PA and SB patterns as their main objective and use different self-report methods. The only study using objective measures of PA and SB excluded females. Despite this lack of accurate data, the limited studies available suggest that PA levels among adolescents in the Middle East and Arab countries are low and that SB levels are high. However, the heterogeneity in study samples, differences in exposure and outcome variables and the reliance of self-report methods limits conclusions and comparisons. The literature highlights the need for further research using accurate, valid and reliable measures of PA and SB. Such research will provide evaluations of current PA and SB levels, the associations between PA, SB and health outcomes and provide baseline information to evaluate future trends of PA and SB.

Table 2.1 Summary of physical activity, sedentary behaviour levels amongst children and adolescents in the Middle East

Region or country, year, (reference)	Population	Study design	Physical activity and sedentary behaviour assessment method	Sample size	Age range (years) Mean (SD)	Outcome measure / main findings
Eastern Mediterranean Region, 2010 (80)	Adolescent male and female	Cross-sectional survey	Self-report	Jordan: 1719 Oman: 2158 UAE: 9916 Egypt: 3664	13-15	Physical activity and sedentary behaviour Median active days (60 minutes/ day at least 5 days/ week Jordan: Male: 2.0 Female: 1.5 Oman: Male: 3.0 Female: 1.0 UAE: Male: 3.0 Female: 1.0 Egypt: Male: 2.0 Female: 1.0 All the above countries had sedentary behaviour levels of >3hrs per day per week ranging from 25-35%

Kuwait, 2011 (24)	Adolescent male and female	Cross-sectional survey	Self- report	2674	13-15	Physical activity: active on at least 5 days of week For total : 20.7% 30.3% Male 10.3% Female sedentary behaviour: ≥3 hours/day 53.2% of adolescents: 49%Male 57.7% Female
Saudi Arabia, 2003 (85)	Adolescent males	Cross-sectional survey	Self- report	894	15.7 (1.8)	50 % had physical activity for more than one day per week
Iran, 2012(86)	Pre-adolescent and adolescent males and females	Cross-sectional study	Interviewed Baecke questionnaire	1200	12-17 14.2 (1.7)	Leisure time physical activity level: Low (EE[b] 180 kcal/hr): 17.7% Moderate (EE 300 kcal/hr) : 79.4% High (EE 420 kcal/hr) : 2.9% Sport time physical activity: low :7.4% moderate :75.2% high: 17.4% Sedentary behaviour: ≥3 hours/day

						TV viewing: 59.9%
Saudi Arabia, 2011 (88)	Adolescent male and female	Cross-sectional study	Self-report	2908	14-19 Male:16.7 (1.1) Female: 16.5 (1.1)	Physical activity more than 1660 METs*-minutes/week: 55.5% Male 21.9% Female Physical activity more than 2520 METs -min/week: 43.5% Male 12.9% Female Sedentary behaviour >2 hours screen time 84% Male 91.2% Female
Saudi Arabia, 2007, (89)	Pre-adolescent male	Cross-sectional survey	Pedometers	296	8-12 10.3 (1.3)	Physical activity: achieved ≥13,000 steps per day :53% achieved <13.000 steps per day: 47.1%

* METs: Metabolic equivalents EE[b]: Energy Expenditure

2.2.2 Sociodemographic correlates of physical activity and sedentary behaviour in the Middle East

Table 2.2 presents a summary of systematic reviews of studies that examined the sociodemographic correlates of PA and SB in young people. Several comprehensive systematic reviews suggested that a number of sociodemographic variables are correlated consistently with PA and SB in children and adolescents (91-95). The findings suggest that girls are less active than boys (the vast majority of included studies were from the USA and Europe) (91, 92). The evidence is inconclusive for age-related differences in PA; results by Uijtdewilligen et al. suggested that the older the child the more active (91), whereas Van der Horst et al. (92) found no evidence that age is a determinant of PA. A systematic review including most of the studies from the USA and Scandinavian countries found that adolescents tend to be more physically active if they come from families with advantaged SES (96). A systematic review of systematic reviews identified six sociodemographic correlates of PA consistently associated with PA including gender, age, ethnicity, parental education, SES and family income (93).

The first published systematic review of SB in young people suggested that the sociodemographic correlates associated with self-reported TV viewing included disadvantaged SES, single parent households, ethnicity and age (94). A recent systematic review of the correlates of screen viewing among children less than or equal to seven years of age found that sociodemographic variables that were associated positively with screen viewing were age and ethnicity, whereas the sociodemographic variables associated negatively with screen viewing were SES (95).

Table 2.3 presents a summary of the sociodemographic variables associated with PA and SB published in studies conducted in the Middle East. A 34 country PA and SB comparison study found that boys were more active than girls, which is consistent with the results of numerous other studies (80). In addition, the Global School Health Survey conducted in Kuwait found that male students were more physically active than female students and that 22.9% and 7.1% respectively had PA of at least 60 minutes on all seven days of the previous week (24). An Iranian study also suggested that levels of leisure time PA and sport PA were higher among boys than girls (86). Similarly, another Iranian study examining the correlates of PA in adolescence suggested that female adolescents are associated with low levels of PA (97). The SES factors examined in this study were limited to parental education and maternal occupation, which were not associated with PA or SB (97). A Saudi study assessing PA, SB and the dietary habits related to age, gender and region suggested that female adolescents had higher SB levels than male adolescents and engaged in less PA (vigorous PA above all) (88).

Table 2.2 Systematic reviews of studies assessing sociodemographic correlates of physical activity and sedentary behaviour in young people

Geographical context, year (reference)	Data used	Aim	Sociodemographic correlates and association with physical activity or sedentary behaviour (+) positive (-) negative (?) indeterminate
USA, Europe, 2011 (91)	30 studies limited to children of 4-12 years and adolescents of 13-18 years	Systematic review of physical activity / sedentary behaviour determinants in young people	Physical activity correlates for adolescents: (+) Age (older) (-) Ethnicity (African-American) Insufficient evidence for sedentary behaviour determinants
USA, Europe, 2010, (95)	71 studies limited to children ≤7 years	Systematic review to synthesize current research on correlates of TV viewing	(+) Age (younger) (+) Ethnicity (non-white) (-) SES
USA, Europe, 2004, (94)	68 studies limited to children and adolescents 2-18 years	Systematic review to present descriptive semi-quantitative review of the correlates of TV viewing	(+) Ethnicity (non-white) (-) Parental income (-) Parents' education

USA, Europe, 2007 (92)	60 studies, limited to 4-18 year-olds	Systematic review to summarize correlates of young people's physical activity / sedentary behaviour	Children's physical activity correlates: (+) Gender (male) Adolescent's physical activity correlates: (+) Gender (male) (+) Sedentary behaviour Adolescent sedentary behaviour correlates: (-) Ethnicity (Caucasian) (-) SES (-) Parents' education No sufficient evidence for age as physical activity / sedentary behaviour determinant
USA, Scandina-vian countries, 2010 (96)	62 studies limited to 13-18-year-olds	Systematic review to summarize effect of SES on physical activity in adolescents	58% of studies included reported physical activity associated with higher SES† 42% reported inverse or no association of physical activity and SES

USA, Scandinavian countries, 2013 (93)	10 systematic reviews limited to children aged 3-12 years and adolescents aged 13-18 years	Systematic review of systematic reviews to integrate findings on correlates of physical activity	Children's physical activity correlates: (+) Gender (male) reported by four reviews (?) Age reported by three reviews (+) SES reported by one review (?) SES reported by one review (+) ethnicity (Caucasian) reported by one review (?) ethnicity reported by one review Adolescent's physical activity correlates: (+) Gender (male) reported by three reviews (-) Age reported by two reviews (?) Age reported by one review (+) SES reported by one review (+) parental education reported by two reviews (+) ethnicity (Caucasian) reported by two reviews

†SES: Socioeconomic status

Table 2.3 Summary of sociodemographic variables associated with physical activity, sedentary behaviour published in studies in the Middle East

Author, year, (reference)	Type of study and data used	Aim	Correlates of physical activity, sedentary behaviour (+) positive (-) negative (0) no association
Guthold et al, 2010 (80)	Cross-sectional (13-15-year-olds)	To describe physical activity and sedentary behaviour levels and compare gender differences in 34 countries	Physical activity correlates: (+) Gender (male) Sedentary behaviour correlates: (+) Gender (female)
Al Baho et al, 2011, (24)	Cross-sectional (13-15-year-olds)	To describe physical activity, sedentary behaviour levels and compare gender differences in Kuwait	Physical activity correlates: (+) Gender (male)
Shokrvash et al, 2013 (97)	Cross-sectional (12-14 years)	To explore factors that predict physical activity	Physical activity correlates: (-) Gender (female) (0) Parental education (0) maternal occupation
Saudi Arabia, 2011 (88)	Cross-sectional (14-19 years)	To report prevalence of physical activity, sedentary behaviour and dietary habits among adolescents and examine associations among these factors	Physical activity correlates: (+) Gender (male) Sedentary behaviour correlates: (+) Gender (male)

In summary, most Western and Middle Eastern studies reviewed in this section found that boys and young men engage in more PA than their female counterparts. In addition, studies in the Middle East suggest SB levels are high in females than in males. While Western studies have explored that PA, SB are associated with several sociodemographic correlates such as age, SES and ethnicity, studies in the Middle East focus largely on gender differences or associations with dietary habits. The limited studies available rely solely on self-report, are heterogeneous in terms of measures of PA, SB and highlight the need for further research to examine the sociodemographic correlates of PA and SB. This study used accelerometer based PA, SB measures to explore the sociodemographic correlates associated with PA and SB help guide policy makers to key target populations among adolescents in Kuwait.

2.2.3 Obesity prevalence amongst children and adolescents in Arab countries

A recent systematic review of 40 studies including several countries in each continent suggested that the prevalence of overweight plus obesity among young people was higher in America, Europe and Oceania than Africa and certain countries in Asia (6). The prevalence was lowest in certain parts of Asia (total prevalence was less than ten percent in Iran and China). The prevalence of overweight and obesity was approximately 30% among American adolescents and 22%-25% of European adolescents (with the exception of the Czech Republic and Italy, 14% and 18% respectively). In Australia and Oceania the prevalence of overweight including obesity was 34% and 23% respectively. Asian adolescents (the Middle East included as part of Asia) had a wide range of overweight and obesity. Using the IOTF cut-offs, the prevalence ranged from five percent in China (Far East) to 36% in Bahrain (Middle East) (6).

Table 2.4 presents a summary of the studies that examined the prevalence of overweight and obesity amongst young people in the Middle East and Arab countries. A study of gender differences in overweight and obesity was carried out in seven Arab countries (7). Using IOTF standards, among boys the prevalence of overweight was the highest amongst Kuwaiti male adolescents (25.6%), followed by Jordanians (21.6%) and by Syrian adolescents (19.7%) (7). The prevalence of female overweight and obesity was highest in Libya (26.6%), followed by Kuwait (20.8%) and Syria (19.7%) (7). Adolescents in Kuwait had the highest obesity prevalence for both females (20.6%) and males (34.8%) (7). Another study conducted in Kuwait as part of the Arab Teen Lifestyle Study study recruited 906 adolescents (463 boys and 443 girls) aged between 14 and 19 years and used IOTF BMI cut off values to define overweight and obesity (98). The prevalence of overweight including obesity was 50.5% in boys and 46.5% in girls (98).

Table 2.4 Summary of the prevalence of overweight and obesity among adolescents in the Middle East and Arab countries

Author, Year (reference)	Overweight and obesity definition	Country	Prevalence of overweight (%)	Prevalence of obesity (%)	Prevalence of overweight including obesity (%)
Musaiger, 2012 (7)	The International Obesity Task Force reference standard (42)	Kuwait	Male: 25.6 Female:20.8	Male: 34.8 Female: 20.6	Male: 60.4 Female: 41.4
		Jordan	Male: 21.6 Female: 17.5	Male: 10.2 Female: 4.6	Male: 31.8 Female: 22.1
		Syria	Male: 20.3 Female: 20.1	Male: 6.7 Female: 5.3	Male: 27 Female: 25.4
		Libya	Male: 16.4 Female: 26.6	Male: 9.6 Female: 10	Male: 26 Female: 36.6
Al Haifi, 2013 (98)	The International Obesity Task Force reference standard (42)	Kuwait	Male: 25 Female: 25.5	Male: 25.5 Female: 21	Male: 50.5 Female: 46.5

In summary, the prevalence of overweight and obesity among adolescents in Kuwait is one of the highest of all Arab countries and among the highest worldwide rates of overweight and obesity. The literature highlights the need to explore the lifestyle behaviours and risk factors associated with overweight and obesity. Examining lifestyle behaviours such as PA and SB levels and the determinants of PA, SB will provide the Kuwaiti health and education authorities with important baseline data for public health programmes aimed at adolescents in Kuwait.

2.2.4 Associations of physical activity and sedentary behaviour with adiposity indices and blood pressure

Association of physical activity with adiposity indices

Table 2.5 presents a summary of the studies that have examined the association between PA and various adiposity indices. A systematic review of studies assessing the association between PA, fitness and health indicators (overweight, obesity, BP, cholesterol levels, mental health and skeletal health) among 5-17-year-olds suggested that most of the observational studies that assessed PA using self reporting tools suggested weak or modest associations between PA and overweight or obesity (3). In contrast, the studies that used objective measures of PA tended to report strong associations of PA with overweight and obesity (3). A systematic review including 850 cross-sectional and longitudinal observational studies suggested that female and male adolescents who engage in reasonably high levels of PA (three to five days a week of MVPA of 30-40 minutes duration) have less adiposity (amount not specified) than their less active counterparts (99). In addition, experimental studies of overweight young people that assessed PA intervention programmes of moderate intensity (30 to 60 minutes in duration, three to seven days per week) suggested a reduction in adiposity (amount not specified) (99).

A recent observational study examined the associations between MVPA (objectively measured) and several cardiometabolic factors (100). The study pooled raw accelerometry data of 14 studies (across Australia, Brazil, Europe and the USA) from the International Children's Accelerometry Database (ICAD) and stratified participants (aged 4-18 years) by tertiles of MVPA and sedentary time (100). The study suggested that belonging to the top MVPA tertile (mean time of 52.5 minutes per day) was associated with better cardiometabolic outcomes, including waist circumference, regardless of the amount of sedentary time (100). Mean differences in waist circumference between the top and bottom tertiles of MVPA were 5.6cm (range 4.8-6.4) for participants with high sedentary time and 3.6cm (2.8-4.3) for participants with low sedentary time (100).

A recent systematic review assessing the association between PA, fitness and overweight or obese adolescents included studies (12 cross-sectional and two longitudinal) published in or after the year 2000 (101). The assessment of overweight or obesity in relevant studies included BMI (all cross-sectional and both longitudinal), waist circumference (two studies), skin fold thickness (five studies) and bioelectrical impedance analysis (one study) (101). A few of the included studies had objective measures of PA such as pedometers and accelerometry (five studies), while ten studies used questionnaires to derive information on the PA pattern (101). A combination of subjective and objective PA data was used in only one study (101). The review suggested that most studies examining the association between PA and overweight or obesity did not report an association between PA and adiposity indices (101).

The studies analysing the association between cardiorespiratory fitness and overweight or obesity reported a negative association (101). A study that included skin fold thickness as a measure of overweight suggested that skin fold thickness was negatively associated with cardiorespiratory fitness (ß-coefficient= -3.334 for boys; ß= -2.571 for girls) (101). Truncal subcutaneous fat, measured by bioelectrical impedance, was also inversely associated with cardiorespiratory fitness (ß= -1.78 for boys; ß= -1.77 for girls) followed by BMI (ß= -0.047 for boys; ß= -0.059 for girls) (101). The association between PA and overweight was less evident than the association with physical fitness (101). One study that analysed the association between PA, physical fitness and overweight suggested that while PA influenced physical fitness and physical fitness influenced BMI, PA alone was not associated with BMI (101). As a result, the study suggested that cardiorespiratory fitness acts as a mediator in the association between PA and BMI (101). A possible limitation of the study was that the results were not classified according to whether the PA measurement was objective or self-reported (101). Furthermore, the review included only studies assessing PA or physical fitness with weight and did not include studies that examined the association of PA or fitness with cardiometabolic risk factors, such as waist circumference, BP, etc. (101).

Another systematic review of 48 studies explored the association between objectively measured PA and adiposity in children and adolescents (102). The studies reviewed used a variety of adiposity indices and were divided into studies that used proxies for adiposity (BMI) or studies using measures of adiposity (skin folds, bio-impedance and DEXA) (102). If a combination of the outcome measures was used, the study was classified as a study with 'more precise measures' (102). Three methods to measure exposure (habitual PA) were considered acceptable: accelerometry (67% of included studies), pedometry and heart rate monitoring (102). The review suggested the consistent evidence of negative associations between objectively measured PA and adiposity (observed in 70% of overall studies) (102). Half of the published studies included in the review were from the USA and only three studies were from developing countries (Saudi Arabia, China and Senegal) (102). Furthermore, the review suggested that publication bias may have influenced the results of the studies in respect of the associations between habitual PA and adiposity in young people (102).

Table 2.5 Studies examining the association of physical activity with adiposity indices

Author, year (reference)	Type of study and of sample	Aim	Associations of physical activity with adiposity indices
Janssen et al, 2010 (3)	Systematic review, 5-17 years of age	Examine the associations between physical activity, fitness and health (overweight, obesity, blood pressure, cholesterol levels, mental health and skeletal health)	Of the 25 data points available from cross-sectional self-report physical activity studies including a reported weak association of physical activity with overweight and obesity (BMI), the median odds ratio for overweight/obesity in the least active group, relative to the most active group, was 1.33. Of the 8 data points available from cross-sectional studies with objective measures of physical activity, the association of physical activity and overweight/obesity (BMI) reported the median odds ratio for overweight/obesity in the least active group in relation to the most active group was 3.79
Strong et al, 2005(99)	Systematic review, 6-18 years of age	Review effects of physical activity on health behaviour and outcomes	Young people who engaged in 30-60 minutes of moderate to vigorous physical activity 3-7

		(overweight, obesity)	days a week had less adiposity than less active counterparts
Ekelund et al, 2012 (100)	Meta-analysis of individual participant data, 4-18 years of age	Examine associations between objectively measured moderate to vigorous physical activity (≥3000 counts per min) with cardiometabolic risk factors (waist circumference)	Mean waist circumference difference between top (average 52.5 minutes of moderate to vigorous physical activity) and bottom (average 12 mins) moderate to vigorous physical activity tertiles is 5.6 cm and 3.6, with high and low sedentary behaviour respectively
Rauner et al, 2013 (101)	Systematic review, 11-19 years of age	Summarize relationship between physical activity, physical fitness and overweight (including obesity)	The association between physical activity and adiposity indices not evident Overweight (including obesity) had a negative association with physical fitness (variance in fitness explained by 13% of variability in waist circumference in boys and 16% in girls. Skin fold thickness was associated with cardiorespiratory fitness (ß-coefficient= -3.334 for boys; ß=2.571 for girls). Bioelectrical impedance was associated with

			cardiorespiratory fitness (ß= -1.78 for boys; ß= -1.77 for girls) followed by BMI (ß= -0.047 for boys; ß= -0.059 for girls).
Jimenez-Pavon et al, 2010 (102)	Systematic review, <18 years of age	Examine association between objectively measured physical activity and adiposity	79% of included studies suggested a negative association between physical activity and adiposity

ß: Beta Coefficient [b]BMI: Body mass index

Association of sedentary behaviour with adiposity indices

Table 2.6 presents a summary of the studies that examined the association between SB and adiposity. A systematic review to determine the association of SB with health indicators in school aged youth suggested that TV viewing of more than two hours per day was associated with unfavourable body composition (103). An observational study with meta-analyses of 14 individual studies examined the associations of SB (objectively measured) with several cardiometabolic factor outcomes, including waist circumference, suggesting that SB was not associated with any cardiometabolic outcomes after adjustment for MVPA (100). The study which pooled data from 14 studies, had follow up data available from seven studies (median follow up time of 2.1 years) (100). The study examined the association of baseline waist circumference with sedentary time and time spent in MVPA at follow up (100). While baseline waist circumference was not associated with time spent on MVPA (ß=-0.0037; 95% CI, -0.60-0.052), higher baseline waist circumference was associated with increased time spent sedentary (ß=0.40; 95% CI, 0.19-0.61) (100).

A meta-analysis to examine the relationship between media use, body fatness and PA in children and adolescents found Pearson's mean sample-weighted corrected effect size of TV viewing on body fatness was 0.066 (95% CI = 0.056–0.078) (104). The mean sample-weighted effect size of video/computer game use on body fatness was 0.070 (95% CI = -0.048 to 0.188) (104). Among all the studies included, 79% used self-reported measures for the assessment of TV viewing, computer and video gaming. In regard to the assessment of body fatness, 60% of the studies included in the meta-analysis used skin fold thickness, 37% used BMI and one study used DEXA (104).

A literature review to examine the effect of SB on the development of overweight and/or obesity in children and adolescents whose ages ranged from 2-18 years found that 28 of the 46 studies included reported a positive association of SB with obesity (105). The studies included in the review used several adiposity indices to assess overweight and obesity, including BMI, skin folds, waist/hip circumferences and DEXA (105). The SB was assessed through self-reported TV viewing, computer use and video gaming (105). However, the review found that most of the included studies did not provide clear definitions of the different kinds of self-reported SB (105).

Cross-sectional studies have suggested the association of SB with adiposity among children and adolescents (103, 106, 107). A cross-sectional study of 5,434 children using objective measures of SB and PA suggested that SB was positively associated with obesity in the children, but this association was not independent of MVPA (108). Another study examined the associations between different types of sedentary time and adiposity indices (BMI and the sum of skin folds) in a large population sample of Portuguese children suggested that watching TV for more than two hours per day, as opposed to less than one hour per day, was associated with higher age and sex specific BMI (ß=0.06; 95% CI, 0.01 to 0.12) (107). The associations between TV watching and the sum of skin folds were also positive: the study suggested that associations between sedentary time and adiposity differ according to both the type of sedentary time and the type of adiposity marker (107). Therefore, studies that examine the association of SB with a single adiposity marker (for example, BMI) may miss or confound the association of SB with other type-specific indicators of adiposity (107)

Table 2.6 Studies examining the association of sedentary behaviour with adiposity indices

Author, year, (reference)	Type of study and sample	Aim	Associations of sedentary behaviour with adiposity indices
Tremblay et al, 2011 (103)	Systematic review, 5-17 years of age	Determine the relationship between sedentary behaviour and health indicators	Meta-analysis of randomized controlled studies that aimed to reduce Sedentary behaviour and report change in BMI as their primary outcome, revealed an overall decrease in mean BMI associated with the interventions (ß**= -0.81; 95% CI of -1.44 to -0.17)
Ekelund et al, 2014 (109)	Narrative review, 0-20 years of age	Discuss role of physical activity, sedentary behaviour in relation to adiposity	Unlikely that higher levels of sedentary behaviour are associated with or are predictive of higher levels of adiposity when physical activity is controlled for in youth
Ekelund et al, 2012 (100)	Meta-analysis of individual participant data, 4-18 years of age	Examine associations between objectively measured sedentary behaviour (<100 counts per minute) with cardiometabolic risk factors (waist circumference)	Higher baseline waist circumference was associated with higher amounts of sedentary behaviour time (ß=0.40; 95% CI[a] = 0.19-0.61) at follow up

Marshall et al, 2004 (104)	Meta-analysis, 3-18 years of age	Review evidence of associations between self-reported television, video/computer game use and body fatness (BMI[b] skin fold thickness and DEXA) and physical activity	The mean sample-weighted corrected effect size (Pearson r) between TV viewing and body fatness was 0.066 (95% CI = 0.056–0.078; total N= 44 707). The mean sample-weighted effect size between video/computer game use and body fatness was 0.070 (95% CI = -0.048 to 0.188; total N[d] = 1722).
Rey-Lopez et al, 2008(105)	Literature review, 2- 18 years of age	Review studies about the relationship between sedentary behaviour and obesity development	Positive associations of sedentary behaviour with obesity found in 28 of the 47 studies included positive association of sedentary behaviour with obesity in girls, found in three studies

ß: Beta Coefficient [b]BMI: Body mass index [a]CI: Confidence interval [d]N: Total sample size

Table 2.7 presents a summary of the studies that suggested an association between PA, SB and adiposity indices in the Middle East. The Arab Teens Lifestyle Study suggested that boys and girls who engaged in MVPA (60 minutes per day, seven days a week) were negatively associated with overweight and obesity (measured by BMI and waist circumference) (98). Self-reported SB, assessed through a question about screen time (time spent watching television and working on the computer) was not associated with obesity in either sex (98). A recent study has suggested that participants significantly underestimated SB when a single question is asked, as compared with accelerometer based SB, whereas a multiple item questionnaire with specific SB domains more accurately estimated average SB (110). Although the Arab Teen Lifestyle Study used a validated questionnaire to estimate PA (its limitations are discussed above) (111), self-reported PA is also subject to limitations, including overestimation (due to the perceived social desirability bias), recall bias and misclassification.

A Saudi study involving 2908 (1401 males and 1507 females) students recruited in three cities revealed that obese students were less active, notably in terms of vigorous activity, than non obese students (112). Overweight and obesity, derived from either BMI or waist to hip ratio, were negatively associated with vigorous (corresponding ≥6 MET) PA levels of 60 minutes per day, seven days a week (112). PA and SB were assessed using the Arab Teen Lifestyle Study questionnaire, the limitations of which are discussed above. However, the study used the IOTF BMI reference values to define overweight and obesity and the waist to hip reference value of 0.5 used in the study to define abdominal obesity was derived for use with Caucasian children and adolescents and may not be applicable for all ages or for adolescents in the Middle East (113, 114).

The Iranian study discussed above suggested that playing computer games was associated with overweight and obesity (86). Furthermore, moderate leisure time was associated with overweight and obesity (86). The study used BMI as the adiposity measure and self-report for measuring patterns of PA and SB based on the Baecke five point scale (86). The use of the Baecke questionnaire (designed for adults) to assess PA and SB may not be a suitable measure for estimating PA and SB time in children and adolescents (87).

Table 2.7 Studies examining the association of physical activity and sedentary behaviour with adiposity indices in the Middle East

Author, year (ref)	Type of study and sample	Aim	Associations of physical activity, sedentary behaviour with adiposity indices	Associations of sedentary behaviour with adiposity indices
Al-Haifi et al, 2013 (98)	Cross-sectional, 14-19 years of age	Examine prevalence of overweight and obesity and associations with lifestyle factors	Moderate to vigorous physical activity had a significant negative association with overweight and obesity among boys and girls Proportion of variance of BMI explained by moderate to vigorous physical activity = 0.03 (partial eta squared) for boys and 0.01 (partial eta squared) for girls	Sedentary behaviour >2 hour per day were not associated with overweight or obesity (BMI[b])
Al-Hazzaa et al, 2012(112)	Cross-sectional, 14-19 years of age	Verify prevalence of physical activity, sedentary behaviour and dietary habits and examine interrelationships among these factors	Logistic regression analysis showed overweight/obesity (based on BMI or waist to hip ratio categories) were inversely associated with vigorous physical activity levels, adjusted	Sedentary behaviour >2 hours per day not associated with adiposity (waist to hip ratio)

			Odds ratio for high level = 0.69, 95% CI 0.41–0.92 for BMI and 0.63, 95% CI 0.45–0.89 for waist to hip ratio)	
Hajian-Tilaki et al, 2012 (86)	Cross-sectional, 12-17 years of age	Prevalence of overweight and obesity, assess levels of physical activity and explore association between overweight/obesity and physical activity	Moderate (300 kcal/hour) leisure time physical activity was associated with higher overweight and obesity	Playing computer games associated with higher overweight/obesity (BMI)

[b]BMI: Body mass index

Association of physical activity, sedentary behaviour with blood pressure amongst adolescents

Table 2.8 presents a summary of the reviews and studies examining the association of PA and SB with BP. A systematic review of PA and cardiovascular risk factors in children suggested that PA is associated with favourable health indicators, such as lipids, BP, metabolic syndrome and physical fitness (3). The study found that PA was associated with lower BP among children (3, 99). Furthermore, the study suggested that PA interventions (30 minutes in duration) of moderate intensity at least three times per week can be effective in reducing BP in children or adolescents with high blood pressure (99). A cross-sectional study examining MVPA, SB (objectively measured) with several cardiometabolic factors suggested the mean differences in systolic BP between bottom and top tertiles of MVPA were 0.7 mmHg (95% CI, -0.07 to 1.6) for high sedentary time and 2.5 mmHg (95% CI, 1.7 to 3.3) for low sedentary time (100).

A cross-sectional study that examined the association between SB and BP in children (aged 3-8 years) used several indicators of SB, including TV viewing, computer use, other screen time and accelerometer based SB, found that TV viewing and screen time were both associated with BP, independently of body fat composition (115). However, accelerometer based SB was not associated with BP (115). A possible limitation of this study is that TV, computer and screen time was assessed via parents' reports and they may have overestimated the child's TV time. A study to assess the relationship between parent-reported TV viewing and objective measures reported that when, parents tend to overestimate children's' TV time, compared to objective measurements of it, by more than four hours per week (116).

A study examining the independent and combined effects of PA and SB on BP among adolescents and assessing gender differences from two cross-sectional studies (conducted in Europe and South America) suggested that the combination of low levels of PA (less than 60 minutes per day) and increased SB (two to four hours of SB per day) is associated with an increase in systolic BP levels in boys, but in girls high levels of SB were associated with systolic BP independent of adequate PA levels (60 minutes per day) (117). Both studies used self-reported questionnaires to assess PA, SB; the European study also included accelerometer based PA, SB measures (117).

A study in the United Arab Emirates examining the correlates of metabolic syndrome, including BP of more than or equal to 130/80 mmHg, suggested that spending more than two hours screen time per day was associated with metabolic syndrome (118). The study found that screen time was associated with increased risk of metabolic syndrome, independently of PA (118). The study estimated SB by asking participants to recall the number of TV or computer hours per typical day. A possible limitation of self-reported measures is that responses to questions may be influenced by cultural norms, recall bias and the lack of validity of self-reported SB measures (119).

Table 2.8 Studies examining the association of physical activity and sedentary behaviour with blood pressure

Author, year (ref)	Type of study and sample	Aim	Associations of physical activity with blood pressure	Associations of sedentary behaviour with blood pressure
Janssen et al, 2010 (3)	Systematic review, 5-17 years of age	Examine the relation between physical activity, fitness and health and make recommendations based on findings	Observational self-reported physical activity or fitness studies reported a weak association of physical activity with blood pressure, odds ratio <1.5; 95% CI[a],1.01-1.50 4 Experimental studies with physical activity aerobic based interventions ranging 4-25 weeks (60-180 minutes of exercise) reported reductions in systolic blood pressure (effect size >0.80) 2 studies which reported reductions in diastolic blood pressure as well (effect size 6-11%)	Not reviewed

Strong et al, 2005 (99)	Systematic review, 6-18 years of age	Review effects of physical activity on health outcomes	30 minutes of moderate to vigorous physical activity 3 times a week associated with lower blood pressure	Not reviewed
Ekelund et al, 2012 (100)	Meta-analysis, 4-18 years of age	Examine associations between objectively measured moderate to vigorous physical activity and sedentary behaviour with cardiometabolic risk factors	Mean difference in systolic blood pressure between top and bottom tertiles of moderate to vigorous physical activity was 0.7 mmHg (95% CI, -0.07 to 1.6) and 2.5 mmHg (95% CI, 1.7 to 3.3) for high and low sedentary behaviour, respectively	Not associated with any cardiometabolic outcome
De Moraes et al, 2013(117)	Cross-sectional studies 12.5-17.5 years of age	Examining the independent and combined effects of physical activity and sedentary behaviour with pressure among adolescents from two observational studies	In both studies the combined effects of low levels of physical activity (<60 minutes per day) and increased sedentary behaviour (>4 hours/day) is associated with an increase in systolic blood pressure levels in boys	In one study increased sedentary behaviour (2-4 hours per day) is associated with increases systolic blood pressure levels in girls, independently of physical activity recommendations

Martinez-Gomez et al, 2009 (115)	Cross-sectional 3-8 years	Examine the association between sedentary behaviour and blood pressure	Not included in the study	No association between objectively measured sedentary behaviour and blood pressure Positive association between self-reported TV and screen time independent of body fat composition
Mehairi et al, 2013, (118)	Cross-sectional, 12-18 years	Prevalence of metabolic syndrome and its correlates	Physical activity not associated with metabolic syndrome	Metabolic syndrome associated with sedentary behaviour (screen time) of more than 2 hours per day independent of physical activity

[a]CI: Confidence interval

In summary, despite the limitations of the literature discussed above, several studies have suggested that PA and SB are associated with adiposity and BP in young people. Studies using only self-reported PA and SB either do not reveal an association of PA and SB with BP or report a weak association. However, several studies using objective measures of PA suggested that increased PA levels are associated with positively with cardiometabolic factors (waist circumference and BP). Furthermore, studies have suggested that increased SB was associated with higher BP levels among adolescents, independently of PA. Therefore, building on this evidence, more research to explain the association of PA and SB with adiposity and BP among adolescents is warranted. To the best of our knowledge, there are no studies examining the association between objectively measured PA and SB with adiposity or BP among adolescents in Kuwait.

2.3 Overall conclusion of the literature review and gaps in the literature

This literature review has focused on the current PA levels and SB patterns of adolescents in Kuwait and the Middle East. Epidemiological studies of both PA and SB in Kuwait and its neighbouring countries are scarce and rely almost entirely on self-reported measures. Children and adolescents have difficulty providing accurate reports of PA and SB, therefore, adolescents PA and SB profiles are more informative combining both self-report and an objective measure of PA and SB. Furthermore, there are aspects of PA and SB that require further investigation. Specifically, the literature relating to the sociodemographic correlates of PA and SB in the Middle East are sparse and inconsistent; these gap will be addressed in the second analysis of the thesis (see Chapter 5).

Studies in the Middle East suggest that prevalence of overweight and obesity among adolescents is high, but most rely on BMI as an adiposity indicator and do not provide a comprehensive profile of adiposity by combining several measures of it. Furthermore, data highlighting BP levels among adolescents in Kuwait are lacking. This gap will be addressed in the third analysis of the thesis (see Chapter 6).

While several studies have suggested that PA and SB is associated with adiposity and BP, the discrepancies in PA and SB measures used in studies conducted in the Middle East warrant further investigation. This issue will be addressed in the fourth analysis (see Chapter 7) of the thesis.

To the best of the PhD candidate's knowledge, there are no studies reporting objectively measured PA and SB levels among adolescents in Kuwait. A few studies have estimated child and adolescent obesity in Kuwait; the existing studies indicate that adolescent overweight and obesity are very prevalent in Kuwait and highlight the need to explore lifestyle behaviours and the risk factors associated with adiposity. To improve PA levels among adolescents in Kuwait requires a better understanding of the prevalence and the demographic and socioeconomic correlates of PA and SB. Existing studies provide limited insights into the associations of PA and SB with adiposity and BP among adolescents in Kuwait. This information will help guide policy makers to key target populations within this group.

2.4 Aim and objectives

2.4.1 Aim

The aim of the present research is to examine the prevalence and correlates of physical activity, sedentary behaviour and the associations of these two behaviours with two key biological outcomes in a school-based sample of adolescents in Kuwait.

2.4.2 Research objectives

1. To examine the levels of self-reported and accelerometer based physical activity, sedentary behaviour among a sample of school age adolescents in Kuwait using a self-administered questionnaire and an accelerometer.
2. To assess the sociodemographic correlates of physical activity, sedentary behaviour.
3. To estimate the prevalence of overweight and obesity among a sample of school age adolescents in Kuwait and to assess the distribution of body fat percent, waist

circumference and blood pressure among a sample of school age adolescents in Kuwait.

4. To examine the associations between physical activity, sedentary behaviour with three indicators of adiposity and blood pressure among school age adolescents in Kuwait.

2.5 Thesis structure overview

This thesis is divided into eight chapters. Chapter 2 reviews the literature on the themes covered by the present work. Chapter 3 describes the general methodology and the SHAAK pilot study. This thesis describes a series of analyses in Chapters 4,5,6 and 7. Chapter 4 examines the criterion validity of the SHAAK PA and SB questionnaire data with accelerometry data and presents an analysis of accelerometer wear time. Chapter 5 examines the levels of self-reported and accelerometer based PA, SB and the sociodemographic correlates of PA and SB. Chapter 6 describes the prevalence of (BMI-defined) obesity and the distribution of body fat percent, waist circumference and BP. Chapter 7 examines the associations between PA and SB with adiposity indices and BP. Chapter 8 summarises the main findings, discusses the strengths and weaknesses of the entire research undertaken as part of this PhD, and puts the results in the context of future research needs. Chapter 9 highlights the challenges with the data collection and the limitations encountered throughout the project.

Chapter 3: General SHAAK methodology

The aim of this chapter is to provide a description of the general methodology used in all parts of the thesis. This chapter is divided into five sections. The first section describes the study design, eligibility criteria, how the participants were recruited and response rates. The second section covers the ethical approval procedures, whilst the third section details the measurement tools and protocols. The fourth section provides an overview of fieldworker training and the pilot study and then outlines the actions taken as a response to the pilot study findings. The fifth section describes the initial preparatory procedure for fieldwork, the standardized data collection protocols devised following the pilot study, the post-data collection procedures and the way that the resulting data were handled. In addition, the last section summarises the general statistical approach whilst detailed descriptions of the statistical analyses specific to the thesis objectives are located in the next few chapters.

3.1 Study design, participants and sampling procedure

SHAAK is a cross-sectional study targeting Kuwaiti adolescent students attending intermediate and secondary state schools. A multistage stratified sampling design with proportionate sampling was used. The sampling frame included all the governmental (intermediate and secondary) schools in Kuwait. The sample was stratified by governorate (Hawalli, Asimah, Jahra, Farwaniya, Ahmadi and Mubarak) and by the gender and the school grades of the students (7 to 12). Each governorate is served by a number of schools, in proportion to its population density. One percent of all Kuwaiti school students in the classes of the previous year were selected proportionally according to governorate, gender, and grade (refer to the sampling frame, section 3.1, Table 3.1, page 75).

A simple, random (raffle-style method used throughout the sampling procedure) sampling procedure was used to select the schools in the first stage (using the Ministry of Education's Schools Directory of Kuwait for the school year 2011-2012). Intermediate schools contains grades 7-9, while secondary schools contains grades 10-12. Two schools for each gender from each governorate (one intermediate school and one secondary school). For example, the Jahra governorate has 17 and 18 intermediate schools for boys and girls respectively. Using the Ministry of Education's Schools Directory of Kuwait for the school year 2011-2012, a serial number was assigned to every intermediate school for each gender. The same serial number was recorded on a paper, then folded and placed in a box. This process was carried out separately for each gender. Subsequently, a paper was randomly selected for each gender and the chosen serial number corresponding to the serial number in the school directory was visited. This process was repeated for the secondary schools. In the second stage and using a similar approach, one class was randomly selected from each grade; three classes from each intermediate school and three classes from each secondary school (refer to flow diagram of multistage sampling design, section 3.1, Figure 3.1, page 75).

All the students in the selected classes were invited to participate in the study, but, the required number of students for each corresponding governorate was randomly selected for the supply of data. One percent of the total student population (N= 128,948) students constituted a target sample size of 1,289 students. However, due to time constraints, data were collected from only three (Hawalli, Asimah and Jahra) of Kuwait's six governorates. The students (n= 591) were selected by a simple random sampling procedure, proportionally to their distribution in the population. The response rates are presented in a flow diagram of the study participants (refer to section 3.1, Table 3.2, page 77).

The criteria of inclusion were to be Kuwaiti students, male or female, in grades 7-12 present in the selected school and present during the time of the study. Any student not present on the day of the research team school visit were excluded from the study. School enrolment in Kuwait for both females and males is high, 97% and 99% respectively (74).

Table 3.1 Total number of students in Kuwait in academic year 2010-2011

Students	Grade 7		Grade 8		Grade 9		Grade 10		Grade 11		Grade 12		Total	Total	Total
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
Ahmadi	2583	2874	2453	2896	2230	2817	1891	2849	1472	2380	1488	2016	12117	15832	27949
Jahra	1587	1735	1619	1745	1363	1679	1402	1640	741	1360	661	1088	7373	9247	16620
Hawalli	1876	1845	1900	1800	2055	1774	2005	1873	1760	1813	1555	1637	11151	10742	21893
Asimah	1680	1668	1841	1663	1860	1742	2007	1974	1843	1834	1666	1951	10897	10832	21729
Farwaniya	2304	2526	2147	2407	1970	2376	1920	2470	1263	2281	1242	2026	10846	14086	24932
Mubarak	1293	1277	1252	1463	1271	1482	1201	1606	1017	1646	800	1517	6834	8991	15825
Total	11323	11925	11212	11974	10749	11870	10427	12412	8096	11314	7412	10235	59219	69730	128948

Table 3.2 Proportionate number of students for the intended sampling strategy

Students	Grade 7		Grade 8		Grade 9		Grade 10		Grade 11		Grade 12		Total	Total	Total
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	
Ahmadi	26	29	25	29	22	28	19	29	15	24	15	20	121	158	280
Jahra	16	*17	*16	*17	*14	*17	*14	*16	*7	*14	*7	*11	74	93	166
Hawalli	*19	*18	*19	*18	*21	*18	*20	*19	*18	*18	*16	*16	112	107	219
Asimah	17	*17	*18	*17	*19	*17	*20	*20	*18	*18	17	*20	109	108	217
Farwaniya	23	25	21	24	20	24	19	25	13	23	12	20	109	141	249
Mubarak	13	13	13	15	13	15	12	16	10	16	8	15	68	90	158
Total	113	119	112	120	108	119	104	124	81	113	74	102	592	697	1289

*****Students who participated in SHAAK in the nine months of the data collection

Figure 3.1: Flow diagram of multistage sampling design

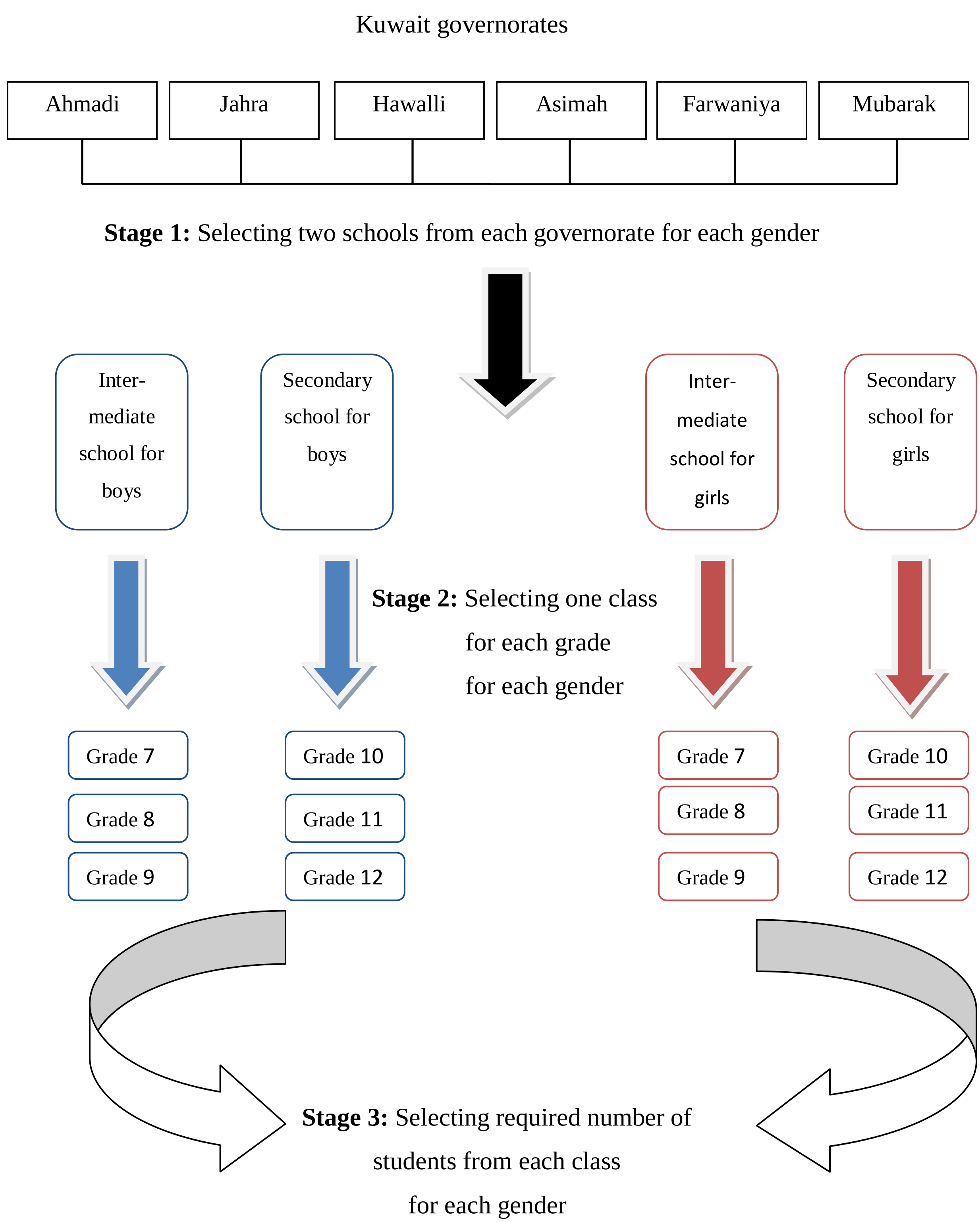
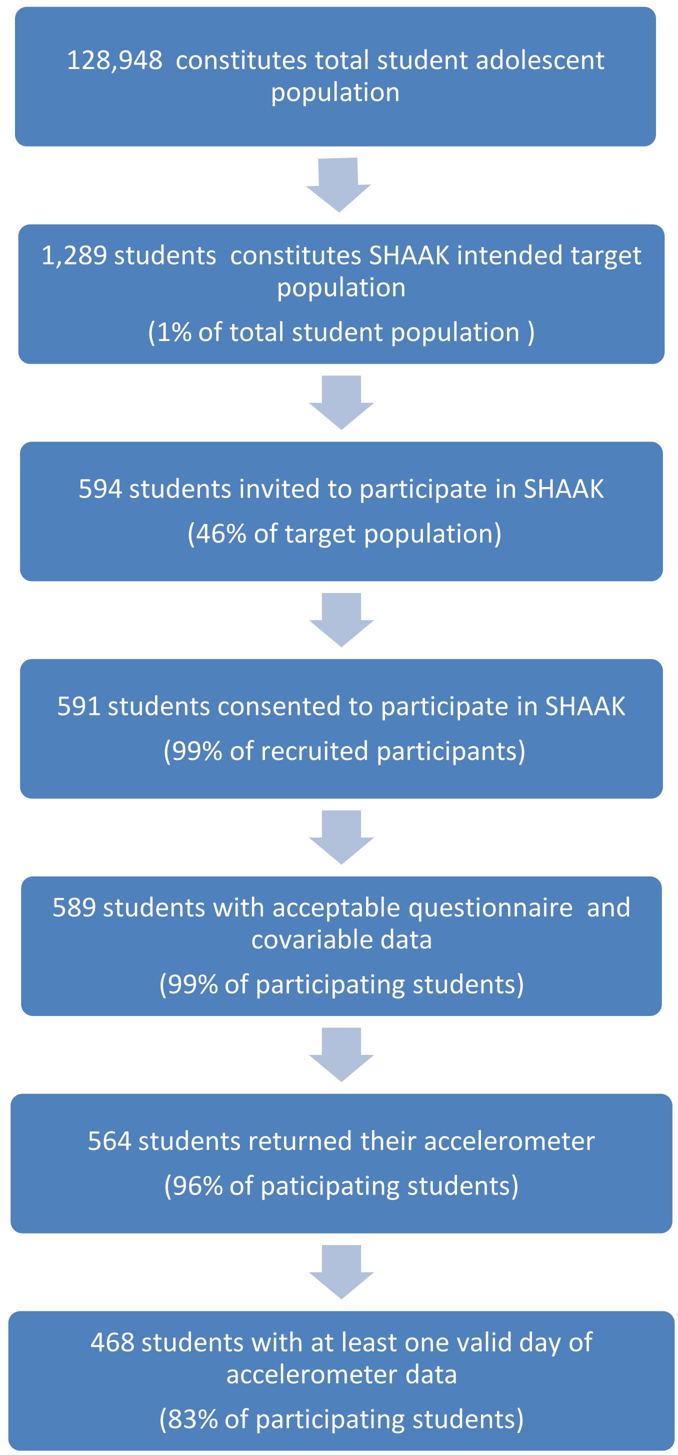


Figure 3.2: Flow diagram of study participants



3.2 Ethical Approval

The study objectives and procedures were discussed with those responsible in the Kuwait Institute for Medical Specialization (KIMS) (Appendix 2). Ethical approval for all study procedures and instruments was obtained by the KIMS and the Ministry of Education. The Ministry of Education issued an official document allowing the researcher to visit any governmental school. Written assent forms for the participants in the study were attached to the questionnaire and signed by the participating students, before starting the assessment (refer to Appendix 3). In addition, the students took home a parental consent form to be signed by their guardians (refer to Appendix 4). All the collected data were dealt with confidentially. Identification information and contact information (for accelerometer retrieval purposes) was kept separately from the questionnaire. Students received an explanation of the aim of the study and its importance (refer to Appendix 5). The students and their parents were free to agree or refuse to participate and/or withdraw from the study at any time, without any obligation. The students and their parents were provided with the PhD candidate's contact number and email for any additional enquiries about the study.

3.3 Measures and measurement protocols

3.3.1 Measures

Questionnaire (refer to Appendix 6)

Data were collected by a self-administered questionnaire which included questions on PA and SB, a set of physical examination measures (taken by the PhD candidate and field workers) and objectively assessed PA and SB using an accelerometer. The questionnaire was developed by the PhD candidate using a number of sources. The questions pertaining to demographic information were similar to the questions used in a number of national Kuwaiti studies (74, 120, 121). School transport, school break activity and health related questions were obtained from the Children's Heart and Health Study in England, which used a multi-ethnic population (122).

The PA and SB questions used in SHAAK are similar to those used in the Arab Teen Lifestyle Study questionnaire which is intended for use among young people in Arab countries (111).

The questions derived from the Children's Heart and Health Study in England were translated into Arabic by the PhD candidate and verified by a qualified English/Arabic translator (Ministry of Foreign Affairs). For the questions intended to collect PA and SB information, the Arabic version of the Arab Teen Lifestyle Study questionnaire was used.

Physical activity questions collected information on:

- School transportation, assessed by MCQ indicating usual mode of transport to and from school, i.e. car, bus, walking or other means.
- School break activity, assessed by MCQ indicating usual behaviour during first school break (repeated again for second school break), i.e. what do you do during the first school break even if you are eating? sit/talk/read, walk/stand or run/play.
- Physical exertion during physical education (PE) class, assessed by MCQ indicating how often participants became short of breath, i.e. never; sometimes; most times; or I do not take part in PE.
- Weekday after-school sport and exercise participation, was assessed by MCQ indicating frequency of participation during the week, i.e. how many times a week do you participate in sports or exercise after school? do not participate; once per week; twice per week; three times per week; or more than three times per week.
- Weekend sport and exercise participation, assessed by MCQs indicating frequency during the week, i.e. how many times a week do you participate in sports or exercise? do not participate; once per week or twice per week.
- Sports and exercise for the previous week, assessed by a table with the following sports activities: basketball, running or jogging, cycling, dance, football, gymnastics, martial arts, tennis, swimming, volleyball, walking fast and other (please specify). The participant was required to tick the appropriate sports activity undertaken and specify the frequency of the activity and the total duration during the previous week.

Sedentary behaviour was assessed by a table with the following sedentary behaviours:

- Home TV viewing
- Non active video games (games played while being seated)
- Computer use
- Social networks
- Home work
- Leisure-time reading

The participant was required to tick the appropriate box for the usual time spent daily on each behaviour, i.e. do not do this; one to two hours; two to three hours; or more than three hours.

The questionnaire collected information relating to: (refer to Appendix 6)

Sociodemographic data:

- Date of birth
- Gender
- School grade
- Birth order and family size
- Socioeconomic status of the adolescents was assessed through the following indicators: parental education (illiterate, read and write, intermediate, secondary, university or higher education); parental occupation, parental ownership of assets (owned or rented apartment or house, number of cars and number of domestic workers); number of bedrooms and bedroom sharing.

Health related behaviours:

- Smoking status was assessed by multiple choice questions (MCQs) i.e. never smoked; tried to smoke once before; used to smoke but no longer smokes; one to six cigarettes per week; or more than six cigarettes per week.
- Dietary habits were assessed by MCQ indicating fresh fruit and vegetable consumption; number of fresh fruit juice drinks; number of nectar based drinks; and number of soft drinks consumed per day, i.e. twice or more per day; once per day; less than once a day but at least once a week; less than once a week; or I do not know.

Physical examination

(For detailed information on the physical examination measurement protocols, refer to Appendix 7)

The physical examination measurements were the following:

- Weight was measured (light clothing, emptied pockets and without shoes), to the nearest 0.1 kg using a SECA (Germany) electronic scale, model 813.
- Height was measured (without shoes, in bare or stocked feet), to the nearest 0.1cm using a SECA (Germany) portable stadiometer, model 217, with adolescents standing upright.
- Waist and hip circumference was measured (over light clothing), using a non-elastic flexible measuring tape (Myotape, USA). Waist circumference measurements were taken midway between the tenth rib and the iliac crest, to the nearest 0.1 cm, with participants standing erect, arms by their sides, feet together and abdomen relaxed (at the end of expiration).
- Bioelectrical impedance at a fixed frequency of 50 kHz using the Bodystat ® 1500 (Bodystat Ltd, Isle of Man, British Isles) was, validated in comparison with dual-energy absorptiometry fat-free mass (FFM) used as the criterion measure (58). The participant was asked to remove shoes, socks and to lie down comfortably on the bed (or table) provided with his/her arms not touching the side of the body and legs slightly apart (to avoid conductivity in the wrong places). Special pads were placed on his/her hands and feet. The pads were placed on the right hand (across and just behind the middle knuckle), right wrist (across the back of the wrist and next to the head of the ulna), right foot (immediately behind the second toe) and on the right ankle (midway between the medial and lateral malleoli). Then the cables were attached: one pair of cables to the arm, one pair of cables to the leg. The Bodystat instrument was then turned on and the bioimpedance measurement was taken by pressing the ‘enter’ (return) button twice. Refer to Appendix 4 for more information on the bioelectrical impedance measurement protocol.
- BP was measured in mmHg using the Omron HEM 907XL (USA) digital BP monitor. The BP was measured on the right side of each participant using the

appropriate cuff, on the bare skin of the upper arm. The participant was asked to sit quietly for 5 minutes with feet flat on the floor, then three readings were taken, one minute apart. Refer to Appendix 7 for more information on the BP measurement protocol.

Accelerometry

To measure PA and SB objectively, participants were given an Actigraph GT1M activity monitor (Actigraph, LLC, Pensacola, FL, USA). The Actigraph is a small and lightweight device about the size of a matchbox, which is attached to a belt around the waist. The Actigraph activity monitor is a uniaxial accelerometer designed to measure change in acceleration in the vertical plane with respect to time. The accelerometer measures the vertical acceleration and deceleration of human motion (123). The detected accelerations are filtered, then converted to a number (count) and subsequently summed over a specified time interval called an epoch (123). The Actigraph has been shown to be a valid measure of PA in young people (124), and a reliable measure when compared with PA measures derived from doubly labelled water (125), heart rate monitoring (126) and room calorimetry (124). However, the Actigraph cannot provide postural allocation information, since neither sitting nor standing involves vertical acceleration (123).

Accelerometers were initialized the day before the field visit and were set to start collecting data at 5 am the following day (after the field visit). At each field visit and at the end of the physical examination, the participants were fitted with an elastic belt (with the attached accelerometer) on their right hip, according to a standardized protocol. The participants were asked to wear the accelerometer during their waking hours for seven consecutive days and to remove the accelerometers when showering, bathing, during any aquatic activities or contact sports in which they felt at risk of injury (127-129). Participants were given a letter to show to their parents and teachers; it described the study and the importance of wearing the accelerometer during activities.

Participants were asked to hand in the accelerometers to a designated teacher after the seven days of data collection. Personal details, such as name, address, contact number were noted and used in a midweek phone call to remind students to wear the accelerometers and for follow up in case students forgot to hand in the accelerometer. Students were told to hand in the accelerometers after one week. Any student who failed to hand in the accelerometer was reminded to do so by a phone call. As a last resort the researcher visited the participant's home to collect the accelerometer.

To reimburse the participant for the time spent on the project, any student who returned the accelerometer was given a 2.5 Kuwaiti Dinar (£5) voucher as an incentive.

3.4 Fieldwork Preparation

3.4.1 Training the fieldworkers

The field workers, two males and two females (all qualified registered nurses), attended a two-day training workshop before the pilot study started. Training included familiarization with the questionnaire instructions and the detailed procedures of data collection. They also received one day's training by the PhD candidate before the pilot study aimed at refreshing their knowledge from the previous workshop, answering enquiries and reviewing details. The training methods included small group discussions, role play and brain storming. The researchers' primary supervisor, Dr Stamatakis, paid two visits to Kuwait. During the first visit, Dr Stamatakis supervised the training of the fieldworkers as well as the pilot study. For the duration of the pilot study, Dr Stamatakis observed the researchers' and fieldworkers' performance during the physical examination measurements, recorded comments on their accuracy and addressed these issues at the end of every measurement session. For the period of the second visit, Dr Stamatakis supervised the initiation of the fieldwork, using a similar approach to the first visit. The researcher, a general physician, assumed this role in the absence of Dr Stamatakis to ensure quality control.

The nurses were trained in measuring the following:

- Weight and height
- Waist circumference
- Bioelectrical impedance
- Blood pressure

3.4.2 The pilot study

Before the beginning of the main data collection, the procedures and instruments were pilot-tested to ensure that the reading level, language and format were appropriate for the intended sample of adolescents. The pilot study was supervised by the PhD candidate's primary academic supervisor (Dr Stamatakis) for first-hand expert advice during the field visit. Dr Stamatakis supervised the fieldworkers performance during the various physical examination measurements, recorded the timings of each examination session and oversaw the handling of the accelerometers by the PhD candidate.

Two conveniently chosen schools for students of each gender were visited on pre-arranged dates by the team of trained medical staff led by the PhD candidate. The pilot study began on 20th May 2012 and lasted for five days; two days were allocated for the boys' school and two days for the girls' school. The final day consisted of a debriefing session with the field workers. The pilot study was carried out on 64 students in total, 33 boys in grade seven and 31 girls in grade nine.

The overall aim of the pilot study was to test the feasibility of all aspects of the research process and its measures and to identify areas for improvement.

The specific objectives of the pilot study were:

a) To identify unclear questions in the questionnaire which were raised by the participants during the administration of the self-reported questionnaire.
b) To estimate the time required to complete the questionnaire.
c) To examine the coordination among the team members, e.g. the PhD candidate, field workers and school co-ordinator and the data collection procedures

d) To identify unforeseen difficulties during the steps of the data collection, e.g. measurement timing issues, number of measurements taken, layout of measurement stations in the clinic, etc.
e) To examine the adherence to wearing the Actigraph and returning it on time.

Pilot study methodology

For the first stages of the pilot study data collection, the questionnaires were distributed to the entire class, the students were asked to answer the questions and raise their hands for any inquiries. It was noted that this method opened the door to students' discussing the questions amongst themselves and it was difficult to make sure that every student was answering all the questions. After completing the questionnaire the students were asked to remain in the classroom (holding their questionnaires) and wait for their turn to be escorted to the clinic by the coordinator. This method also proved challenging: the students would often take advantage of the brief absence or focus elsewhere of the coordinator and enter the clinic to inquire about their turn for the physical examination. Moreover, the work flow tended to be disrupted further when students forgot to bring their questionnaires with them when it was their turn to be escorted to the clinic.

The second approach that the research team tested was to abandon the attempt to deal with a whole class and deal instead with a fixed number of students in the school clinic. The students permitted in the clinic were asked to answer the questionnaire and await a physical examination by the research team. This method demonstrated a marked improvement on the former approach described in the previous paragraph. It allowed closer monitoring of the students, ensured that the questionnaire was completed and resolved the issue of leaving the questionnaire behind in the classroom. However, some concerns were noted with the latter approach as well, including the number of students allowed to enter the clinic. The timings of the various sessions revealed that a group of ten students was too big and of six students was too small. In addition, if all the students at the beginning of the session started answering the questionnaire, the research team had to wait with not much to do for approximately 20 minutes. Afterwards, when the research team was engaged in the physical examination of three or four students, the remainder tended to talk or giggle amongst themselves and distract or disrupt the physical examination session.

The third questionnaire completion method tested proved the most successful. Here, eight students were allowed in the clinic, four of whom worked on the questionnaire while the other four were asked to undergo the physical examination. This method kept to a minimum the students' interaction with one another and ensured that both the students and the research team were occupied for the entire session. Afterwards the students would change places, so that the students who had answered the questionnaire would move to the physical examination and vice versa. This '4 x 4' method was adopted formally throughout the main stage data collection. A detailed description of this method is given below

3.4.3 Pilot study results

The pilot study revealed the need to improve several key areas before beginning the main field work.

Questionnaire related issues:

Students required an average of twenty minutes to complete the whole questionnaire. Several questions in the questionnaire were deemed unclear by the participants. For example, the first item in the questionnaire was dedicated to the serial number of the participant (to be filled out by the researcher afterwards), however, students would frequently ask what the term 'serial number' meant or attempt to fill it out themselves, albeit incorrectly.

For question 7 'How many people live in your home including yourself?', students would frequently ask if the answer should include housemaids. For question13 'How many household employees work for your family', students would frequently inquire about the meaning of the term 'household employee' and for question 38 'What do you do during the first school break?' students would often raise that the fact that eating is not included among the possible answers. The same concerns are applied to question 39 regarding the second school break. Some students attempted to complete the last page of the questionnaire by themselves, that was intended for the details of their physical examination measurements.

Physical Examination and workflow related issues:

The need to make three BP measurements, one minute apart with a five-minute resting period to begin with, demanded much time and disrupted the work flow. In addition, making the two weight and height measurements was also time consuming, because the measurements when repeated were almost always identical.

Following the experimentation and timing of several methods for data collection, it was discovered that fieldworkers took longer to complete physical examination measurements if they attempted to take all the measurements at once than if the measurement tasks were divided amongst them. For example, if a single fieldworker attempted to measure height, weight, bioimpedance, waist circumference and BP in sequence, the average time to complete the measuring was approximately 15 minutes per participant. However, when the researcher and the fieldworkers were each assigned one or two measurements to make (for example, bioimpedance alone), the average time to complete all the measurements was approximately ten minutes per participant.

Accelerometry related issues:

Adherence to wearing the Actigraph during the pilot study based on the required 600 minutes per day criterion for inclusion, was low (Table 3.3). Returning the devices on time also proved challenging; four of the 64 accelerometers given out were not returned/reported as lost (a six percent loss for which boys alone were responsible).

Table 3.3 Number of valid days (≥600 minutes per day) of Actigraph wear in the pilot study

Number of days wearing the Actigraph	Number (and / or percentage) of participants
<1	23
1	8
2	13
3	10
4	5
5	1
6	0
7	0
Less than 1 day	23 (38%)
Wearing it for 1 day or more	37 (62%)
Wearing it for 3 days or more	16 (27%)

3.4.4 Actions following the pilot study

Table 3.4 details all the issues raised during the pilot study and the actions used to rectify them. Minor modifications were required in the questionnaire. A data collection protocol was devised to implement a single method for data collection. The protocol proved efficient after several methods were tested in the pilot. Each fieldworker was responsible for a measurement station and the students moved from one station to another. A mid-week phone call to remind students to wear the Actigraph was added to the data collection protocol and a 2.5 Kuwaiti Dinar (approximately 5 Great British Pounds) gift voucher was awarded for all participants who returned the Actigraph. All the personal details (address, mobile, home phone number) of the students were recorded separately in case the student continued to forget to hand in the device, requiring a personal visit for its collection.

Table 3.4 Identified issues during the pilot study and action taken to rectify them

Identified issues during the pilot study	Action taken to rectify the issue
Questionnaire related issues	
Serial number at start of the questionnaire	Serial number removed from questionnaire and a cover page was added for serial number
Question inquiring about the number of people living in home	‘Not including domestic maids’ added to the question
Question inquiring about ‘How many household employees work for your family’	Question changed to ‘How many people work in your home?’
Question asking ‘What do you do during the first school break?’	Question changed to ‘What do you do during the first school break (even if it is eating)?’
Question asking ‘What do you do during the second school break?’	Question changed to ‘What do you do during the second school break (even if it is eating)?’
Students mistakenly attempted to fill out the physical examination measures themselves in last page of questionnaire	‘Please do not complete this page’ added at the top of the last page of the questionnaire
Physical examination related issues	
Three BP measurements, one minute apart with a five minute resting period were time consuming	Reduced to two BP measurements, one minute apart with a three minute resting period
Two weight and height measurements were time consuming	Reduced to one weight and one height measurement
Fieldworkers took longer to complete physical examination measures if they attempted to take all the measurements at once	Measurement tasks were divided amongst the researcher and the fieldworkers in separate stations

Workflow related issue	
Unsuccessful attempts to ensure efficient data collection and effective workflow process	The ‘4 x 4’ data collection protocol was devised for efficient, timely data collection and work flow
Accelerometry related issues	
Low adherence to wearing the Actigraph given the 600 minutes per day criterion for wear time validation	Mid-week phone call added to the data collection protocol and more emphasis during the data collection process on the need to wear the Actigraph for the requested period
Returning the devices on time proved challenging	A 2.5 Kuwaiti Dinar gift voucher was given to all participants who returned the device. Personal details of the students were recorded to remind them via a phone call to return the device or for retrieval by the researcher via a personal home visit

3.5 Main stage data collection

Data collection took place from October 2012 through June 2013 during school field visits lasting up to six hours each. Fieldwork for the main study commenced in October 2012, approximately two weeks after school had officially started. As of June 2013, 591 students were recruited, making up 46% of the target sample. Out of the six governorates, data were collected from three governorates (Jahra, Hawali and Asimah). Several factors contributed to the inability to recruit the intended target sample; these factors include the limited availability of accelerometers and time constraints (official school holidays, examination periods and study leave). The number of students who participated in SHAAK is indicated in section 3.1, Table 3.2, page 74.

The main stage data collection followed a standard protocol that was used throughout the data collection process. The standard data collection protocol is described in detail in the sections below.

3.5.1 Initial school meeting

The PhD candidate visited each selected school to inform the principal about the date of the expected field work. The approximate time taken for each initial school visit was approximately three hours. The principal was briefed about the purpose of the study and given the necessary approval forms from the Ministry of Health and Ministry of Education. Following inquiries about the number of classes in each grade and the use of the raffle style method, the PhD candidate asked the principal to allow the three randomly chosen classes from three different school grades, to be available on the day of the field visit. For example, if grade 7 had six classes, the PhD candidate recorded the numbers one to six on separate pieces of paper, folded them and placed them in a box. The PhD candidate or the principal picked a paper randomly for each grade. The PhD candidate asked permission to give the three allocated classes (e.g. classes 7.3, 8.2 and 9.4) a brief talk about the nature and purpose of the study. In the class the PhD candidate described the nature of the study and its purpose and answered the students' questions. At the end of the discussion, the PhD candidate handed out a consent form to each students and asked them to sign it if they were willing to participate in the study.

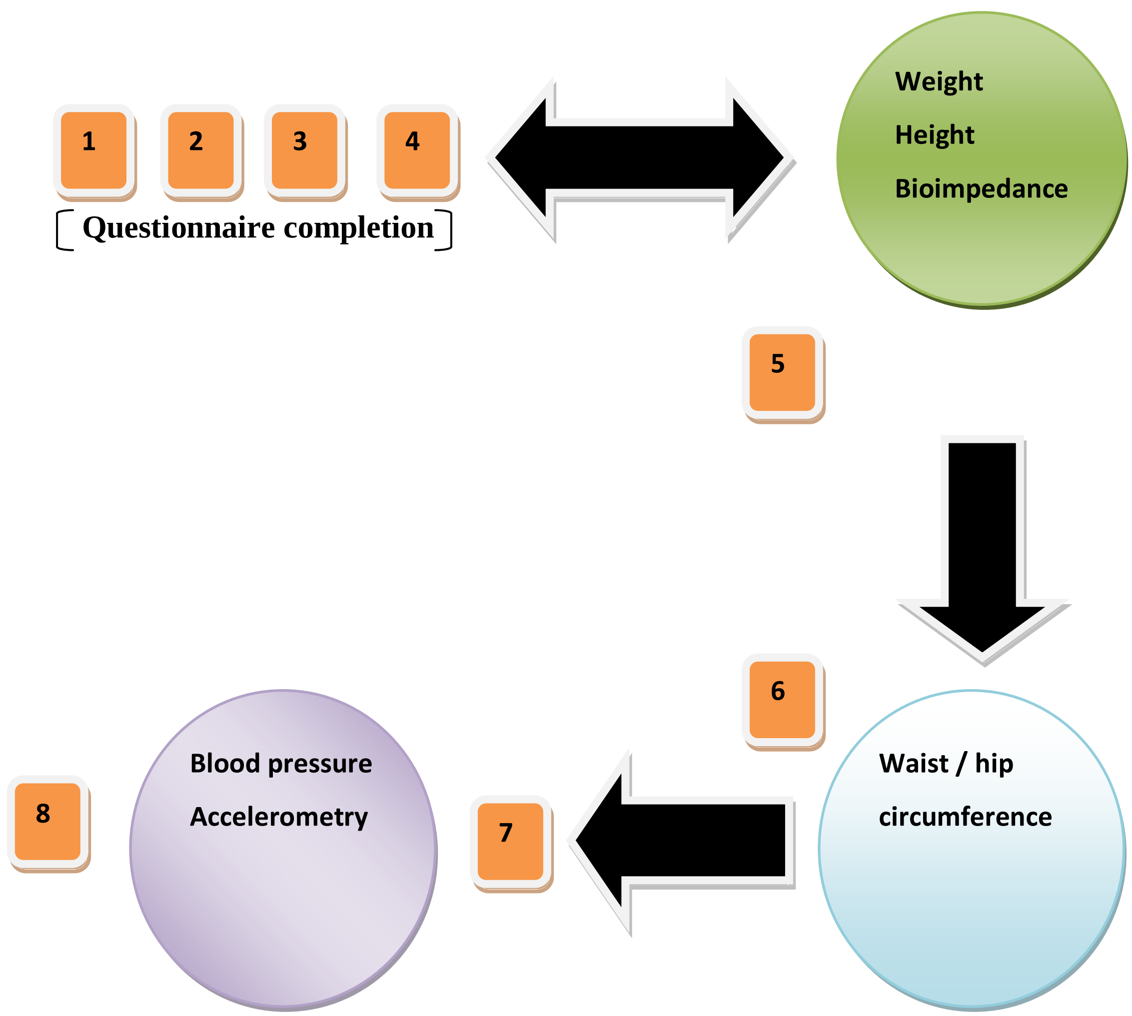
The PhD candidate then asked to take a look at the school clinic, which is where the field work would be done. The PhD candidate requested eight chairs for the students to be available on the day of the visit. In addition, the PhD candidate requested that a school coordinator be present that day to help escort students to and from class. Finally the PhD candidate collected the relevant register lists for each of selected classes, thanked the principal and informed him/her of the time of the research team's arrival on the day of the field visit (approximately 7.30am). The PhD candidate used a similar raffle style approach to randomly choose the required number of students from the classes for each grade and highlighted their serial number/names on the class register list. The class register list was given to the school coordinator early in the morning of the field visit to help escort the students to the school clinic.

3.5.2 Data collection protocol

Following experimentation during the May 20th pilot study, the research team devised a '4 x 4' method to help run the data collection smoothly and efficiently. This kind of protocol ensured the consistency of the field work and will aid in future field visits should the need arose. Figure 3.3 presents a flow diagram of the 4 x 4 data collection protocol.

Figure 3.3: Flow diagram of the 4 x 4 data collection protocol

The two groups comprising four students each followed one another to supply their data (Appendix 8), four of them were either sitting to complete the questionnaire or proceeding around the measurement stations. The two groups then switched places to complete the data collection process, which took approximately an hour for each group of eight students.



This section describes the 4 x 4 data collection protocol in detail. *The 4x4 protocol includes the following aspects:*

1. Room setting and equipment set-up.
2. Student preparation and separation into two groups.
3. Designated tasks of the research team.
4. Workflow of the data collection.
5. Concluding process

1. Room setting and equipment set up:

The approximate time needed to complete the setting and set-up was 20-30 minutes. On the day of the field visit, at approximately 7.30am, the research team started the day by preparing the room for the arrival of the students. A sign with **'DO NOT ENTER… MEDICAL EXAMINATION TAKING PLACE'** was hung on the door of the clinic. The eight chairs were divided into a group of four near the door of the clinic and the other four towards the end of the room. A shoe bin was placed next to the door and three data collection stations were set up.

Station 1 contained the weight scale, stadiometer and the body composition device which was placed on an examination bed. Station 2 was set up behind a medical screen. It included the measuring tapes and clothes pegs. Station 3 consisted of two BP devices, accelerometers and instruction leaflets. The general layout of the stations in the clinic had to be practical and the stations placed in a way that minimized the chance of students' facing each other or being close to each other.

2. *Student preparation and separation into two groups:*

The approximate time needed to prepare and separate each group of eight students was 5-7 minutes. As soon as a group entered the room, they were asked to take off their socks and shoes and put them in the shoe bin provided near the door. The students were then greeted and asked to sit in the chairs set out for them. They were asked to write their names and contact numbers on the cover page of the questionnaire. The four students who completed their contact details first were asked to go to the various stations to be measured. They were requested to keep their questionnaires with them all the time. The remaining four students were asked to stay seated and to start completing the questionnaires. They were asked to take their time and check the meaning of the questions. The students remained in their seats until the measurements of the first group had been taken. Then the two groups switched places: the measured group sat down in the chairs near the door and the questionnaire group went to the different stations to be measured.

3. *Designated tasks of the research team:*

The approximate time needed to complete the data collection from a group of 8 students is 60 minutes. The research team was made up of three personnel: The PhD candidate, Fieldworker A and Fieldworker B. In Station 1, Field worker A measured weight, height and body fat composition. Field worker A usually finished early, and if so could help Field worker B by measuring body circumferences. In Station 2, Field worker B measured waist and hip circumferences. This was done behind a medical screen to ensure privacy for the student. In Station 3, the PhD candidate measured the blood pressure and resting heart rate of the student and then allowed some time to explain in detail the purpose of the accelerometer, including instructions for wearing it, when to wear it and all the other information the student needed. After assisting the student to put on the elastic belt and making sure they knew how to wear it, the PhD candidate handed out an instructional leaflet about the of the accelerometer. It was the PhD candidate's responsibility to collect the completed questionnaires from the students once their measurements had been taken and they had answered all the questions. The PhD candidate was also responsible for supervising the field workers, monitoring the students, making sure that the team was running on schedule and contacting the school coordinator after the data had all been collected.

4. *Work flow of the data collection*

Stations 1 and 2 could take only one student at a time, whereas Station 3 could take two students. It did not matter which station the students went to first as long as they went to all 3 stations. The stations were placed in a manner which allowed the team to see what the other members were doing while at the same time providing some privacy for the student present in each station. At Station 3, where two students were present, their seating arrangement enabled the PhD candidate to measure BP from the right arm of both students, i.e. the students were seated with their backs to each other. The two groups never mixed: as soon as the first group finished, the second group took its place.

5. *Concluding process for each data collection session:*

The approximate time it took to conclude the session was 20-30 minutes. The research team packed all the items of equipment in their original boxes. The questionnaires were counted to verify that the total corresponded to the number of participating students and the contact details were double checked.

3.5.3 Data cleaning

The questionnaire data were entered in an Excel file by the Statistics Department in the Ministry of Health of Kuwait. The data were subsequently sent to the researcher with the original questionnaires for data cleaning to detect outliers and implausible values.

Unprocessed data from the accelerometers were downloaded to the laptop that was used to initialize them and saved in multiple locations including the researcher's personal computer, a back-up hard drive and an online Actigraph data vault. ActiGraph data files were batch processed using a data reduction software programme (Actilife, version 6.7.0). The software program was used to generate the PA and SB outcomes that were in turn entered on a spreadsheet.

A number of inclusion and exclusion criteria were specified to reduce the accelerometer data. First, a 20-minute count of consecutive “zero” counts was used to indicate that the accelerometer was not worn. These data points were subsequently eliminated from all calculations. Second, days with fewer than ten hours of wear time data were excluded from the analyses to account for unrepresentative days of activity. Last, data for any participant with at least one valid day were included in the analyses to maximise the use of the sample (130).

To estimate the minutes per day spent in PA and in SB, the Evenson (131) classification was chosen for categorizing the four intensities of activity, namely, as sedentary (≤100), light (>100), moderate (≥2296) or vigorous (≥4012). A recent study compared five sets of accelerometer cut points to indirect calorimetry (as the criterion reference standard) in young people and to predict the accuracy of the intensity of an activity (whether light, moderate, vigorous and MVPA) (132); the study suggested that the Evenson cut points when compared to other cut points provided acceptable classification accuracy for all four levels of PA intensity among children of all ages (132). The main measures of overall activity included mean daily activity counts, mean daily steps and activity counts per minute (CPM) of valid wear time. In addition, mean daily times (minutes) spent in sedentary (defined as <100 CPM), light (100 to <2296 CPM), moderate (2296 to <4012 CPM), vigorous (≥4012 CPM) or moderate to vigorous physical activity (MVPA) were also recorded, the latter by combining moderate and vigorous levels of physical activity into one single variable. Following data cleaning, the two spreadsheet files, one containing the questionnaire variables and one containing the accelerometry PA, SB outcomes were converted to two separate SPSS files. The SPSS files were subsequently merged by a unique study identifier.

3.5.4 General statistical approach

The data management, analysis and graphical presentation were carried out using the computer software 'Statistical Package for Social Sciences, SPSS version 20.0' (IBM Corp, Armonk, NY, USA). The data were explored to assess the distribution of continuous variables by plotting histograms and by looking at value of kurtosis and skewness (Appendix 9). To describe the SHAAK variables, frequencies and percentages were used for the categorical variables and the median and inter-quartile range were used for the continuous variables. Parametric techniques were used when the variables were normally distributed. When the assumptions of parametric analysis were not met (e.g. non-normal distribution, large skewness to kurtosis ratios), non-parametric tests were chosen. Statistical significance was set at the 5% level in all analyses.

Chapter 4: Adherence with wearing the accelerometers and the criterion validity of self-reported physical activity and sedentary behaviour against accelerometry

4.1 Introduction

Comprehensive assessment of PA and SB with low measurement error in children and adolescents is important; it allows public health research to document levels of, and changes over time in, PA and SB within and between young people (119, 133). Self-reported PA and SB measures can provide details about the type or domain of PA and SB which is not possible using objective measures of PA and SB (83). However, objective PA assessments research may be better for evaluating links between PA and health outcomes (134, 135). Consequently, inappropriate or crude measures of PA and SB may lead to spurious results and misestimated effect sizes (136, 137).

The validity and reliability of self-reported measures vary by race (138); therefore, accurate PA and SB measurements in specific populations and the appropriate choice of method is vital for researchers examining the relationship between PA or SB and health outcomes (138). PA presents a multidimensional, complex set of behaviours to measure and no single accurate method of assessing all its domains and subcomponents has been found (136). Each measurement tool has its own advantages and disadvantages.

A published systematic review comparing the use of self-reported and objective measures of PA in the paediatric population suggested that correlations between self-reported and objective measures of PA (including accelerometers) were low to moderate at best (correlation coefficient in the range of: $r = -0.56$ to 0.89) and are subject to substantial discrepancies in PA outcome if different measurement protocols are used on the same individual (82). For the studies that used accelerometry (conducted in primarily in Western countries) as the direct measure of PA, the review suggested that, overall, self-reported PA was overestimated by an average of 114% among males and 548% among females (82).

A recent systematic review that assessed the available self-reported PA instruments for use among young people in mainly European countries, based on validity and reliability ratings, suggested that three self-reporting measures (from the 20 activity-based measures included in the review) gained the support of the authors and the PA expert panel (133). The questionnaires supported by the expert panel provided convergent validity data of moderately strong agreement beyond chance (a correlation coefficient of 0.4 or above) using an objective assessment of PA (including accelerometers) (133). Although these measures showed good agreement (r = 0.4-0.7) with accelerometry, their suitability and feasibility are designed for use on children and adolescents living in Western countries and may not be feasible for Arab young people (138).

The only identified study that assessed the validity of a self-reported PA questionnaire against an objective measure of PA (pedometers) in the Middle East found moderately strong correlation coefficients between pedometer based step counts and self-reported total time spent on all activities in the Arab Teen Lifestyle Study questionnaire (Pearson r = 0.37) (111). The study recruited a sample of 75 (39 males and 36 females) Saudi Arabian adolescents with a mean age of 16 years (111). However, there are a number of issues related to the use of the SW digi-walker pedometer as a criterion method (90). First, unlike accelerometers, pedometers are not capable of assessing the intensity of PA and like accelerometers are not able to qualify movement related to activities such as cycling, weight training and swimming (111). Second, pedometers have several limitations, such as the over counting of steps, which may occur when driving motor vehicles (90). For example, driving a distance of ten miles will record six to ten erroneous steps (90). Double-counting steps during running or brisk walking is also a limitation of pedometers (90). Another limitation of the digi-walker pedometer is the undercounting of steps during slow walking; for example, at 1.5 mph it counts 75% of actual steps, while at two mph 88% of actual steps are recorded (90). The digi-walker also undercounts steps to a much greater extent in obese individuals, which may be as a result of the reduced sensitivity when the pedometer is tilted away from the vertical axis (90).

The PA and SB assessment questions used in SHAAK resemble the questions used in the Arab Teen Lifestyle Study (26). Although, the validity of the Arab Teen Lifestyle Study PA questionnaire with an electronic pedometer has already been examined among Saudi Arabian adolescents (111), the results of which are subject to debate. To date, the criterion validity of self-reported SB with an objective measure has not been assessed in any study conducted in the Middle East or Arab countries. SB is multi-faceted, therefore, measuring SB accurately necessitates more thorough assessment than can be attained by indicators of overall sitting time (119). In this study, SB measures other than TV viewing were added to the SHAAK questionnaire; they include, doing homework, reading for leisure and time spent on social networks (119).

Accelerometry is now more commonly used as an objective method of measuring PA and SB in young people (119, 139). However, as previous studies have suggested, bias may result here also from the selective failure to wear the accelerometer (140). Examining the characteristics associated with adherence to wearing the accelerometers helps researchers to better understand the possible occurrence of bias when the accelerometer is not worn according to instructions.

SHAAK is the first study in the Middle East to use accelerometry to estimate time in PA and SB; therefore, the aim of this chapter was to examine the criterion validity of the self-reported PA and SB questions against accelerometry and to examine the characteristics associated with adherence in wearing the accelerometers. The results presented in the subsequent research chapters were interpreted in relation to the findings of the present chapter.

4.2 Objectives

The objectives of the present chapter are:

1. To assess the demographic, anthropometric, PA and SB characteristics of participants associated with adherence to wearing the accelerometer;
2. To examine the criterion validity of self-reported PA questions against the Actigraph.
3. To examine the criterion validity of self-reported SB questions against the Actigraph.

4.3 Method

4.3.1 Study design, participants and sampling procedure

For information on the design, recruitment and sampling procedure, refer to the general SHAAK methodology chapter (Chapter 3, section 3.1, page 72).

4.3.2 Data collection

For detailed information on data collection, refer to the general SHAAK methodology chapter (Chapter 3, section 3.3 pages 78-83 and section 3.5, pages 92-98).

4.3.3 Data processing

Questionnaire-derived physical activity and sedentary behaviour variables:

The MVPA variable was calculated by summing the duration estimates of hours and minutes from the weekly volume PA table in the questionnaire. The total volume of MVPA for the previous week was subsequently divided by 7 to find the average daily amount of MVPA in minutes (26).

Average daily MVPA (minutes) = [(weekly hours * 60) + weekly minutes] / 7

Another MVPA self-report variable was derived from the questionnaire. The variable summed the average daily amount of MVPA (calculated from the previous week recall table) plus 15 minutes of break time activity for those participant who had answered *yes* to ‘Run and Play’ as their activity during the first and second school breaks. Previous studies devised similar self-reported variables to determine the average daily self-reported MVPA (141).
New daily MVPA variable (minutes) = Average daily MVPA + 15

SB variables were derived by calculating the midpoint value of the interval for each SB measure. The sum of all midpoints for different SB measures was used to calculate the total daily volume of SB in hours (142-144).

Average daily SB (hours) = midpoint TV (hours) + midpoint PC (hours) + midpoint HW (hours) + midpoint LR (hours) + midpoint VG (hours) + midpoint SN (hours)

Accelerometer-derived physical activity and sedentary behaviour variables:

Data from the accelerometers were downloaded to the accelerometry processing software (Actilife, Actigraph, version 6.7.0.). Accelerometer activity outcomes included the number of valid days, activity counts per minute (CPM) and average daily minutes in sedentary, light, moderate, vigorous and MVPA activity.

The average daily accelerometer wear time (AWT) for each participant, was calculated as total accelerometer wear time for the valid days (TWT), divided by the number of valid days.

AWT = TWT / valid days

The inclusion and exclusion criteria specified to reduce the accelerometer data are described in detail in Chapter 3, section 3.5.3, page 97. The accelerometer variables used in this chapter are the average daily time spent in MVPA, daily CPM, average daily sedentary time, valid days and AWT. The Evenson et al (131) cut points for youth were chosen as appropriate cut points for categorizing the intensities of activity as sedentary (≤100), light (>100), moderate (≥2296) and vigorous (≥4012) (131). A recent study comparing accelerometer cut points in young people to predict the intensity of an activity suggested that, compared to other cut points, the Evenson cut points correctly predicted the activity intensity, (132). For sensitivity analyses, the average daily sedentary time using ≤200 cut point was also calculated (145).

4.3.4 Statistical analyses

Statistical package, key descriptive statistics:

The data management, analysis and graphic presentation were carried out using SPSS version 20.0’ (IBM Corp, Armonk, NY, USA). The data were explored to assess the distribution of quantitative or continuous variables. To describe the key SHAAK variables, frequencies and percentages were used for the categorical variables and the median and inter-quartile range was used for the continuous variables. Gender differences were assessed by chi-square for categorical and the Mann-Whitney U test for continuous variables. Due to the compelling amount of evidence suggesting gender differences in the youths PA and SB, a stratified analysis by gender was considered *a priori* in this study (93). Statistical significance was set at the 5% level in all analyses.

Accelerometer adherence:

Frequencies and percentages were used to describe the number of valid days (at least 600 minutes per day).

Correlation strength:

A correlation coefficient value of one indicates a perfect linear association and a value of zero indicates no correlation. A correlation coefficient value between 0.7 and 0.9 indicates a strong correlation, while a value between 0.6 and 0.4 reveals a moderately strength association. A correlation coefficient within 0.3 and 0.1, indicates that the association is weak (146).

Correlations between AWT, valid days and sociodemographic, anthropometric characteristics, PA and SB

To begin with, the distribution of the continuous variables was investigated so as to choose between parametric and non-parametric statistical testing. The data showed that the relevant assumptions for parametric tests were not met (the distribution of the variables was skewed); therefore, Spearman Rho and its two-tailed p-value were used to examine the correlation between AWT and several demographic characteristics such as, age and school grade. Spearman Rho was used to examine the correlation between AWT and several anthropometric measures such as, weight, waist circumference, BMI and BMI categorised as normal, overweight or obese. Spearman Rho was used to examine the correlation between AWT and PA, SB measures such as average daily self-reported PA, SB and accelerometer based average time spent in MVPA, SB.

Correlations between self-reported and objectively measured PA and SB:

Spearman Rho and its two-tailed p-value were used to examine the correlation between the average daily total as self-reported and as accelerometer based MVPA. The Spearman Rho was used to examine the correlation between self-reported average daily MVPA with break time activity added and accelerometer based MVPA. Spearman Rho and its two-tailed p-value were used to examine the correlation between average daily total self-reported MVPA and daily accelerometer based counts per valid minute.

Spearman Rho and its two-tailed p-value were used to examine the correlation between average daily total self-reported and accelerometer based SB. To account for the differences in the average length of time that the accelerometer was worn daily, partial correlations were repeated for the above measures while controlling for the average daily accelerometer wearing time.

Sensitivity Analysis:

For sensitivity analysis, Spearman Rho was used to examine the correlation between the questionnaire- and the accelerometer-based measures of MVPA, SB for participants with one and three valid days and repeated with ≤200 as the SB cut point (147, 148).

4.4 Results

For details of the participants response rates, refer to the flow diagram in Chapter 3, section 3.1, page 77. To summarise,591 students enrolled in the study (the response rate for students was 99%), but, two students failed to provide data for most parts of the questionnaire and were subsequently dropped from the study. Several of the remaining 589 students who had completed the questionnaires, provided invalid data on some of the questions as indicated in Table 4.1. Of the 589 students, 564 provided accelerometer data (25 students failed to return their accelerometer), however, of the 564 students, 96 recorded less than one valid day of accelerometer data.

4.4.1 Descriptive statistics for the study variables

Table 4.1 describes the frequencies and key descriptive statistics of the SHAAK questionnaire and accelerometer based PA and SB variables. The median age of males and females was 15.0 and 14.0 years respectively. Of the total sample, 279 (46.9%) were males and 310 (52.1%) females.

Table 4.1 Descriptive statistics of the SHAAK variables by gender (n= 589)

Categorical variables	**[a]**	**Male n (%)**	**Female n (%)**	**p**
Gender		279 (46.9)	310 (52.1)	
School grade:				0.001
Grade 7		20 (7.2)	52 (16.8)	
Grade 8		56 (20.1)	54 (17.4)	
Grade 9		54 (19.4)	52 (16.8)	
Grade 10		56 (20.1)	55 (17.7)	
Grade 11		70 (25.1)	50 (16.1)	
Grade 12		23 (8.2)	47 (15.2)	
Self reported physical activity				
First break activity:				0.018
Sit / talk / read		120 (43.0)	105 (33.9)	
Stand / walk		144 (51.6)	195 (62.9)	
Run / play games		15 (5.4)	10 (3.2)	
Second break activity:	[2]			0.001
Sit / talk / read		137 (49.5)	97 (31.3)	
Stand / walk		135 (48.7)	201 (64.8)	
Run / play games		5 (1.8)	12 (3.9)	
BMI in categories:				0.001
Normal		111 (40.2)	152 (50.8)	
Overweight		70 (25.4)	93 (31.1)	
Obese		95 (34.4)	54 (18.1)	
Continuous variables	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Age (years)	[17]	15.0 (3.0)	14.0 (3.0)	0.24
Moderate-to-vigorous physical activity for previous week (minutes/day)		21.4 (25.7	17.1 (25.7)	0.06
Total daily sedentary behaviour (hours/day)	[14]	7.5 (4.0)	9.0 (4.0)	0.001*
TV viewing (hours/day)		1.5 (1.0)	2.5 (1.0)	0.001*

Playing non-active video games, e.g. PlayStation (hours/day)		1.5 (1.5)	0.0 (1.5)	0.001*
Using computer (hours/day)	[6]	0.0 (1.5)	1.5 (0.0)	0.001*
Using social networks (hours/day)	[5]	1.5 (1.0)	1.5 (2.0)	0.16
Doing homework (hours/day)	[1]	1.5 (0.0)	2.5 (1.0)	0.001*
Reading for leisure (hours/day)	[4]	0.0 (1.5)	0.0 (1.5)	0.001*
Accelerometer valid days (≥600 minutes/day)	[121]	3.0 (3.0)	4.0 (3.0)	0.06
Accelerometer average daily wearing time (minutes/day)	[121]	827.0 (140.3)	865.3 (132.9)	0.001*
Accelerometer average daily sedentary behaviour (minutes/day)	[121]	501.5 (132.9)	568.5 (136.7)	0.001*
Accelerometer average daily moderate-to-vigorous physical activity (minutes/day)	[121]	19.0 (20.6)	8.8 (10.9)	0.001*
Counts per valid minute per day	[121]	2005.5 (2597.9)	1743.1 (2036.8)	0.04*
Weight (kg)		72.4 (32.1)	57.0 (22.5)	0.001*
Waist circumference (cm)		85.0 (26.9)	77 (16.8)	0.001*
BMI		24.8 (10.7)	23.3 (7.7)	0.004*

(%) percent within gender [a] value represents number of participants with missing data for given variable *Significant gender difference at $p < 0.05$ assessed by chi-square for categorical, and by Mann-Whitney U test for continuous variables

4.4.2 Adherence to wearing the accelerometer

This section describes the participants' adherence to wearing the accelerometers and the demographic and anthropometric correlates of wearing the accelerometers.
Table 4.2 presents the frequency and percentage of participants who had worn their accelerometers. A total of 473 (83%) of the participants had done so for one day at least, while 355 (63%) of them had done so on at least three days.

Table 4.2 Frequency and percentages of participants with valid days of accelerometer wear time for total sample and by gender

Valid Days	Male n (%)	Female n (%)	N (%)	Cumulative %
0	45 (17.3)	51 (16.8)	96 (17.0)	17.0
1	27 (10.4)	30 (9.9)	57 (10.1)	27.1
2	32 (12.3)	29 (9.5)	61 (10.8)	37.9
3	50 (19.2)	31 (10.2)	84 (14.4)	52.3
4	26 (10.0)	41 (13.5)	67 (11.9)	64.2
5	33 (12.7)	53 (17.4)	88 (15.2)	79.4
6	24 (9.2)	31 (10.2)	55 (9.8)	89.2
7	23 (8.8)	38 (12.5)	61 (10.8)	100.0
Total	260 (100)	304 (100)	564 (100)	

Using the 100 cpm cut point to denote a 'sedentary' minute, the correlation between the valid days or AWT and some characteristics of the participants for one valid day is presented in Table 4.3. A weak positive correlation was noted between the number of valid days with weight, BMI, BMI in categories and average daily MVPA (accelerometer based) for male adolescents. A moderate positive correlation between the average accelerometer wearing time and the average daily SB (accelerometer based) for male adolescents. A moderate positive correlation was found between average wear time and average daily SB (accelerometer based) for female adolescents as well.

Table 4.3 Bivariate correlations between valid days, average daily accelerometer wearing time and participants characteristics

Characteristic	Valid days[d]		Average accelerometer wearing time	
	r (p-value)		r (p-value)	
	Male	Female	Male	Female
Age	0.02 (0.81)	-0.04 (0.45)	-0.04 (0.55)	0.06 (0.35)
Grade	0.05 (0.47)	-0.04 (0.46)	-0.02 (0.74)	0.04 (0.54)
Weight	0.14 (0.03)*	-0.02 (0.76)	-0.01 (0.87)	0.09 (0.13)
Body mass index	0.12 (0.05)*	-0.01 (0.93)	0.003 (0.97)	0.09 (0.14)
Body mass index categorised†	0.14 (0.02)*	0.01 (0.85)	0.05 (0.46)	0.01 (0.13)
Waist circumference	0.09 (0.14)	0.03 (0.56)	0.05 (0.51)	0.09 (0.13)
Total daily sedentary behaviour (self-reported)	-0.04 (0.50)	0.05 (0.41)	0.02 (0.81)	-0.14 (0.82)
Average daily sedentary behaviour (accelerometer)	0.15 (0.03)*	0.21 (0.001)*	0.48 (0.001)*	0.58 (0.001)*
Total daily physical activity (self reported)	0.06 (0.34)	0.11 (0.06)	0.03 (0.65)	0.03 (0.64)
Average daily physical activity (accelerometer)	0.13 (0.05)*	0.14 (0.03)*	0.09 (0.20)	0.13 (0.04)*

[d]Data for participants with 1 valid day with 100 as sedentary behaviour cut point r: Spearman Rho correlation coefficient

*denotes significant at the 0.05 level †Body mass index (BMI) categories: normal, overweight, obese(42)

4.4.3 The criterion validity of the self-reported physical activity and sedentary behaviour questions against accelerometry

This section describes the criterion validity of the self-reported PA, SB variables with the corresponding accelerometry variables. The correlation between average daily self-reported and accelerometer based MVPA for participants with at least one and three valid days is presented in Table 4.4. No evidence for a correlation between the average self-reported and accelerometer based MVPA was found for at least one or three valid days.

Table 4.4 also presents the correlation between the daily self-reported MVPA and total counts per day (accelerometer based) for participants for at least one or three valid days. A weak positive correlation was observed for one valid day between the average daily self-reported MVPA and MVPA with school break activity added, and daily counts per valid minute (accelerometer based), (r=0.14) and (r=0.13) respectively. Similarly, a weak positive correlation was noted between the average daily self-reported MVPA and MVPA with school break activity added with daily counts per valid minute (accelerometer based), (r=0.11) and (r=0.11) respectively when the number of valid days equalled three.

Table 4.4 Bivariate correlations between self-reported and accelerometer based physical activity

	Moderate-to-vigorous physical activity (accelerometer based)	
Self-reported physical activity variable	**At least one valid day n=473**	**At least three valid days n= 355**
	r (p)	**r (p)**
Moderate-to-vigorous physical activity	0.06 (0.17)	0.05 (0.35)
Moderate-to-vigorous physical activity †	0.06 (0.18)	0.04 (0.42)
Self-reported physical activity variable	**Counts per valid minute (accelerometer based)**	
Moderate-to-vigorous physical activity	0.14 (0.03)*	0.11 (0.01)*
Moderate-to-vigorous physical activity †	0.14 (0.02)*	0.11 (0.01)*

r: Spearman Rho correlation coefficient *denotes significant at the 0.05 level †MVPA with 15 minutes of break time activity added for those who answered *yes* to 'Run and Play' during the first and second school breaks.

Table 4.5 presents the correlations of self-reported daily SB measures, e.g. watching TV, playing video games, etc. with average daily SB (accelerometer based) for one valid day and three valid days at the SB cut points of 100 and 200. A weak positive correlation was found with daily TV viewing, (r= 0.14) for one valid day, at the 100 SB cut point. Similarly, a weak correlation was observed for one valid day, at the 200 SB cut point, as well as for three valid days, at both the 100 SB cut point and the 200 SB cut point (r = 0.15). Self-reported SB measures including PC use and reading for leisure weakly correlated with the average daily SB (accelerometer based) for three valid days at both the 100 and 200 SB cut points, (r=0.11). A weak negative correlation was seen between self-reported non-active video gaming and the average daily SB (accelerometer based).

Partial correlations for the above measures while controlling for the average daily accelerometer wearing time, revealed that the weak positive correlation with TV viewers persisted. In addition, a weak positive correlation was observed between the average daily SB (accelerometer based) and the total SB (self-reported) for the three valid days, at the 200 SB cut point (r =0.11).

Table 4.5 Bivariate correlations between self-reported and accelerometer based sedentary behaviour measures

Sedentary behaviour variable (self-reported)	Sedentary behaviour variable (accelerometer based)			
	At least one valid day		At least three valid days	
	r (p)^{100}	r (p)^{200}	r (p)^{100}	r (p)^{200}
Watching TV	0.14 (0.003)*	0.14 (0.002)*	0.15 (0.001)*	0.15 (0.001)*
Playing non-active video games	-0.10 (0.04)*	-0.080 (0.08)	-0.104 (0.05)	-0.010 (0.06)
Using personal computer	0.08 (0.08)	0.08 (0.07)	0.12 (0.03)*	0.11 (0.04)*
Using social networks	-0.02 (0.73)	-0.02 (0.75)	-0.02 (0.69)	-0.02 (0.78)
Doing homework	0.03 (0.45)	0.04 (0.35)	0.09 (0.11)	0.10 (0.05)
Reading for leisure	0.05 (0.33)	0.06 (0.18)	0.01 (0.08)	0.12 (0.04)*
Total daily sedentary measure	0.05 (0.32)	0.06 (0.18)	0.09 (0.11)	0.10 (0.06)
	Average daily sedentary behaviour (accelerometer based)†			
Watching TV	0.13 (0.005)*	0.16 (0.001)*	0.13 (0.01)*	0.12 (0.02)**
Playing non-active video games	-0.06 (0.19)	-0.08 (0.07)	-0.08 (0.13)	-0.06 (0.30)
Using personal computer	0.08 (0.09)	0.06 (0.20)	0.11 (0.04)*	0.10 (0.05)
Using social networks	0.02 (0.72)	0.01 (0.88)	-0.01 (0.83)	-0.02 (0.75)
Doing homework	-0.01 (0.88)	0.07 (0.15)	0.04 (0.49)	0.09 (0.11)
Reading for leisure	0.04 (0.40)	0.06 (0.21)	0.11 (0.05)	0.09 (0.09)
Total daily sedentary behaviour	0.07 (0.16)	0.09 (0.07)	0.09 (0.09)	0.11 (0.04)*

r: Spearman Rho correlation coefficient *denotes significant p-value at the 0.05 level

^{100}Sedentary behaviour cut point at ≤100 ^{200}Sedentary behaviour cut point at ≤200

†Partial correlation controlling for average daily accelerometer wear time

4.5 Discussion

4.5.1 Accelerometer wear time and correlates of adherence to wearing the accelerometer

This study found that almost 11% of the participants wore their accelerometer for more than or for as much as ten hours per day for all the seven days that they had been requested to wear. This finding is lower than the observations made in previous studies. A study to assess the feasibility of using accelerometers to measure PA in young adolescents (school grades 6-8) found that 50% of the participants wore their accelerometers for the requested time of seven days (149). However, in this study, as with most other research studies using accelerometers, participants were to be included in the analyses even if they wore their accelerometer less than the requested number of days.

Sixty two percent of the participants in this study had at least three valid days of accelerometer wear time. The findings in this regard are somewhat lower than those in previously published studies. A Belgian cross-sectional study to assess PA using accelerometers recruited 637 adolescents (13-15 years) and requested the students to wear their accelerometers for seven days (150). The study found that 80% of participants wore the accelerometer for more than or equal to three days, the minimum number of valid days required for inclusion in the study analyses (150).

A study to assess activity patterns in European children (9-15 years) found that 70% had more than or as much as four valid days of accelerometry data (151). It is possible that the studies mentioned previously had better adherence because they included younger children or adolescents (age range 9-15), who were more likely to wear their accelerometers for the requested time (147, 152). Studies which employ incentives for participants may further explain the variability in adherence to accelerometer protocol (153). Furthermore, the discrepancies found between studies regarding wear time and non-wear time criteria during the statistical analyses can produce different results with regards to the number of valid days for each participant (154).

Eighty three percent of participants in this study wore their accelerometer for at least one valid day, which is similar to the figure in the International Children's Accelerometry Database study. The International Children's Accelerometry Database study suggested that, when using more than or as much as to ten hours of accelerometer as the wear per day criterion, 93% of participants provided at least one valid day of data (130).

The findings which relate to the characteristics associated with accelerometer wear time and number of valid days, are partly consistent with previous studies. Specifically, the number of valid days had a weak positive correlation with weight, BMI and BMI in categories, average daily SB (accelerometer) and average daily MVPA (accelerometer) for male adolescents. A weak positive correlation was found between valid days and average daily SB (accelerometer) for female and male adolescents. Consistent with this finding other studies have reported a positive correlation between valid days and a greater BMI and being overweight (149).

The results in this study are somewhat inconsistent with findings from previous studies, two previous studies conducted in the UK found that females, younger children and those with a lower BMI were more likely to wear the accelerometer for the required length of time (147, 153, 155). Accelerometer wear time and valid days in this study were correlated weakly with BMI, which is similar to a UK study that assessed the characteristics associated with the requested and required accelerometer wear in children (155). Other studies have found that the greater the BMI, the less likelihood there is of wearing the accelerometer for the required time (147, 153).

A correlation between valid days or accelerometer wearing time and waist circumference was not found in this study, which is similar to the findings from previous studies (155). Self-reported time spent in SB and number of valid days were not correlated in this study, but a negative correlation is suggested by observations in other studies (155). The weak correlation of MVPA and valid days and accelerometer wear time is similar to that in other studies which found that more active children were more likely to fulfil the requested accelerometer wear time (155).

The moderately strong correlation of accelerometer based average daily SB with average daily accelerometer wear time among males and females is a novel finding in study. A previous study that assessed characteristics associated with accelerometer wear time reported that children with higher screen time viewing are less likely to provide accelerometer data (155). The findings in this study are substantial as they present a systematic bias in the sample. Therefore, the results in subsequent chapters, particularly the average daily levels of SB, should be interpreted with caution as it appears that average daily SB (accelerometer based) was moderately correlated with accelerometer wearing time.

4.5.2 The correlation of self-reported physical activity with accelerometer based physical activity

In general, this study did not find a correlation between self-reported MVPA and accelerometer based average daily MVPA. The only study in the Middle East that was identified assessed the correlation between the self-reported Arab Teen Lifestyle Study questionnaire with an electronic pedometer found the correlation coefficient between self-reported total time spent on all activities and pedometer based step counts was moderate at best (Pearson $r = 0.3$) (111). The Arab Teen Lifestyle Study sample comprised a relatively small sample of 75 Saudi Arabian adolescents (39 males and 36 females) with a mean age of 16 years (111). A possible explanation for the discrepancy between the findings in this study and those in the Saudi Arabian study includes, differences in the measurement properties of the devices.

Pedometers have several limitations, such as the over counting of steps, which may occur when driving motor vehicles and the double-counting steps during running or brisk walking (90). While the SHAAK questionnaire asked the participants to recall the frequency and duration of their PA for the previous week, the Arab Teen Lifestyle Study questionnaire was designed to collect information on the frequency, duration of a variety of activities of light, moderate and vigorous intensity during a typical week (111). An important consideration is whether the question used in the SHAAK questionnaire was representative of the PA levels of the participant; if it were unrepresentative it might account for the failure to observe a correlation with accelerometry.

While the Arab Teen Lifestyle Study questionnaire is designed to collect information on the frequency and duration of a variety of activities of light, moderate and vigorous intensity during a typical week (111), another limitation of the pedometer is its inability to assess PA intensity. These results suggest that the validation of the Arab Teen Lifestyle Study PA questionnaire is open to discussion because, at least to some extent, the Arab Teen Lifestyle Study questionnaire and pedometer measured different components of PA (111, 156).

Other studies which examined the correlations between self-reported PA and objectively measured PA have suggested (regardless of the objective method employed) a poor or low to moderate association between measures (82). A possible explanation for the findings in this study is that reported measurements are taken over different lengths of time, sometimes with or without time lag. For example, the self-reported recall of MVPA for the previous week over one or three days was used to objectively measure MVPA. This was also noted in other studies assessing the correlation between self-reported MVPA and objectively measured MVPA (157, 158). Accelerometers measure data in 'real time' which can determine habitual activity, but this necessitates measurement over several days as suggested by previous studies (159). Furthermore, a systematic review highlights that different accelerometer outcomes are used to assess the correlation between self-reported and objectively measured PA (82). For example, two studies included in the review, assessed the correlation between a self-reported PA questionnaire with the total counts per day (accelerometer based) (160, 161). Results were markedly different amid the two studies and with this study. The analyses in this study showed weak positive correlation between the average daily self-reported MVPA and total counts per minute per day (accelerometer based) (r=0.13). This is partly supported by previous findings from Argiropoulou et al. which reported a Pearson r in the range of 0.09-0.65 between the three day PA recall and lifestyle questionnaires and the total counts per minute per day (accelerometer based) (160). Ekelund et al. reported a moderate correlation between the self-administered PA checklist and accelerometer based daily total counts per minute, (partial correlation adjusted for gender was in the range of 0.44-0.51 (161). The likely explanation for the inconsistencies in the findings in this study and previous research include the variations of the study participants characteristics, the use of different self-reported PA measures and more importantly, the questionnaire used in this study being a poor measure of MVPA and SB (82).

Other possible explanations for findings in this study may be the fundamental difference between self-reported PA and objectively measured PA. Self-reported PA, commonly measured through self administered questionnaires, is subject to social desirability and recall bias. Due to the cognitive demands of recall, the participant finds it difficult to ascertain the frequency duration and intensity of PA (136). In addition children's activity is unique in that it is characterised by short bouts rather that longer sustained periods as suggested by previous studies (162). These issues along with questionnaire reliability and sensitivity issues are well documented in previous studies (136) and may provide some perspective for possible the pitfalls of self-reported PA data. In addition, self-report measures of PA are culturally very dependent; therefore, a validated questionnaire used a specific population may not be systematically be used in other ethnic groups, populations or geographical regions (163).

The device used in this study measure acceleration in one plane (vertical), as a result, is unable to measure all activities (such as upper body movement or cycling) equally because the device is positioned at the waist. Accelerometers may underestimate the energy cost of walking on an incline or carrying heavy loads, because despite the increase in effort, the acceleration patterns remain unchanged.

The choice of cut points for the classification of PA intensities has been subject to debate in previous studies (164). Based on selected cut points, the levels and patterns of time spent in MVPA may be determined. Using different cut points may result in discrepancies concerning time engaged in MVPA. This study utilized the Evenson cut points as appropriate for use among youth as previous studies have suggested (165). A recent systematic review suggested that there is no consensus on the 'best' cut points for the classification of children and adolescent MVPA (164).

Another challenging issue which may have affected the results of the correlation of the self-reported questionnaire with accelerometry is the issue of missing data from both the questionnaire and accelerometer output. Missing accelerometer based PA data may have an important bearing on outcome variables used in this study and as suggested by previous studies (159). The fact that accelerometer counts are not being documented during periods in which the device is not worn results in many common measures of daily PA being biased downwards (166).

4.5.3 The correlation of self-reported with accelerometer based sedentary behaviour time

The correlation between self-reported with accelerometer based SB was low. Of all the different SB measures asked about in the questionnaire, TV viewing was the only measure to have a consistent positive, albeit weak, correlation with average daily SB from the accelerometer. Although the correlations found in this study were weak (r=0.15), the positive correlation was evident even after adjusting for valid days and accelerometer wearing time. This is the first study in the Middle East to assess the correlation between a self-reported and objectively measured SB; therefore, the findings in this study cannot be compared to other studies in the same geographical and cultural context. However, the findings in this study are to some extent consistent with other studies comparing self-reported SB results with those of accelerometry (167, 168). This study also found personal computer use to be weakly correlated with accelerometer measured SB for those participants with three valid days of accelerometer wear. Previous studies which reported stronger correlations between self-reported SB and objectively measured SB (r=0.30) used questions that determined the total volume of SB for the previous seven days (169), rather than at hourly intervals, as this study did. The correlations were similar for the data analyses using different SB cut points for sensitivity analyses. This is similar to the findings from previous studies (170).

The issue of missing data in both self-report measures and accelerometer based measured SB also applies in this study and may explain why stronger correlations between the measures were not evident. The decision on whether the accelerometer output data are actually missing data rather than what would be produced by a sustained period of inactivity is contested by previous studies (136). Confusing inactivity with missing data leads to underestimating SB which may have been the case in this study. A study which assessed accelerometer data reduction in adolescents and its effects on sample bias suggested that small differences in data reduction criteria such as non wear periods has an impact on sample size and SB outcomes (154).

4.5.5 Strengths, limitations and implications of the study

This study has several strengths; it includes adolescents from a wide age range (12-18 years) and shows that the vast majority of participants recruited in the study gave complete sociodemographic, anthropometric data and good adherence with wearing the Actigraph. This study has several limitations. The study did not include students from all the governorates of Kuwait, thereby reducing the power of the study and limiting its representativeness. The findings in this study are representative of the three governorates included and cannot be generalized to all Kuwaiti adolescents. Findings in this study showed that adherence to wearing the Actigraph for at least three valid days was lower compared to other studies (151, 152). Furthermore, the reliability of the self-reported and objective measures of PA and SB was not assessed in this study. Self-reported PA and SB did not overlap the same time period of the objectively measured PA and SB. The time lag between the administration of the self-reported PA, SB questionnaire and objectively measured PA and SB is another limitation of this study. Accelerometry data reduction decisions including the definition of non-wear time (20 minutes of consecutive zeros) may have underestimated objectively measured sedentary time. The findings in this study had several implications for subsequent data analyses. The correlations for participants with three valid days were similar to those with one valid day. In accordance with this finding and in line with previous studies, to maximise the use of our collected accelerometry data, all the participants who wore their accelerometer for more than or as much as one day were included in the subsequent study analyses. The data analyses using different SB cut points showed no major differences. Therefore, only the 100 SB cut point were adopted in the consequent analyses. This study found no correlation between self-reported and objectively measured PA and SB. In accordance with this finding, only accelerometer based PA and SB data will be used when examining the sociodemographic correlates of PA and SB, as well as the association of PA, SB with adiposity and blood pressure.

4.5.6 Conclusion

In conclusion, 63% of the participants fulfilled more than or as much as three days of accelerometer wearing time and 83% wore the accelerometer for at least one day. Participants with higher accelerometer based SB were more likely to meet the accelerometer wearing time criteria, which may present a wear time bias that warrants cautionary interpretation of results in subsequent analyses. There was no correlation between self-reported MVPA and accelerometer average daily MVPA, which demonstrates that the self-reported and accelerometer based measures of PA used in this study may be incongruent. However, TV viewing was a self-reported SB measure that was weakly but consistently found to correlate with average daily SB (accelerometer based). There was no correlation between accelerometer based SB and total daily self-reported SB. These results support the contention that there is no ideal measure for assessing PA and SB among adolescents. Although it is unclear whether the self-reported and objective measures of PA and SB in this study are congruent, this does not necessarily indicate that self-reported PA and SB should be discredited.

Chapter 5: Self-reported and objectively assessed physical activity and sedentary behaviour and their socio-demographic correlates

5.1 Introduction

Observational and experimental studies have documented the association of PA with favourable health outcomes (3). International agencies and local governments have recommended that children and adolescents should engage in MVPA for at least 60 minutes and up to several hours every day (171-173). Young people’s PA is somewhat different from that of adults in that it is intermittent in nature (sporadic), often unplanned (short bouts of activity) and not time bound (174). PA assessment is necessary to determine whether adolescents in Kuwait are meeting the recommended guidelines to maintain adequate heath, to make cross-cultural comparisons with other populations, to monitor time trends and to evaluate the effect of PA interventions (175).

Over the past few decades, technological advancements have brought about immense changes to societies all over the world. Among the profound changes is the increase in the availability of sedentary forms of entertainment including video games, television, the internet and smartphones. Regardless of the amount of time spent on PA, some international agencies and local governments have recommended that children and adolescents should minimise their sedentary time (although a daily limit is not specified) (173), while others recommend spending no more than two hours daily as ‘screen time’ (small screen media use) (176). Assessment of SB is necessary to develop effective intervention programmes aimed at reducing the time that children and adolescents spend in SB (127).

Kuwait (whose socioeconomic and political landscape has been described in Chapter 1, section 1.2, pages 30-33) has an affluent economy and its GDP ranks among the highest between Arab countries (177, 178). Kuwaiti citizens have several privileges, granted by the government as part of the social policy. These privileges include, free health care, free education (including university), a financial grant upon marriage and free housing (177).

Urbanization and the rapid boost in economic well-being in Kuwait have come with profound lifestyle changes including the PA and SB levels of Kuwaitis (73).

In the year 2010, a strategy to combat obesity and promote PA in Arab countries (including Kuwait) presented a number of objectives for elementary and secondary school students (33). It was recommended that by the year 2015, Arab countries should have increased the percentage of children who are physically active for one hour or more, on five or more days of the week by 25% (33). Furthermore, it was recommended that the percentage of students who watch television daily for more than two hours be reduced by 20% (33). PA and SB data in Arab countries are based on the available Global School Health Survey (WHO statistics) (24) or the Arab Teen Lifestyle Study (26). The limitations of these self-reported measures was described in the previous chapter. To summarise, the self-reported measures seem to be incongruent with objectively measured PA and SB. To fulfil gaps in the literature, comprehensive data (self-reported and objectively measured) on existing patterns of PA and SB among adolescents in Kuwait are addressed in the present chapter. The generated data will provide baseline information for comparative purposes or follow up studies (33).

Understanding the key characteristics associated with PA and SB patterns among young people is a crucial prerequisite for the planning and implementing of effective intervention programmes (179, 180). Studies have suggested several sociodemographic factors are consistently associated with PA of children and adolescents (93). PA and sedentary lifestyles may be especially common among certain population subgroups (181). Assessing socioeconomic differences in PA and SB may provide insights into optimal intervention points at the different PA and SB domains in which these inequalities begin to emerge (181). Socioeconomic status is commonly conceptualized as the social standing of an individual and is often measured as a combination of education, income, and occupation (182, 183).

While Western studies have explored the associations of PA and SB with several socio-demographic correlates, studies in the Middle East focus largely on gender differences or associations with dietary habits (184-186). Furthermore, the limited studies available are heterogeneous in terms of their measures of PA and SB. To address the gaps and inconsistencies in the literature, the demographic and socioeconomic correlates of accelerometer based PA, SB will be examined in the present chapter as well.

5.2 Objectives and hypotheses

5.2.1 Objectives

1. To examine the levels of PA among school age adolescents in Kuwait, using a self-administered questionnaire and an accelerometer.
2. To examine the levels of SB among school age adolescents in Kuwait, using a self-administered questionnaire and an accelerometer.
3. To examine the socio-demographic correlates of PA in school-age adolescents
4. To examine the socio-demographic correlates of SB in school-age adolescents

5.2.2 Hypotheses

1. MVPA levels among adolescents are low and do not meet the current MVPA recommendations
2. SB levels among adolescents are high and do not meet the current SB guidelines
3. Younger adolescent girls (grade 7) would have higher MVPA and lower SB levels than older age girls (grade 12).
4. Adolescents with advantaged SES are associated with higher levels of MVPA and lower levels of SB.

5.3 Method

5.3.1 Study design, participants and sampling procedure

For information on the design, recruitment and sampling procedure, refer to the general methodology chapter (Chapter 3, section 3.1, pages 72).

5.3.2 Data collection

For detailed information on data collection, refer to the general SHAAK methodology chapter (Chapter 3, section 3.3 pages 78-83 and section 3.5, pages 92-97). Information relevant to the present chapter is summarised in the following sections.

SHAAK questionnaire

Demographic variables of adolescent gender, age and grade were collected using a self-administered questionnaire.

As an indicator of socioeconomic status, adolescents reported their parents' highest level of education (post graduate, university, secondary, intermediate, primary, read/write or illiterate). In addition adolescents reported parental occupation, number of bedrooms, number of cars the family owned, number of domestic staff, home ownership and bedroom sharing.

The time spent in MVPA was estimated by asking the participants to recall the exercise and sport activities during the previous week (Appendix 3). Participants who answered *yes* to any activity (e.g. football) were asked to provide details of the frequency and average duration of their participation in that activity.

SB was assessed by asking such questions as: "How many hours a day do you spend watching TV?" with the following answering categories: 'Don't do this activity', 1-2 hours, 2-3 hours and more than 3 hours (Appendix 3).

Accelerometry

Refer to Chapter 3, section 3.3.1, pages 82-83 for the details of the accelerometer based measurements.

5.3.3 Data processing

Questionnaire-derived physical activity and sedentary behaviour variables:

The handling of the self-reported MVPA and SB variables is described in Chapter 4, section 4.3.3, page 103.

One more self-reported MVPA variable was derived for the present chapter. The variable categorised participants into those who met the daily MVPA recommendations and those who had not.

Participants who met the MVPA recommendations = MVPA $\geq$ 60 minutes per day

Participants had not met the MVPA recommendations = MVPA < 60 minutes per day

An additional self-reported SB variable was derived. The variable categorised participants into those who met the daily SB guidelines and those who had not.

Participants who met the SB guidelines = SB < 2 hours of screen time per day

Participants had not met the MVPA recommendations = SB $\geq$ 2 hours of screen time per day

Accelerometer-derived physical activity and sedentary behaviour variables:

Refer to Chapter 4, section 4.3.3, page 104 for the handling of the MVPA and SB variables.

Additional accelerometer based MVPA and SB variables were derived for the present chapter, these variables categorised participants according to those who had and who had not met the MVPA and SB recommendations. Refer to the above section for details.

Socioeconomic status derived variable:

Two SES variables were used to define the social position of adolescents families. The first variable used parental education as an indicator for overall familial social position. The variable categorized adolescents reported parental education into higher education (both parents have a university or higher degree) or lower education (both parents are of secondary, intermediate, primary, read/write and illiterate level).

The other SES variable used overall familial material circumstances as a social position indicator. To define this variable, a unique scale to measure SES was devised and named the SHAAK SES Scale (SSS). The measure consisted of ten different items: fathers' education (university/higher=1, other=0), fathers' occupation (employed=1, other=0), mothers' education (university/higher=1, other=0), mothers' occupation (employed=1, other=0), number of cars (≥3=1, <3=0), number of domestic staff (≥3=1, <3=0), home ownership (owned=1, rented=0), bedroom sharing (no=1, yes=0), number of bedrooms (≥3=1, <3=0) and governorate (Assimah=1, other=0).

Then the SES score was calculated by summing the responses, ending with a score ranging from 0 to 10. Accordingly, the SES score was categorized as two-level: middle= 0-6 and high=7-10. Although SSS is unique to the present study, it incorporated three items from the Family Affluence Scale (FAS) (187) which is often used to define SES among adolescent.

5.3.4 Statistical analyses

Key descriptive statistics:

The data were explored to assess the distribution of categorical or continuous variables. First, to describe the SHAAK variables used in this study, frequencies and percentages were used for the categorical variables and the median and inter-quartile range for the continuous variables. The median was used to describe the levels of MVPA and SB for continuous variables in the discussion section. Due to the extensive amount of evidence suggesting gender differences in the prevalence and correlates of PA, a stratified analysis by gender was considered *a priori* in this study (188, 189).

Descriptive statistics for self-reported and accelerometer based PA and SB data were presented by gender and by SES status (assessed by parental education). Gender and SES status differences were assessed by Chi-square for the categorical variables and by Mann-Whitney for the continuous variables. When more than two groups or categories were found, a two-tailed Kruskal-Wallis test was used.

Bivariate correlations of accelerometer based MVPA, SB with sociodemographic variables:

The Spearman Rho and its two-tailed p-value were used to assess the correlation of accelerometer based MVPA with the socio-demographic variables.

Bivariate correlations were repeated to assess the correlation of accelerometer based SB with the socio-demographic variables.

Multiple linear regression analyses:

Lastly, to examine the association between each of the socio-demographic factors and PA and SB, multiple linear regression analyses was performed to calculate percent variance explained and used to determine linear trend p values. Prior to analysis, regression assumptions were checked. Skewed variables were log transformed before analysis (accelerometer based MVPA).

Statistical models were run for each dependant variable (accelerometer based PA and SB) and independent variables (socio-demographic factors: age, mother's education, SSS). To account for differences in accelerometer wear time, models were further adjusted for average daily accelerometer wear time.

To minimise effects of collinearity and prior to multiple linear regression, the Spearman Rho and its two-tailed p-value were used to assess the correlation between the adiposity indices and all the explanatory variables (e.g. age and school grade or parental education and parental occupation). If the bivariate correlations were strong ($r = 0.7$-0.9), one demographic (e.g. age) or one socioeconomic variable (e.g. mother's education) was used in the model. Statistical significance was set at the 5% level in all analyses.

5.4 Results

For details on response rate and missing data, refer to Chapter 3, section 3.1, pages 76.

5.4.1 Descriptive statistics of the study variables

Descriptive statistics of the independent variables are presented in Table 5.1. The study participants were 46.9% male, the median age of males and females was 15.0 and 14.0 years respectively. Approximately 58% of fathers and 66% of mothers had at least a college degree. According to SSS devised for the purpose of this study, 38.4% and 61.6% of the participants were in the middle and high SES classes respectively. With the exception of school grade, bedroom sharing and number of cars owned by a family, girls and boys were similar in each of the other independent variables.

Table 5.1 Descriptive statistics of the sociodemographic variables by gender (n= 589)

Categorical variables	[a]	Male n (%)	Female n (%)	p-
Gender		279 (46.9)	310 (52.1)	
Governorates:				0.173
Hawalli		116 (41.6)	108 (34.8)	
Asimah		95 (34.1)	109 (35.2)	
Jahra		68 (24.4)	93 (30.0)	
Father's education:				0.225
Illiterate		1 (0.4)	0 (0)	
Read and write		12 (4.3)	20 (6.5)	
Intermediate		24 (8.6)	7 (2.3)	
Secondary		46 (16.5)	48 (15.5)	
University		102 (36.6)	130 (41.9)	
Higher		57 (20.4)	54 (17.4)	
Don't know		37 (13.3)	51 (16.5)	
Father's work status:				0.597
Unemployed		28 (10.0)	36 (11.6)	
Employed		251 (90.0)	274 (88.4)	
Mother's Education:				0.446
Illiterate		0 (0)	0 (0)	
Read and write		14 (5.0)	19 (6.1)	
Intermediate		3 (1.1)	7 (2.3)	
Secondary		33 (11.8)	39 (12.6)	
University		139 (49.8)	164 (52.9)	
Higher		50 (17.9)	41 (13.2)	
Don't know		40 (14.3)	40 (12.9)	
Mother's work status:				0.523
Unemployed		84 (30.1)	85 (27.4)	
Employed		195 (69.9)	225 (72.6)	
Living arrangement:	[7]			0.131
Both parents		228 (83.5)	254 (82.2)	

Extended family		30 (11.0)	46 (14.9)	
Only mother or father		15 (5.5)	9 (2.9)	
Home ownership:				0.569
Rented		42 (15.1)	52 (16.8)	
Owned		237 (84.9)	258 (83.2)	
Bedroom sharing:	[1]			0.009
Yes		76 (27.3)	116 (37.4)	
No		202 (72.7)	194 (62.6)	
Socioeconomic status:				0.391
Middle		102 (36.6)	125 (40.0)	
High		177 (63.4)	186 (60.0)	
Continuous variables	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Age (years)	[17]	15.0 (3.0)	14.0 (3.0)	0.24
Number of cars		4.0 (2.0)	4.0 (2.0)	0.019*
Number of domestic staff		2.0 (1.0)	2.0 (1.0)	0.949
Number of bedrooms		6.0 (2.0)	6.0 (2.0)	0.818

(%) percentage within gender [a] value represents number of participants with missing data for given variable *Significant gender difference at p <0.05 assessed by chi-square for categorical, and by Mann-Whitney U test for continuous variables
IQR: Inter-quartile range

5.4.2 Self-reported and accelerometer based physical activity

Table 5.2 presents levels of PA (self-reported and accelerometer data) by gender. Around nine percent of the total sample reported walking to and from school, 17.9% of whom were boys and only 0.6% girls. Overall, more girls than boys reported running or playing during the first and school break, at 1.6% and 0.7% respectively. While 27.3% of boys participated in sports on more than three occasions on weekdays, 8.7% of girls did the same.

Gender differences were noted in all sports participation, with the exception of cycling, martial arts, volleyball and swimming. More girls than boys reported dancing during the previous week, at 38.7% and 7.2% respectively. This applies also to walking fast, with 51.0% of girls versus 25.4% of boys reporting having done so in the previous week. However, 68.8% of boys versus 22.3% of girls reported playing football in the previous week. The median of daily minutes of self-reported MVPA was 17.1 for girls and 21.4 for boys; no gender differences were noted.

Gender differences were evident for all accelerometer based PA outcomes. The median of daily minutes spent in moderate PA was 16.7 for boys versus 8.2 for girls (p value 0.001). The median daily minutes of accelerometer based MVPA was 19.0 for boys versus 8.8 for girls. For self-reported MVPA, gender differences were noted in terms of meeting the daily recommendations of MVPA of at least 60 minutes, more girls than boys reported meeting the recommendations, at 17.1% versus 10.0% respectively. For accelerometer based MVPA, more boys than girls accumulated the daily MVPA recommendations at 4.7% versus 1.3% respectively.

Table 5.2 Descriptive statistics of self-reported and accelerometer based physical activity by gender (n= 589)

Physical activity measure	[a]	Males n (%)	Females n (%)	p
Self-reported physical activity				
School transport:				0.001*
Walking to and from school		50 (17.9)	2 (0.6)	
Car, bus or other		229 (82.1)	308 (99.4)	
School break activity during first and second break:	[1]			0.001*
Running and playing		2 (0.7)	5 (1.6)	
Sit and talk		91 (32.6)	62 (20.0)	
Stand or walk		186 (66.7)	242 (78.4)	
After school sport participation on weekdays:	[2]			0.001*
Do not participate		39 (14.0)	92 (29.8)	
Once a week		43 (15.5)	55 (17.8)	
Twice a week		73 (26.3)	111 (35.9)	
Three times a week		47 (16.9)	24 (7.8)	
More than three times a week		76 (27.3)	27 (8.7)	
Weekend sport participation:	[6]			0.001*
Do not participate		84 (30.5)	174 (56.5)	
Once a week		104 (37.8)	70 (22.7)	
Twice a week		87 (31.6)	64 (20.8)	
Basketball during previous week[e]		47 (15.2)	29 (10.4)	0.11
Running during previous week[e]		69 (24.7)	124 (40.4)	0.001*
Cycling during previous week[e]		33 (10.6)	29 (10.4)	0.92
Dancing during previous week[e]		20 (7.2)	120 (38.7)	0.001*
Football during previous week[e]		192 (68.8)	69 (22.3)	0.001*
Gymnastics during previous week[e]		10 (3.6)	44 (14.2)	0.001*
Martial arts during previous week[e]		34 (12.2)	24 (7.7)	0.07

Tennis during previous week[e]		5 (1.8)	25 (8.1)	0.001*
Swimming during previous week[e]		55 (19.7)	57 (18.4)	0.68
Volleyball during previous week[e]		36 (12.9)	46 (14.8)	0.49
Walking fast during previous week[e]		71 (25.4)	158 (51.0)	0.001*
Other sports during previous week[e]		50 (17.9)	57 (18.4)	0.88
Meeting daily moderate-to-vigorous physical activity minutes recommendation of ≥60 minutes		28 (10.0)	53 (17.1)	0.01*
Self-reported physical activity	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Moderate-to-vigorous physical activity minutes for previous week minutes/day		**21.4 (25.7)**	**17.1 (27.5)**	**0.06**
Active video games hours/day e.g. Wii		**0.0 (1.5)**	**0.0 (1.5)**	0.18
Accelerometer based physical activity	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Light PA minutes/day	[121]	290.2 (121.0)	262.5 (95.0)	0.001*
Moderate PA minutes/day	[121]	16.7 (16.5)	8.2 (9.5)	0.001*
Vigorous PA minutes/day	[121]	2.0 (4.5)	0.7 (1.8)	0.001*
Moderate-to-vigorous physical activity minutes/day	[121]	19.0 (20.0)	8.8 (10.9)	0.001*
Accelerometer based physical activity		**n (%)**	**n (%)**	**p**
Meeting daily moderate-to-vigorous physical activity recommendation of ≥60 minutes	[121]	10 (4.7)	3 (1.2)	0.02*

[a] value represents number of participants with missing data for given variable (%) percentage within gender *Significant gender difference at $p < 0.05$ assessed by Chi-square for categorical, and by Mann-Whitney U test for continuous variables MVPA†: Moderate-to-vigorous physical activity [e]Data only for participants who reported participating in these activities IQR: Inter-quartile range

Table 5.3 presents the descriptive statistics of self-reported and accelerometer based PA by parental education. For self-reported PA, participants who had one parent with university or higher education participated in gymnastics more than did participants whose both parents had a university or higher education (15.6% and 6.9% respectively; p= 0.003). No significant differences were noted between the two parental education classes and other self-reported variables.

Regarding accelerometer based PA, participants whose parents achieved a secondary or lower education accumulated fewer minutes in moderate PA than did participants whose parents achieved a university or higher education (median minutes 13.1 versus 14.0 respectively). A similar finding was noted for accelerometer based daily MVPA. Participants in the lower parental education class accumulated less than participants in the higher parental education class (median minutes 11.0 versus 12.3 respectively). No significant differences were noted between the two education classes and self-reported or accelerometer based MVPA in terms of meeting the daily recommendations of MVPA of at least 60 minutes.

Table 5.3 Descriptive statistics of self-reported and accelerometer based physical activity by parental education (n= 589)

Physical activity measure	[a]	Parents with secondary or lower education n (%)	Parents with university or higher education n (%)	p
Self-reported physical activity				
School transport:				0.79
Walking to and from school		16 (10.6)	26 (9.0)	
Car, bus or other		161 (89.4)	264 (91.0)	
School break activity during first and second break:				
Run and play		0 (0.0)	2 (0.7)	0.59
Sit and talk		55 (30.6)	79 (27.2)	
Stand and walk		125 (69.4)	209 (72.1)	
After school participation in sport on weekdays:	[2]			0.47
Do not participate		47 (26.1)	60 (20.8)	
Once a week		32 (17.8)	49 (17.0)	
Twice a week		53 (29.4)	90 (31.2)	
Three times a week		15 (8.3)	37 (12.8)	
More than three times a week		33 (18.3)	52 (18.1)	
Weekend sport participation:	[6]			0.84
Do not participate		60 (44.4)	125 (43.7)	
Once a week		50 (28.9)	78 (27.3)	
Twice a week		48 (26.7)	83 (29.0)	
Basketball during previous week[e]		17 (9.4)	40 (13.8)	0.16
Running during previous week[e]		55 (30.6)	103 (35.5)	0.26
Cycling during previous week[e]		17 (9.4)	28 (9.7)	0.94
Dancing during previous week[e]		48 (26.7)	65 (22.4)	0.29

Football during previous week[e]		70 (38.9)	136 (46.9)	0.08
Gymnastics during previous week[e]		28 (15.6)	20 (6.9)	0.003*
Martial arts during previous week[e]		20 (11.1)	31 (10.7)	0.88
Tennis during previous week[e]		4 (2.2)	13 (4.5)	0.20
Swimming during previous week[e]		30 (16.7)	56 (19.3)	0.47
Volleyball during previous week[e]		20 (11.1)	39 (13.4)	0.43
Walking fast during previous week[e]		64 (35.6)	110 (37.9)	0.60
Other sports during previous week[e]		35 (19.4)	46 (13.9)	0.31
Meeting daily moderate-to- vigorous physical activity recommendation of ≥60 minutes		19 (10.6)	42 (14.5)	0.21
Self-reported physical activity	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Moderate-to-vigorous physical activity minutes for previous week minutes/day		17.1 (21.4)	17.1 (26.4)	
Active video games hours/day e.g.Wii		0.0 (1.5)	0.0 (1.5)	
Accelerometer based physical activity	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Light physical activity minutes/day	[121]	259.2 (118.6)	280.0 (104.6)	0.08
Moderate physical activity minutes/day	[121]	11.0 (13.3)	12.2 (13.2)	0.04*
Vigorous physical activity minutes/day	[121]	1.0 (2.8)	1.0 (3.0)	0.06
Moderate-to-vigorous physical activity minutes/day	[121]	13.1 (16.1)	14.0 (16.4)	0.01*
Accelerometer based physical activity	**[a]**	**n (%)**	**n (%)**	**p**
Meeting daily moderate-to- vigorous physical activity minutes recommendation of ≥60 minutes	[121]	5 (3.4)	7 (3.0)	0.84

[a] value represents number of participants with missing data for given variable (%) percentage within parental education IQR: Inter-quartile range *Significant difference between parental education at p <0.05 assessed by Chi-square for categorical, and by Mann-Whitney U test for continuous variables [e]Data only for participants who reported participating in these activities

5.4.3 Socio-demographic correlates of physical activity

Table 4 presents the correlations between the sample's socio-demographic variables and accelerometer based PA by gender. With the exception of weight which was weakly associated with accelerometer based MVPA (r=0.15), there were no statistically significant correlations between the socio-demographic variables and the accelerometer based MVPA scores.

Table 5.4 Bivariate correlations between accelerometer based moderate-to-vigorous physical activity and socio-demographic variables by gender

	Male (n=279)	**Female** (n= 310)
	Accelerometer based moderate-to-vigorous physical activity† r	
Age	0.08	-0.05
Grade	0.09	-0.02
Governorate	(0.16)[a]	(0.97)[a]
Father's education	0.04	0.11
Mother's education	0.09	0.05
Number of cars	-0.02	0.05
Number of domestic staff	-0.01	0.11
Bedroom sharing	(0.48)[e]	(0.39)[e]
Number of rooms	-0.04	0.10
Home ownership	(0.08)[e]	(0.44)[e]

†Correlation for participants with 1 valid day accelerometry data *Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed) [a]p-value for Kruskal-Wallis [e]p-value for Mann-Whitney U test

Table 5.5 presents multivariable-adjusted associations between socio-demographic factors and accelerometer based moderate-to-vigorous physical activity in boys. Among boys, none of the socio-demographic variables were associated with accelerometer based MVPA.

Table 5.5 Multivariable-adjusted associations between socio-demographic factors and accelerometer based moderate-to-vigorous physical activity in boys

	Accelerometer based moderate-to-vigorous physical activity †
Socio-demographic variables	**Beta coefficient (95% CI)**
Age, years	0.02 (-0.02 to 0.05)
Parental education	-0.01 (-0.17 to 0.16)
Socioeconomic scale	0.01 (-0.03 to 0.06)
	R^2 0.01
	Adj R^2 0.01
	Model significance: F= 0.42 p value= 0.73

†Linear regression for participants with 1 valid day accelerometry data; Model was also adjusted for average accelerometer wear time on valid days *p-value <0.05

Results of multivariable-adjusted associations between socio-demographic factors and accelerometer based moderate-to-vigorous physical activity in girls are shown in Table 5.6. Age was inversely associated with MVPA minutes per day among girls. With the exception of age, the socio-demographic variables were not associated with accelerometer based MVPA among girls.

Table 5. 6 Multivariable-adjusted associations between socio-demographic factors and accelerometer based moderate-to-vigorous physical activity in girls

	Accelerometer based moderate-to-vigorous physical activity †
Socio-demographic variables	**Beta coefficient (95% CI)**
Age, years	-0.19 (-0.05 to 0.01)
Parental education	0.02 (-0.12 to 0.17)
Socioeconomic scale	0.02 (-0.02 to 0.06)
	R^2 0.01
	Adj R^2 0.00
	Model significance: F =0.10 p value =0.40

†Linear regression for participants with 1 valid day accelerometry data; Model was also adjusted for average accelerometer wear time on valid days *p-value <0.05

5.4.4 Self-reported and accelerometer based sedentary behaviour

Table 5.7 presents the descriptive statistics of self-reported and accelerometer based SB by gender. Gender differences were noted for all self-reported and accelerometer based SB with the exception of personal computer use. More girls than boys reported car or bus transport to and from school: 90.4% of girls travelled by car (versus 81.0% boys). 32.6% more boys than girls (20.0%) sat and read in the first and second school break.

Median daily hours of total self-reported SB was 7.5 for boys and 9 for girls. Viewing TV was higher among girls, as well; the median daily time was 2.5 hours for girls and 1.5 for boys. Similar to this was the median daily time spent on homework: 1.5 for boys and 2.5 for girls. In terms of SB guidelines, more girls than boys did not meet the guidelines of less than two hours TV viewing per day at 52.9% and 27.6% respectively. This was also true for total screen time (computer use, social networks, etc) per day, girls more than boys did not meet the guidelines of less than two hours per day at 97.0% versus 90.9% respectively.

The accelerometer based outcome for SB was higher for girls; the median daily time was 9.4 hours for girls and 8.3 for boys. This is also true for sedentary bouts lasting for ten minutes measured by the accelerometer. The median time was 5.8 minutes for girls and 4.7 for boys.

Table 5.7 Descriptive statistics of self-reported and accelerometer based sedentary behaviour by gender (n=589)

Sedentary behaviour measure	[a]	Males n (%)	Females n (%)	p
Self-reported sedentary behaviour				
School transport				0.01*
Transport by car or bus		226 (81.0)	308 (99.4)	
Walking or other		53 (19.0)	2 (0.6)	
School break activity during first and second break:	[1]			0.001*
Sit, talk, read during first and second school break		91 (32.6)	62 (20.0)	
Walk, stand, run or play		188 (67.4)	248 (80.0)	
Not meeting sedentary behaviour guidelines of ≤2 hours/day TV time		77 (27.6)	164 (52.9)	0.001*
Not meeting sedentary behaviour guidelines of ≤2 hours/day TV and screen time	[10]	249 (90.9)	296 (97.0)	0.001*
Self-reported sedentary behaviour	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Total daily sedentary behaviour (hours/ day)	[16]	7.5 (3.38)	9.0 (4.0)	0.001*
TV viewing (hours/day)		1.5 (1.0)	2.5 (1.5)	0.001*
Playing non-active video games, e.g.PlayStation (hours/day)		1.5 (2.5)	0.0 (1.5)	0.001*
Using computer (hours/day)	[6]	0.0 (1.5)	1.5 (1.5)	0.004*
Using social networks (hours/day)	[5]	1.5 (1.0)	1.5 (2.0)	0.16
Doing homework (hours/day)	[1]	1.5 (0.0)	2.5 (1.5)	0.001*
Reading for leisure	[4]	0.0 (0.0)	0.0 (1.5)	0.001*
Accelerometer based sedentary behaviour	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Sedentary hours/day	[121]	8.4 (2.2)	9.5 (2.3)	0.001*

[a] value represents number of participants with missing data for given (%) percentage within gender *Significant gender difference at p <0.05 assessed by Chi-square for categorical, and by Mann-Whitney U test for continuous variables IQR: Inter-quartile range

Table 5.8 presents descriptive statistics of self-reported and accelerometer based SB by parental education. Total self-reported SB time was slightly greater among participants whose parents had achieved a secondary or lower education than participants whose parents achieved a university or higher education; the median self-reported total daily SB was 8.5 versus 8.0 hour per day respectively.

The self-reported TV time also differed between the parental education classes, the median self-reported TV time for participants whose parents had achieved a secondary or lower education was 2.5 hours per day versus 1.5 hours per day participants whose parents achieved a university or higher education. No other self-report and accelerometer based SB statistically significant differences were noted between the parental education classes.

Table 5.8 Descriptive statistics of self-report and accelerometer based sedentary behaviour by parental education (n=589)

Sedentary behaviour measure	[a]	Parents with secondary or lower education n (%)	Parents with university or higher education n (%)	p
Self-reported sedentary behaviour				
School transport				0.79
Transport by car or bus to and from school		160 (88.9)	263 (90.7)	
Walking or other		20 (11.1)	27 (9.3)	
School break activity during first and second break:				0.41
Sit, talk, read		55 (30.6)	79 (27.2)	
Walk, stand, run or play		125 (69.4)	211 (72.8)	
Self-reported sedentary behaviour	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Total daily sedentary behaviour (hours/ day)	[16]	8.5 (3.5)	8.0 (3.5)	0.02*
TV viewing (hours/day)		2.5 (1.0)	1.5 (1.0)	0.01*
Playing non-active video games, e.g. PlayStation (hours/day)		1.0 (1.5)	0.0 (1.5)	0.32
Using computer (hours/day)	[6]	1.5 (1.5)	1.5 (1.5)	0.71
Using social networks (hours/day)	[5]	1.5 (1.0)	1.5 (1.5)	0.89
Doing homework (hours/day)	[1]	1.5 (1.0)	1.5 (1.0)	0.99
Reading for leisure	[4]	0.0 (1.5)	0.0 (1.5)	0.13
Accelerometer based sedentary behaviour	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Sedentary minutes/day	[121]	8.9 (2.5)	8.9 (2.5)	0.81

[a] value represents number of participants with missing data for given variable (%) percentage within parental education*Significant difference between socioeconomic status at p <0.05 assessed by Chi-square for categorical, and by Mann-Whitney U test for continuous variables IQR: Inter-quartile range

5.4.5 Socio-demographic correlates of sedentary behaviour

Table 5.9 presents the bivariate correlations between several socio-demographic variables and accelerometer based SB outcomes and by gender. For boys, age (r=0.12), grade (r= 0.22) and number of domestic staff were positively associated with accelerometer based average daily minutes spent being sedentary. Among girls, only age and school grade were positively associated with the average daily time spent being sedentary.

Table 5.9 Bivariate correlations between and accelerometer based sedentary behaviour and socio-demographic variables by gender

	Male (n=279)	**Females** (n= 310)
	Accelerometer based sedentary behaviour† r	
Age	0.12**	0.14*
Grade	0.22**	0.18**
Governorate	(0.69)[a]	(0.23)[a]
Father's education	0.03	-0.07
Mother's education	-0.01	-0.06
Number of cars	0.04	-0.01
Number of domestic staff	0.14*	-0.10
Bedroom sharing	(0.24)[e]	(0.62)[e]
Number of rooms	0.03	-0.09
Home ownership	(0.93)[e]	(0.72)[e]

*Correlation is significant at the 0.05 level (2-tailed) **Correlation is significant at the 0.01 level (2-tailed) [a]p-value for Kruskal-Wallis test [b]BMI: Body Mass Index †Correlation for participants with 1 valid day accelerometry data [d]BMI categorized into normal weight, overweight and obese (42) [e]p-value for Mann-Whitney U test

Table 5.10 presents multivariable-adjusted associations between socio-demographic factors and accelerometer based SB in boys. Age had a significant (p value <0.05) positive association with accelerometer based SB in boys.

Table 5.10 Multivariable-adjusted associations between socio-demographic factors and accelerometer based sedentary behaviour in boys

	Accelerometer based sedentary behaviour †
Socio-demographic variables	**Beta coefficient (95% CI)**
Age, years	14.45 (6.01 to 22.89)*
Parental education	-0.97 (-11.37 to 9.43)
Socioeconomic scale	-4.81 (-14.74 to 5.12)
	R^2 0.26
	Adj R^2 0.22
	Model significance : F= 7.80 P value <0.001

†Linear regression for participants with 1 valid day accelerometry data; Model was also adjusted for average accelerometer wear time on valid days *p-value <0.05

Results of multivariable-adjusted associations between socio-demographic factors and accelerometer based SB in girls are shown in Table 5.11. For accelerometer based SB, the model was significantly associated with minutes of SB per day. Age had a significant (p value <0.05) positive association with accelerometer based SB minutes per day.

Table 5.11 Multivariable-adjusted associations between socio-demographic factors and accelerometer based sedentary behaviour in girls

	Accelerometer based sedentary behaviour †
Socio-demographic variables	**Beta coefficient (95% CI)**
Age, years	8.14 (1.13 to 14.96)*
Parental education	7.33 (-0.99 to 15.65)
Socioeconomic scale	-8.91 (-17.88 to 0.05)
	R^2 0.30
	Adj R^2 0.27
	Model significance: F = 11.47 p value < 0.001

†Linear regression for participants with 1 valid day accelerometry data; Model was also adjusted for average accelerometer wear time on valid days *p-value <0.05

5.5 Discussion

5.5.1 Self report and accelerometer based physical activity levels

This study found that 13.8% of adolescents met the PA recommendations (using self-report) set by international organizations (31). The percentage of adolescents that met PA recommendations were much lower using objective data (2.2% accelerometer based). There were gender differences in terms of meeting the daily PA recommendations of at least 60 minutes of MVPA every day. More girls than boys reported meeting the daily recommendations at 17.1% and 10.0% respectively. With regards to girls being more likely than boys to meet the PA guidelines, findings in this are inconsistent with other studies findings. The Global School Health Survey conducted in Kuwait in 2011 reported that 15.4% of adolescents aged 13-15 years met the PA recommendations, however more boys than girls reported meeting the recommendations (24). A possible explanation for the discrepancy between this study and the WHO survey is that the study used different questions to assess PA. The study asked participants if they were physically active for at least 60 minutes on all days the past week without specifying frequency or duration of activity (24). A Saudi Arabian study that reported 43.5% of boys and 12.9% of girls met the daily MVPA recommendations (88), the study did not specify the questions used assess MVPA among adolescents.

This study found that girls were more likely to over-report PA than boys. This finding is consistent to some extent with previous research. A study conducted in the Netherlands to assess disagreement in PA by means of self-report and an objective measure (accelerometer) in subgroups of age, gender, education and weight status suggested that the disagreement with respect to PA was greatest for higher educated adolescents girls (190). A possible explanation was that higher educated adolescents girls self-reported more socially desirable answers and reported that they were involved in more moderate intensity active ties than their peers (190). Research conducted in the USA to assess social desirability bias in self-reported PA, dietary and weight concerns among African-American youth, suggested that self-reported PA levels were subject to response bias as a result of social desirability (191). The bias was established as a significant overestimation of self-reported activity compared to the criterion of accelerometer counts among African-American girls (191). Since social and parental influences are known to affect PA perceptions and behaviors in children and adolescents, it is plausible that such influences may be related to intentional or unintentional bias in self-reporting (192). In particular, girls may respond to parental or other perceived social demands by offering responses they perceive as socially desirable, therefore, more frequently endorsing physically active behaviors. This may very well be a possible explanation for findings in the present study, however, further exploration is warranted to determine why Kuwaiti girls over-report their PA levels compared to boys.

This study found significant gender differences in most aspects of self-report and accelerometer based PA. Around nine percent of participants reported active school transport, which is lower compared to findings from other studies (193-195). The significant gender difference in active school transport was similar to the findings in the first Global School Health Survey conducted in Kuwait by the Ministry of Health for the academic year 2010-2011(24). The survey reported that 85.7% of girls had not walked to school in the past week, compared with 55.3% of boys. Several studies reported similar results in terms of gender differences in active school transport (194, 196) while other studies found no gender difference with regard to active school transport.

Studies carried out in England (193), Denmark (194)and the United States (195) reported higher participation in active transport. It is noteworthy that the above studies asked different questions about school transport. Therefore, comparisons cannot be made meaningfully; for example, the Health Survey for England (193) asked about participation in active school transport on at least one day in the past week and reported that approximately 65% of 11-15 year olds walked to and from school on at least one day the previous week (193). In this study, active transport was assessed by asking what the usual method was for commuting to school. In this study more adolescent boys than girls reported walking to and from school (17.9% versus 0.6% respectively). Although, previous studies have suggested that active school transport can contribute to young people’s overall PA levels (197), the findings in this study indicate that a very low proportion of adolescents actively commute to school.

Gender differences were also noted in this study in terms of after school sports participation and in the different sports activities. More adolescent girls than boys reported participation in activities such as running (40.4% versus 24.7% for boys), walking fast (51.0% versus 25.4% for boys), dance, gymnastics and tennis; the boys mostly reported engaging in football. This is contrary to findings in other studies which suggest higher sports participation among boys (193, 194, 198), walking fast being the exception reported as being higher among girls (which resembles the findings in the present study). A possible explanation for the difference between the findings in this study and in others is that the high scores for girls could be caused by over-reporting. A common disadvantage of all self-report methods is that they are subject to social desirability bias and failure to recall time or the rounding up of time (136).

No gender differences were noted for self-reported daily MVPA, unlike several other self-reported PA studies which have found gender differences (199). A self-reported PA study carried out in ten European cities reported significant gender differences in all the self-reported PA domains (199). Boys reported more PA in school-based PA (240 versus 180 minutes per week), leisure-based PA (380 versus 280 minutes per week), vigorous PA (190 versus 60 minutes per week) and total PA than girls (199). No gender differences were noted for playing active video games, a finding which is similar to the findings in other studies. A study examining the prevalence of active and non-active video gaming among Dutch adolescents found no gender differences in playing active video games (143).

A nationally representative study among U.S. adolescents found that less than 20% reported meeting the aerobic PA guidelines, boys being more active than girls (200). Participants were asked to report the frequency and average duration of moderate intensity PA by recalling activities (such as brisk walking, golf or dancing) in the past 30 days. The US study administered the PA questionnaire via face-to-face interviews and provided opportunities for follow up or clarification which may have increased recall of activities. The discrepancy between findings in this study and other studies may be due difference in questions used to assess MVPA. The challenges and limitations that self report methods pose in determining the MVPA, differences in measurement methodologies and sample characteristics may explain discrepancies in MVPA findings.

In terms of accelerometer based PA outcomes, gender differences were noted in all the measured PA outcomes, with the exception of vigorous activity. Boys accumulated more minutes in the intensity of each PA activity. Among the intensity distributions, adolescents' waking hours were dominated by light intensity PA, the median being 271.5 minutes per day for the total sample. Boys accumulated more minutes in light (median 290 minutes per day), moderate (median 16.7 minutes per day) and MVPA (median 19 minutes per day). With the exception of light intensity activity, girls accumulated approximately half the time that boys did in each level of intense activity. Among girls, the time spent in each intensity of their activity was as follows: medians for light, moderate and MVPA activity were 262.5, 8.2 and 8.8 minutes per day, respectively.

As this is the first study in the Middle East to assess PA objectively, comparisons of the average time spent in PAs of different intensities will be made with previous studies (carried out predominantly in Western countries) which used similar objective methods to measure PA. In terms of adolescents accumulating PA minutes predominantly in light intensity activity. The findings in the present study are similar to those in a recent study conducted in the UK to assess the levels, patterns, volumes and intensity distribution of objectively measured PA (201). However, while participants in this study accumulated a median of 271.5 minutes per day of activity, the UK study reported that adolescents spent a mean of 571 minutes per day (201), almost 50% more than Kuwaiti adolescents spent. As well as the important methodological differences between the studies (such as monitor type, season of monitoring placement and data reduction), another explanation may be that there are true differences in PA levels due to variation in sample characteristics (such as geographic location, climate differences, culture differences and different fitness levels) (201). At present, the acquired health benefits from light PA are mostly unknown; therefore, additional research surrounding this intensity is warranted, given the high prevalence of this exposure in both adolescent girls and boys.

The acquired health benefits of MVPA are well established (3, 99): this study found that adolescent boys spent 17 and 19 minutes per day in activity of moderate to vigorous or moderate intensity respectively. Girls spent less than half the amount of time in activity of moderate or MVPA intensity (8 and 9 minutes respectively). For boys, the estimated self-reported MVPA was very similar to the accelerometer based MVPA measure at 21 (versus 19) minutes per day. However, girls reported spending 17 minutes per day doing MVPA, almost double the accelerometer based measure of MVPA, which was nine minutes per day.

Gender differences were seen in the time spent in activity of vigorous intensity (albeit minimal difference), the median of which was two minute per day for boys versus 0.7 minutes for girls. The gender difference noted in this study is similar to that in two UK studies assessing the patterns and levels of objectively measured PA in adolescents (193, 201). However, the HSE study reported that boys aged 12-15 years (nationally representative) spent 52 minutes per day engaging in MVPA, while girls spent 28 minutes per day on it (193). The UK ROOTS study found that their data were very similar to HSE; boys spent 58.4 minutes while girls spent 32 minutes per day in MVPA (201).

Methodological differences between the studies may be a possible explanation for the discrepancies seen in the volume of moderate, vigorous and MVPA reported in these studies. More importantly, these discrepancies are more likely to be explained by the differences pertaining to the characteristics of the samples.

In terms of meeting the daily recommended MVPA guidelines (31), according to accelerometer based MVPA, this study found that 2.2% of the adolescents met the PA recommendations. More boys than girls engaged in MVPA, at 4.7% versus 1.2% respectively. In terms of gender differences findings in this study are similar to other studies (127, 202), however with regards to the proportion of adolescents meeting the daily PA recommendations, findings in this study are lower than other studies that utilized objective methods to assess PA. A study conducted in Spain to assess accelerometer based MVPA among 13-16 year old adolescents found that overall, 71% of adolescents met the PA recommendations, boys more than girls at 82% and 61% respectively (203). A study in

France to assess levels of PA among 12-13 year old children found that 44% of children met the daily PA guidelines, boys more than girls at 60% versus 31% respectively (204).

A likely explanation for discrepancies between findings in this study and other studies may be a result of actual difference in levels of PA among adolescents in Kuwait compared to other Western countries. On the other hand, differences may be a result of discrepancies in measurement methodologies, sample characteristics and the utilization of different cut-off points to determine MVPA. A recent systematic review to assess PA levels objectively by accelerometry among children and adolescents in Europe suggested that depending on the cut points used (to determine MVPA), between 4% and 100% of adolescents were found to achieve the PA recommendations (205). If the three METs cpm equivalent from Freedson et al (206). were used, at least four in ten adolescents (ranging from 44% to 66%) complied with the PA guidelines (205). When the MVPA cut point of approximately 2000 cpm was used, this proportion was in the range of 20% to 71%, and the proportion was less than 10% (ranging from four to nine percent) if the cut-off point used was less than 3000 cpm (205). This study used the cut point of more than or equal to 2296 to determine MVPA, which may have affected the proportion of adolescents meeting the daily PA recommendations. Nonetheless, the proportion of adolescents that met the PA guidelines are lower than what other studies using accelerometry have found (205).

When self-reported PA was described in relation to SES class (assessed by parental education), no differences were noted between the groups, with the exception of gymnastics, in which more participants from the low parental education class participated. This is similar to a study conducted in the Middle East (Iran) to examine correlates of PA among adolescents, which reported no differences in self-reported PA among the high and low SES (97). Other studies in the Middle East mostly examined gender differences in relation to PA (98, 186, 207). These findings are somewhat different to findings from other studies. A recent systematic review of systematic studies which suggest that SES status (assessed by parental education) was consistently associated with PA among adolescents and that adolescents from a higher SES status were more physically active (93). The modest discrepancy between the higher and lower parental education classes reported is perhaps due to the fact that Kuwait is an affluent country, which ensures free education, housing, health and various other social privileges for all its citizens (177). Government policy on education yields a literacy of 90% (74). As a result most Kuwaitis have more or less the same SES which may hinder prospects of detecting health related disparities among subgroups of the population. Nonetheless this is the first study to examine differences in levels of PA by parental education as an indicator for social position among adolescents; the findings in this study are supported by what other studies have suggested (93).

5.5.2 Socio-demographic correlates of physical activity

The second aim of this study was to assess the socio-demographic correlates of PA. A weak negative association was found between weight and accelerometer based PA (r= 0.15). When multivariable-adjusted associations between socio-demographic factors and accelerometer based MVPA were applied, none of the socio-demographic variables were associated with accelerometer based MVPA among boys and girls. The findings in this study are inconsistent with previous studies examining the correlates of PA (93, 208). A recent systematic study of systematic reviews found 16 correlates which were consistently associated with PA (self-reported and objectively measured) (93). Among the identified correlates, age showed a negative correlation, as was found in the present study (93). Gender (boys), and SES had a positive correlation with PA (93) , which was not evident in this study after testing for multivariable-adjusted associations. Given that the proportion of adolescents that met daily PA recommendations was extremely low (2.2% accelerometer based MVPA), and no particular correlates were identified in multivariable analyses, an intervention program to promote PA should be targeted at all Kuwaiti adolescents.

In addition, there is a need for studies which use homogeneous and validated measurement methods for PA assessment. This is the first study in the Middle East to have used multiple measures of PA, providing a more complete description of adolescents' activity than that suggested by existing research (209). Population and individual interventions focusing on the correlates that can be influenced or modified are more likely to bring about behaviour changes (210). This study did not examine the psychosocial and environmental correlates of adolescents PA.

5.5.3 Self reported and accelerometer based sedentary behaviour

With the exception of social network use, this study found gender differences in every self-reported and accelerometer based SB measure. More girls reported non-active school transport (by car or bus) than did boys. Studies which examined the correlates of active school transport also reported that girls are more likely to use motorized vehicles for school transport (194, 211). The self-reported total daily hours of SB was higher among girls than boys (9 versus 7.5 hours respectively); girls spent more time than boys watching TV (2.5 versus 1.5 hours per day) and also reported spending more time using a personal computer (1.5 versus zero hours per day) and doing homework (2.5 versus 1.5 hours per day). Boys reported spending more time than girls playing non-active video games (1.5 versus zero hours per day).

The self-reported total time devoted daily to SB and the habit among girls of spending more time watching TV, using a computer and doing homework found in this study are similar to what is reported in other studies in the Middle East. A study to assess self-reported PA, SB and dietary habits relative to age and gender among Saudi adolescents found that girls reported watching TV for longer than boys did (mean= 3.6 versus 2.77 hours per day). The study also reported that girls spent more time using computers than boys did (mean= 3.2 versus 2.67 hours per day). A possible explanation for the higher self-reported SB levels in the Saudi study than in the present one is that the Saudi study reported mean daily SB hours even though the SB data were non-normally distributed. As a result, the mean SB measure used in the latter study is likely to have been influenced by outliers and is not an appropriate measure of center.

Furthermore, cross-sectional studies examining the levels of SB which have been conducted in the Western countries have reported somewhat different results. A study conducted in the US reported boys spent more time in SB than girls (212). The study assessed SB by asking about screen time alone; SB questions included time spent watching

TV, using a computer and playing video games (212). These findings are somewhat different from the ones in the present study, which found that, while boys spent more time playing non-active video games, girls watched TV and used the computer more than boys. In terms of boys playing non-active games, other studies conducted in Western countries report similar results to the findings in the present study (143). However, several other studies in Western countries report that boys spend more screen time than girls do (92, 212, 213). Variations in terms of geographical location and sample characteristics may be a possible explanation for the gender differences in relation to SB.

This study found significant gender differences in terms of limiting TV viewing to less than two hours per day (214). More girls than boys reported watching TV for more than two hours per day at 52.9% and 27.6% respectively. Overall 41 percent of the sample reported TV viewing for more than 2 hours daily. The findings in this study is similar to findings in the GSHS study in Kuwait, which reported that 53% of adolescents aged 13-15 years (girls more than boys) spent more than three hours per day in activities that involve 'sitting' (24). Similarly, a study conducted in Iran reported that 60% of adolescents aged 12-17 years reported more than three hours per day of TV viewing (86). Possible explanation for the discrepancy between findings in this study and other studies in the Middle East may be that the Kuwait GSHS study assessed SB by asking about time spent in activities that involve 'sitting' (24), whereas this study inquired about specific SBs including time spent viewing TV. The study in Iran reported a higher proportion of adolescents viewing TV, a possible explanation may be that Kuwait has a higher economy compared to other countries in the region (74), therefore other means of screen time entertainment (smartphones, personal computer use, etc) may be readily accessible for use (22). Unlike lower income countries in the region where adolescents tend to rely more on TV as a form of screen time entertainment.

Studies to assess SB among youth conducted predominantly in Western countries reported boys more than girls watched TV at 1.5-3.7 and 1.4-3.0 hours per day (215-217). A possible explanation for the dissimilarity between findings in studies in the Middle East and studies in Western countries may be differences in cultural and sample characteristics. In the Middle East adolescent girls do not enjoy the freedom and liberties that adolescent boys have. While it is acceptable for adolescent boys to partake in outdoor activities they deem fit, (for example, go to sports clubs or visit a friend's house) adolescent girls in the Middle East are encouraged and expected to stay indoors, which may account for higher levels of TV viewing than boys.

Studies have suggested limiting all forms of screen time (personal computer use, non-active video games, etc) to less than two hours per day as a means to promote more caloric expenditure opportunities (176). This study found that overall 92.5% of the sample did not limit screen time to less than two hours per day. Girls more than boys reported more than two hours screen time at 97.0% versus 90.9% respectively. These findings are supported by other studies conducted in the Middle East (88). A study in Saudi Arabia to assess PA, SB and dietary habits among 14-19 year old adolescents reported that 91% of girls (and 84 percent of boys) reported screen time of more than two hours per day (88).

Similar findings have been reported in studies to assess screen time among youth conducted primarily in Western countries. A US cross-sectional study for adolescents aged 15-17 years reported that girls more than boys spent time in screen based and non-screen based activities at 8 and 7.6 hours per day respectively (218). Other European studies reported that boys reported more time than girls in screen based activities (219, 220). The gender discrepancy found between findings in studies in the Middle East and other studies may be a result of differences in cultural and sample characteristics. Regardless of the gender differences noted in this study, the majority of adolescents in the sample (92.5%) did not limit screen based SB to less than two hours per day. Previous studies have suggested that failure to adhere to PA and SB guidelines presents a three to four times greater risk of obesity (214).

The accelerometer based SB outcomes confirm the self-reported findings in this study: gender differences were noted, with girls accumulating more time in SB than boys did (median 9.4 versus 8.3 hours per day). When compared to self-reported SB, girls and boys had somewhat similar scores (self-report: 9 versus 7.5 hours per day). These findings show that the various questions used to assess SB were appropriate to accurately quantify SB among adolescents. The results in this study are supported by a literature review examining SB in young people, which suggests that self-reported SB in screen-based and non-screen-based SB ranged from 4.7 to 8.0 hours per day (22). In comparison, accelerometer measured SB ranged from 3.6 to 8.1 hours per day (22).

This is the first study to assess SB in Kuwait by means of an accelerometer and therefore the results of the study are not comparable with other studies in the Middle East that primarily use self-reported measures. The results of the accelerometer based SB measures found in this study are somewhat similar to those in studies conducted mainly in Western countries. The Health Survey for England study conducted in a nationally representative sample of 12-15 year old children found that they spent 8.4 hours per day in SB (193). The Health Survey for England data are supported by a recent multi-centre European study, which reported that adolescents spent nine hours per day in SB (221). Research assessing the levels and patterns of objectively-measured SB among adolescents in the US reported that the sedentary time among older adolescents (16-19 years old) was 8 hours per day (129). Even when the results from the present study are compared with those in studies from very different geographical locations (and with methodological differences, e.g. in their classification of non-wear time), the findings in this study are consistent with theirs. These data support existing cross-sectional evidence that young people (adolescent girls in particular) spend much of their time in SB.

The present study found gender differences between total daily self-reported SB and daily self-reported TV viewing in relation to parental education (an indicator of socio-economic position). This study found that participants total daily self-reported SB time and daily TV viewing was greater among the lower parental education class than participants whose parents achieved a university or higher education; These findings are similar to the few studies that have examined SES and SB, that also suggested an inverse socio-economic gradient and SB indicators (TV and other screen time) (219, 222). Recent research using Health Survey for England data for children and adolescents (2-15 years old) Health Survey for England reported that participants in the highest socio-economic position category spent 16 minutes per day less in watching TV than those participants in the lowest socio-economic position (223). No accelerometer based SB statistically significant differences were noted between the parental education classes. These findings are somewhat different to a recent study that suggested that low socioeconomic position was linked to higher levels of self-reported TV viewing but with lower levels of accelerometer based SB (223). These findings suggest that the relationship between SB and socio-economic position are rather complex and warrants further research.

5.5.4 Socio-demographic correlates of sedentary behaviour

Among boys, multivariable-adjusted associations between socio-demographic factors and accelerometer based SB revealed that accelerometer based SB age had a positive association with accelerometer based SB in boys.

A US study to assess accelerometer based SB in a representative sample of US civilians reported that older adolescents (16-19 years old) were associated with accelerometer based SB (129). This supports the findings in the present study, where age had a positive association with accelerometer based SB. While the systematic review suggested that SES was inversely associated with SB (92), the present study did not find an association SES and self-reported or accelerometer based SB. A possible explanation for this is the unique situation in Kuwait, where SES class is more or less uniform among Kuwaiti adolescents in governmental schools. This study did not include Kuwaiti adolescents studying in private schools, whom are more likely to belong to a high SES class. This may explain the lack of SES differences in relation to PA and SB noted in this study.

5.5.5 Strengths, limitations and implications of the study

The present study has several strengths, it is the first study in Kuwait and the Middle East to use both self-reporting and accelerometer based methods to assess the levels of PA and SB. In addition, it is the first study to report PA and SB in terms of parental education and to examine accelerometer based PA and SB figures with several socio-demographic variables. This study differs from other studies in the Middle East in terms of both methodology and critical findings. In addition to covering a wide age range, this study provides a unique insight into the current levels of PA and SB among Kuwaiti adolescents. Furthermore, this study was dedicated in part to different SB indicators through various measures (both screen time based and non screen time based indicators).

By assessing the socio-demographic associations with PA and SB, this study may help to steer PA promotion programmes to specific key target populations. However, at present the evidence from this study has revealed that the situation among Kuwaiti adolescents is alarming. Accelerometer based PA outcomes revealed that 2.2% of the adolescents in this sample met the MVPA guidelines (60 minutes of MVPA every day) set by many organization and governments, including Kuwait (31, 33). In addition, when compared to young people in the West, Kuwaiti adolescents have higher SB levels (193) and very few meet the current recommendations of limiting daily SB to less than two hours. The findings from this study indicate that an immediate action plan should be developed and implemented to promote PA and reduce SB, with particular emphasis on older adolescent Kuwaiti girls.

At the same time, this study has several limitations. It did not include students from all the governorates of Kuwait, thereby limiting the representativeness of the study. For accelerometer based measures this study included only participants with at least one valid day of accelerometry data to maximize the use of the collected data. However, to get a better idea of children's and adolescents' PA and SB profiles, studies recommend including participants with at least four valid days of accelerometry data (224). As a result, the weekday and weekend PA and SB patterns were not differentiated, as suggested by previous studies (224). Moreover, the uniaxial accelerometer used may not differentiate between sitting and standing, thereby affecting SB outcomes. Although several variables as potential confounders for future analysis, may be adjusted for (e.g. age), pubertal development (a factor which influences physiological processes (225)) was not assessed.

There are several methods of assessing PA and SB in young people, including self-reporting and accelerometry; both these methods have sets of advantages and disadvantages. Self-reported PA and SB questionnaires are a simple method of assessing PA and SB; however, they are subject to several limitations, including recall bias which may be intentional (aiding a social desirability bias) or accidental false recall in reporting different intensities of PA (174). Self-reporting questionnaires remain the only method available of assessing the domain and type of PA (175). However, the validity of the specific types and domains of PA is difficult to assess in self-reported questionnaires, which tend to overestimate the intensity and duration of different types of sport (175). With regard to SB, most self-reported questionnaires ask about screen time (TV viewing and PC use) as a way of assessing total SB (212, 226), which represents only one sedentary behaviour domain.

Objective methods such as accelerometers have been used to assess PA and SB in young people. Accelerometers can measure the volume, pattern, intensity, frequency and duration of PA (175). Accelerometers have also been used to measure SB among children and adolescents (227). Previous studies suggest, however, that the correlation between any self-reporting method and an objective device is low to moderate at best (82).

5.5.6 Conclusion

Few adolescents met the PA and SB guidelines and recommendations set by most international agencies and local governments. The number of adolescents that met PA recommendations were much lower using accelerometer based data compared to self-reported PA. This study found that more girls than boys spent time in each self-reported SB measure and according to accelerometer based SB outcome. Multivariable analyses revealed that age was positively associated with accelerometer based SB for both girls and boys. These findings highlight that there is no ideal method to assess PA or SB among children and adolescents. Moreover, discrepancies may arise when using different methods to assess PA and SB for the same individual.

Finally, because this is the first study in the Middle East, to the best of my knowledge, that measured PA and SB with accelerometers, these data are preliminary and further studies are warranted to corroborate the current findings.

Chapter 6: Prevalence of adolescent overweight, obesity and the body fat percentage, waist circumference and blood pressure percentiles

6.1 Introduction

The prevalence of non-communicable diseases is increasing worldwide, the increase being much more rapid in developing countries (100, 228, 229). The WHO estimates that, by the year 2020, non-communicable disease will be responsible for three quarters of all deaths in the developing world (230). This should be acknowledged with great concern in the Middle East, which has undergone rapid socio-economic growth and speedy urbanization. Among the Middle Eastern countries affected by these changes is Kuwait, an affluent country where the gross national income per capita is currently ranked 13th among world economies (231). Rapid economic development in Kuwait has resulted in shifts in nutritional and lifestyle behavioural patterns, which have in turn led to an increase in obesity rates and non-communicable diseases (232, 233). From 1980 to 1993, the percentage of Kuwaiti individuals (aged 18–29 years) who were overweight rose from 30.6% to 54.4% and the percentage of those who were obese increased from 12.8% to 24.6% (234). According to the Dasman Center for the Research and Treatment of Diabetes, 15% of Kuwait's adult population has diabetes; 50% of people over the age of 45 live with the disease (235).

Formerly confined mainly to adults, the obesity epidemic has now come to include the paediatric population worldwide (12, 236, 237). Adolescence, is the stage when obesity develops and may persist into adulthood (238). Childhood obesity often precedes insulin resistance and is a component of paediatric metabolic syndrome (239, 240). Defined as a pattern of metabolic disturbances, metabolic syndrome includes central obesity, hypertension, hyperglycemia, hypertriglyceridemia and low high density lipoprotein (240). If three of these five features are present in an adult, then they are considered to have metabolic syndrome which is an important predictor of type two diabetes and cardiovascular disease (240). For children however, no similar clear cut definition has yet been established hence, paediatric metabolic syndrome is not defined clearly (240). Studies have suggested that childhood obesity is the single factor persistently associated (in cross-sectional and longitudinal studies) with the clustering of components of the metabolic syndrome and is as useful as metabolic syndrome in predicting the development of cardiovascular disease and type 2 diabetes during adulthood (241). Therefore, it is recommended that obese children in particular should be screened for the risk factors of cardiovascular disease (240).

Gold standard methods (based on the four-compartment model) of assessing adiposity in children and adolescents are not feasible in large epidemiologic studies. Dual energy x-ray absorptiometry (DEXA), which has performed very well against the gold standard, is also not readily available or feasible (63). Furthermore, DEXA emits radiation (although in small amounts), which may discourage children from participating in studies (63). Identifying feasible alternative methods which are highly correlated with the gold standard measures is crucial to correctly assessing adiposity in children and adolescents. There are several methods of assessing adiposity in children and adolescents, which include BMI, bio-impedance and waist circumference (41). Since the adiposity measures used in SHAAK measure different aspects of adiposity, collecting data using the three adiposity markers provides a more comprehensive adiposity profile for Kuwaiti adolescents.

During the last few decades, the prevalence of high BP in children and adolescents has increased (242). The increased awareness of child and adolescent BP is partly due to easier detection and improved classification (243). Paediatric primary hypertension is present in one to five percent of children and adolescents of all age groups (244, 245). However, obesity-related high BP is the most prevalent illness associated with childhood obesity (246). Identifying high BP in youth is crucial, as high BP during childhood is associated with elevated BP in adulthood (247, 248).

Paediatric pre-hypertension is defined as the average systolic blood and/or diastolic BP of more than or equal to 120/80, or, more than or equal to the 90th percentile for gender, age and height on at least three occasions (249). Hypertension is defined as the average office systolic and/or diastolic BP of more than or equal to 125/85, or more than or equal to the 95th percentile for gender, age and height (249).

6.2 Objectives

1. To estimate the prevalence of overweight and obesity among school age adolescents in Kuwait.
2. To describe the distribution of percentage body fat among school age adolescents in Kuwait.
3. To describe the distribution of waist circumference among school age adolescents in Kuwait
4. To describe the distribution of high blood pressure among school age adolescents in Kuwait.

6.3 Method

6.3.1 Study design, participants and sampling procedure

For information on the design, recruitment and sampling procedure, refer to the general methodology chapter (Chapter 3, section 3.1, page 72).

6.3.2 Data collection

For detailed information on data collection, refer to the general methodology chapter (Chapter 3, section 3.3, pages 78-83 and section 3.5, pages 92-98).
Information relevant to the present chapter is summarised in the following sections.

Physical examination

Anthropometry

Weight was measured (light clothing, emptied pockets and without shoes), to the nearest 0.1 kg, using a SECA (Germany) electronic scale, model 813.

Height was measured (without shoes, in bare or stocking feet), to the nearest 0.1cm using a SECA (Germany) portable audiometer, model 217, with adolescents standing upright.

Waist circumference was measured (over light clothing), using a non-elastic flexible measuring tape Myotape (USA). Waist circumference measurements were taken midway between the tenth rib and the iliac crest, to the nearest 0.1 cm.

Bioelectrical impedance

Bioelectrical impedance at a fixed frequency of 50 kHz using the Body stat ® 1500 (British Isles), validated in comparison with dual-energy absorptiometry fat-free mass (FFM) was used as the criterion measure (58). All participants were measured in an assumed normally hydrated state. Participants were tested after the removal of shoes and socks in a supine position with their arms by their side and legs slightly apart (to avoid conductivity in the wrong places). The BIA procedure was performed twice in succession and the mean of the resulting impedance measures was used for subsequent analyses.

Blood pressure

BP was taken using the Omron HEM 907XL (USA) digital BP monitor. BP was measured on the right side of the participant using the appropriate cuff, on the bare skin of the upper arm. The participant was asked to sit quietly for three minutes with feet flat on the floor and then two readings were taken, one minute apart.

6.3.3 Data processing

BMI status derived variable:

BMI was calculated as weight (kg) divided by the height squared (m^2) and categorized into normal, overweight and obese using the Cole et al. (42) cut-off points. Cole et al. (42) used data on the body mass index for children from six large nationally representative cross sectional surveys, from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the United States (42). Each survey had over 10,000 subjects, with ages ranging from 6-18 years, and quality control measures to minimise measurement error. Centile curves for body mass index were constructed for each dataset by sex, using the L (lambda), M (mu), and S (sigma) - LMS - method, which summarises the data in terms of three smooth age specific curves. The M and S curves correspond to the median and coefficient of variation of body mass index at each age, while the L curve allows for substantial age dependent skewness in the distribution of body mass index. The values for L, M, and S were to be tabulated for a series of ages. The assumption underlying the LMS method is that after Box-Cox power transformation the data at each age are normally distributed. Each centile curve defines the cut off points through childhood that correspond in the prevalence of overweight or obesity to that of the adult cut off point—the curve joins up those points where the prevalence matches are seen at age 18. This process is repeated for all six datasets, by sex. Superimposing their curves leads to a cluster of centile curves that all pass through the adult cut off point yet represent a wide range of overweight and obesity. The curve is representative of all the datasets involved but is unrelated to their obesity. The cut-off point is effectively independent of the spectrum of obesity in the reference data (42).

Body fat composition derived variable:

To estimate the body fat percentage of participants, first, their fat free mass (FFM) was calculated using the validated pediatric specific bio-impedance equation (58):

FFM (kg) = [−7,655 + 297 (Ht) + 125 (BM) − 17.4 (Imp)]/1,000

where Ht: standing height (cm); BM: body mass (kg); and Imp: bio-impedance (ohms).

Second, to calculate fat mass (FM), FFM was subtracted from body mass (BM):

FM (kg) = FFM (kg) – BM (kg)

Finally, body fat percentage was calculated by dividing FM by BM and then multiplying by 100

Body fat % = FM (kg) / BM (kg) x 100

Waist circumference derived variable:

The participants were categorized into those with normal waist circumference or abdominal obesity using the Jackson et al. waist circumference percentiles developed specifically for Kuwait's child and adolescent population (250). The Jackson et al (250) smoothed waist circumference percentile graphs and tables were developed using the LMS method, which resulted from smoothing three age-specific curves. The LMS software program used was Chartmaker Pro (Institute of Child Health, London, UK), using the method developed by Cole et al (251). The data imported in the program resulted in a waist circumference cut-off for male children and another for female children at each percentile

(3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles) for each age category (250). The graph and table percentiles calculated were the 3rd, 10th, 25th, 50th, 75th, 90th and 97th percentiles. The LMS method involved summarizing the percentiles at each age (separately for males and females) on the basis of the Box–Cox power transformations, which were used to normalize the data. The final percentile curves were the result of smoothing three age-specific curves. The L, M and S curves describe the skewness, median and coefficient of variation of the distribution of waist circumference at each age (250). According to the Jackson et al. proposed cut off points, participants below the 90^{th} centile were defined as having a waist circumference within normal range, while participants at or above the 90^{th} centile were defined as having abdominal obesity.

Blood pressure level derived variable:

Refer to Appendix 10 for details on BP level derived variable and additional analyses examining the prevalence of high BP and the prevalence of high BP according to BMI among adolescents.

6.3.4 Statistical analyses

The general approach underpinning the data analyses involved descriptive statistics (for prevalence and distribution related research questions).

Key descriptive statistics:

First, to describe the SHAAK variables used in this study, frequencies and percentages were used for the categorical variables and the median and inter-quartile range for the continuous variables. Gender differences were assessed by Chi-square for the categorical variables and by Mann-Whitney for the continuous variables.
Statistical significance was set at the 5% level in all analyses.

Prevalence of overweight, obesity and distribution of body fat percentage, waist circumference and blood pressure

The prevalence of overweight and obesity and abdominal obesity was described in terms of frequencies of and percentages for the categorical variables

The distribution by percentiles of waist circumference, BFP and BP measurements were also presented.

6.4 Results

For details on response rate and missing data, refer to the flow diagram in Chapter 3, section 3.1, page 76.

6.4.1 Descriptive statistics of the study variables

Descriptive statistics of the variables are presented in Table 6.1. The study participants had a median age of 15 years. Gender differences were noted in BMI, waist circumference, BP. Refer to Appendix 9 for histograms showing the distribution of BMI, body fat percentage, waist circumference and BP.

Table 6.1 Descriptive statistics of the study variables by gender (n=589)

Categorical variables	[a]	Male n (%)	Female n (%)	p
BMI in categories:	[17]			0.01*
Normal		110 (40.0)	150 (50.5)	
Overweight		70 (25.5)	93 (31.3)	
Obese		95 (34.5)	54 (18.2)	
Waist circumference in categories[b]:	[17]			0.01*
Normal		214 (77.8)	283 (95.3)	
Abdominal obesity		61 (22.2)	14 (4.7)	
Continuous variables	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Age (years)	[17]	15.0 (3.0)	14.0 (3.0)	0.24
BMI	[12]	24.6 (10.3)	23.4 (7.7)	0.01*
Waist circumference (cm)	[21]	83.2 (26.6)	76.5 (16.5)	0.01*
Body fat percentage	[5]	40.1 (17.9)	40.3 (13.5)	0.35
Systolic blood pressure (mmHg)		117.0 (21.0)	101.0 (16.0)	0.01*
Diastolic blood pressure (mmHg)	[9]	67.0 (13.2)	65.0 (14.0)	0.01*

[a] value represents number of participants with missing or invalid data for given variable *Significant gender difference at $p < 0.05$ assessed by chi-square for categorical, and by Mann-Whitney U test for continuous variables (%) percentage within gender IQR: Inter-quartile range [b]Waist circumference ≥90th percentile

6.4.2 BMI defined prevalence of overweight and obesity

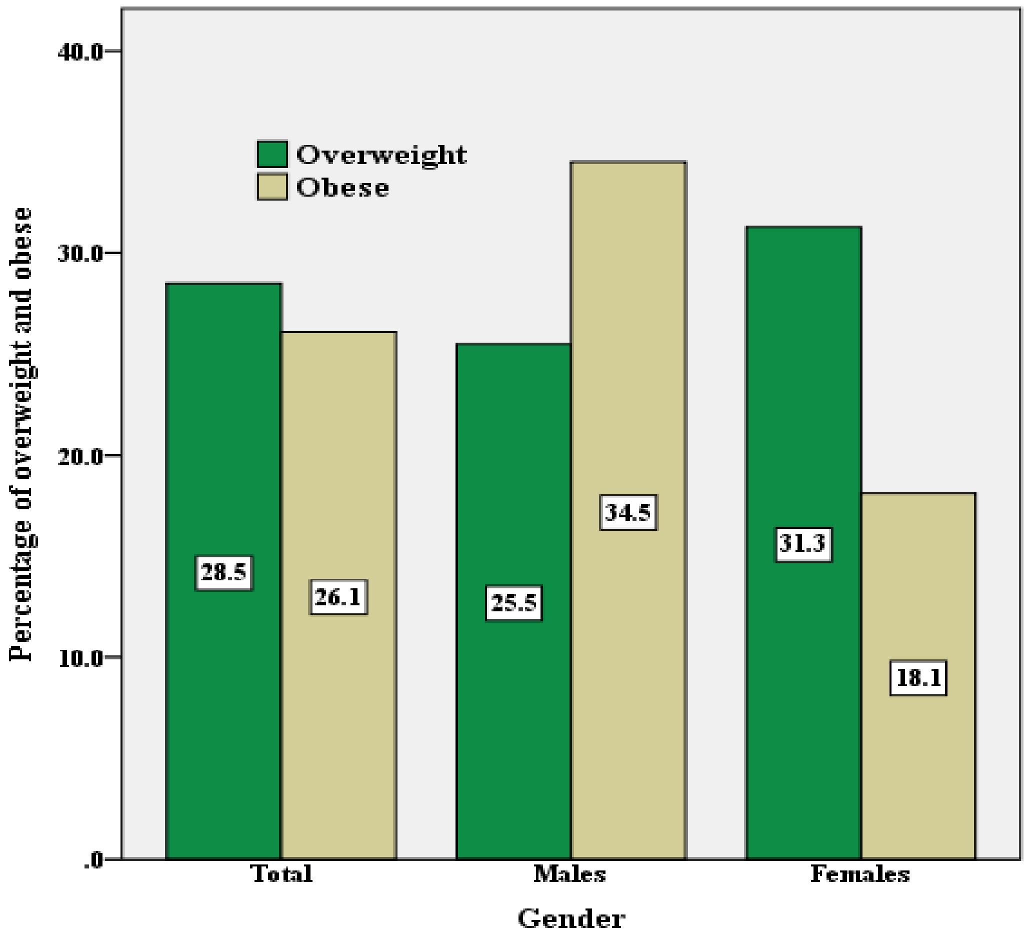
The prevalence of overweight and obesity in the SHAAK sample, according to BMI by age and gender is presented in Table 6.2. Highest rates of overweight were evident in the age group 14-15 years for both males and females. Obesity prevalence peaked at age of 16, followed by the 14-15 years age group. The prevalence of overweight plus obesity in males and females was 60% and 49.5% respectively.

Table 6.2 Prevalence of overweight and obesity according to BMI by age and gender

Age (years)	Male n (%)		Female n (%)	
	Overweight	**Obese**	**Overweight**	**Obese**
12	6 (27.3)	9 (40.9)	11 (22.4)	8(16.4)
13	16 (29.6)	22 (40.8)	16 (32.7)	5 (10.2)
14	15 (26.3)	19 (33.3)	22 (44.0)	10 (20.0)
15	15 (31.9)	9 (19.1)	18 (34.0)	11 (20.7)
16	14 (21.2)	27 (40.9)	13 (27.1)	11 (22.9)
17	4 (13.8)	9 (31.0)	13 (27.1)	9 (18.8)
Total	70 (25.5)	95 (34.5)	93 (31.3)	54 (18.2)

The prevalence (percentage) of overweight and obesity according to BMI among the participants and by gender is presented in Figure 6.1. According to BMI, 28.5 % participants were overweight and remaining 26.1% were obese. More females than males were in the overweight category (31 versus 25% respectively). However, more males than females were in the obese category (34% versus 18% respectively).

Figure 6.1 Prevalence of overweight and obesity among adolescents and by gender



Distribution of body fat percentage

The distribution of (2^{nd}, 9^{th}, 25^{th}, 50^{th},75^{th}, 85^{th},$90^{th,}$ 95^{th} and 98^{th}) percentiles for BFP by age and gender are presented in Table 6.3. Males showed relatively higher percentile values compared to females. At the 50^{th} percentile, the variability across the ages was lower among males (36.0% to 42.7%) compared to females (33.1% to 43.5%), a similar pattern was noted at the 95^{th} percentile values. The maximum BFP values, among females were evident at the age of 14 years, and showed a reduction at the age of 17 years. At the age 17 years, the median BFP in males and females was 40.3% and 41.0% respectively, however at 95^{th} percentile the BFP increase was much higher in males (40.3% to 60.0%) compared to females (41.0% to 53.2%).

Table 6.3 Body fat percentage percentiles by age and gender

	Percentiles								
Age & Gender	**2**	**9**	**25**	**50**	**75**	**85**	**90**	**95**	**98**
Males									
12	16.2	19.6	26.7	36.0	45.9	49.1	53.6	55.7	-
13	20.6	25.6	30.1	42.7	51.6	53.5	56.8	58.2	62.3
14	17.7	24.1	31.5	39.2	47.7	52.5	55.4	58.3	63.4
15	14.6	23.7	32.0	38.7	44.3	56.2	57.7	59.6	-
16	16.2	27.2	31.3	42.5	50.7	54.4	57.3	59.7	63.0
17	21.3	23.4	31.6	40.3	50.6	52.8	57.0	60.0	-
All Ages	**18.1**	**25.9**	**31.2**	**40.1**	**49.0**	**53.1**	**56.8**	**58.1**	**61.9**
Females									
12	2.9	14.9	25.3	33.1	40.5	45.1	47.9	48.3	-
13	15.1	18.2	25.6	35.0	44.5	45.4	49.3	52.7	-
14	22.9	29.6	36.7	43.5	47.8	49.3	53.1	62.8	69.9
15	3.5	25.0	34.8	40.3	46.9	50.3	53.7	56.4	57.4
16	8.6	28.4	39.1	43.2	49.5	52.1	56.7	58.4	-
17	25.0	32.5	36.2	41.0	47.5	49.5	51.9	53.2	-
All Ages	**12.9**	**24.9**	**32.4**	**40.3**	**46.0**	**49.0**	**52.0**	**53.6**	**58.3**

Distribution of waist circumference

The distribution of (2nd, 9th, 25th, 50th,75th,90th and 97th) percentiles for waist circumference by age and gender is presented in Table 6.4. Male adolescents had higher waist circumference than females. Waist circumference increased with age in both genders. At the age of 12, 13 and 16 years, males had higher percentages in the ≥ 90th waist circumference percentile. For girls, at the ages of 14, 15 and 17 had higher percentages in the ≥90th waist circumference percentile.

Table 6.4 Waist circumference percentiles by age and gender (in cms)

	Percentiles							
Age & Gender	**2**	**9**	**25**	**50**	**75**	**90**	**97**	**≥90***
Males								
12	59.5	64.1	68.7	80.6	91.7	106.8		9.1
13	63.7	67.5	72.8	89.4	106.3	121.6	136.8	9.3
14	54.6	63.9	71.9	85.7	95.1	107.3	135.7	7.0
15	28.5	43.7	70.0	76.0	90.0	117.7	136.9	8.5
16	30.0	40.3	68.8	82.0	98.6	118.0	132.2	9.1
17	30.0	39.0	60.7	83.2	100.4	110.9		6.9
Female								
12	57.7	59.5	64.7	74.0	84.4	92.0	106.0	8.2
13	59.0	60.0	63.5	75.2	79.2	91.0	100.5	8.2
14	58.3	65.0	70.4	76.5	83.1	90.2	98.9	10.0
15	60.0	61.7	66.8	78.5	85.7	95.3	101.6	9.4
16	38.6	65.0	70.5	76.5	83.1	97.7	112.8	8.3
17	33.6	66.1	72.6	78.9	88.8	98.4	104.5	8.3

** Percentage of youth with waist circumference ≥ 90th percentile*

6.4.3 Distribution of blood pressure

The distribution of (2nd, 9th, 25th, 50th,75th, 85th,90th, 95th and 98th) percentiles for systolic BP is presented in Table 6.5. Males showed relatively higher systolic BP percentile levels compared to females. At 50th percentile, the variability across the ages was found to be higher in males (104 to 120) compared to females (96 to 111), a similar pattern was noted at the 95th percentile values; 132 to 147 among males versus 119 to 135 among females. Maximum percentile values, among males were at the age of 15 & 17 years, whilst in females the values were highest at 14 & 15 years.
(refer to Appendix 10 for additional BP descriptive statistics)

Table 6.5 Systolic blood pressure percentiles by age and gender

Age & Gender	2	9	25	50	75	85	90	95	98
Male									
12	86.0	93.0	98.3	104.5	116.1	123.3	127.9	132.3	-
13	84.3	97.4	107.5	120.0	128.3	132.5	134.6	139.5	146.4
14	83.9	92.6	98.5	107.0	120.5	124.0	127.6	133.6	136.2
15	85.0	97.4	109.0	117.0	126.0	129.0	142.5	147.6	-
16	85.0	101.1	109.8	119.8	129.0	131.0	135.0	138.3	141.6
17	94.0	99.0	110.0	118.0	127.5	133.0	138.6	141.5	-
All ages	**85.0**	**95.5**	**105.0**	**117.0**	**126.0**	**129.0**	**134.0**	**137.2**	**144.4**
Females									
12	74.0	77.5	86.0	96.0	100.0	105.0	109.0	124.0	-
13	77.0	79.5	94.0	100.0	106.5	110.0	121.0	121.0	-
14	86.0	92.6	100.0	111.0	119.5	123.7	127.4	130.8	134.9
15	79.2	88.9	94.5	103.0	112.0	116.0	125.1	135.2	139.8
16	81.0	89.4	97.0	101.0	108.5	111.0	112.6	121.2	-
17	82.0	87.4	94.8	101.0	107.8	113.3	116.2	119.0	-
All ages	**77.0**	**86.0**	**94.0**	**101.0**	**110.0**	**115.0**	**121.0**	**124.0**	**132.0**

6.5 Discussion

6.5.1 Adiposity among adolescents in Kuwait

Prevalence of overweight and obesity according to BMI

This study found that overall, according to BMI, 29% were overweight and the remaining 26% were obese. The findings in this study with respect to the percentage of overweight participants are similar to the findings in previous research conducted in Kuwait in 2009 (31% overweight) (121). However, the percentage of obese adolescents is markedly higher in the present study compared to previous work, that estimated the prevalence of obesity was approximately 15% (121). Methodological differences are a possible explanation for the discrepancy between the findings in this study and the previous study. The 2009 study included adolescents who were in the 10-14 years age range during the educational year 2005-2006 and used reference data from the United States National Centre for Health Statistics reference population to define overweight (85th to 94 percentile) and obesity (>95 percentile) (121). The present study used the Cole et al. (42) cut off points which are age and sex specific to define overweight and obesity, and included adolescents in a wider age range (12-17 years).

Previous research conducted in Bahrain to estimate the prevalence of overweight and obesity among Bahraini adolescents using three different sets of criteria (WHO, CDC and IOTF references) suggested that there is considerable variation between these standards in the prevalence of overweight and obesity when applied to the same sample population (252). Another explanation for the discrepancy between this study and the 2009 Kuwait study is a real increase in the prevalence of obesity (an 11% increase) among adolescents in Kuwait during the years in question.

The present study found significant gender differences in the percentages of overweight and obesity according to BMI. The findings in this study are somewhat similar to those in a recent study comparing the prevalence of overweight and obesity among adolescents in seven Arab countries, including Kuwait (7). The recent study found significant gender differences in the prevalence of overweight and obesity among adolescents in Kuwait. However, while this study found that more females than males were in the overweight category (31% versus 25% respectively) and more males than females were in the obese category (34% versus 18% respectively), the comparison study found that males were more overweight and obese than females (26% overweight, 35% obese versus 21% overweight and 21% obese, respectively) (7). While the same reference data was used to define overweight and obesity in this study and the recent comparison study, a possible explanation for the discrepancy based on gender difference may be the older age range used in the comparison study (15-18 years) (7). Another explanation is that the prevalence of overweight among females has increased by 10% and actually exceeds the equivalent in males, which has remained more or less unchanged since 2010, when the data were collected for the comparison study. Data were collected for the present study in 2012-2013.

The findings in this study sample suggest that the prevalence of overweight and obesity among adolescents in Kuwait is the highest of all countries in the Middle East and Arab region. The present findings are in agreement with previous research which suggest that Kuwait has the highest prevalence of overweight and obese people of all Arab countries including Algeria, Jordan, Libya, Syria, the United Arab Emirates and Palestine (7). This study found that, overall, overweight and obesity characterised 59% of male adolescents and 49% of female adolescents while the study comparing the prevalence of overweight and obesity in seven Arab countries found similar results and suggested that Kuwait registered the highest percentages of overweight and obesity (61% for males and 42% for females) of all countries in the Middle East and Arab region (7). The United Arab Emirates and Jordan had somewhat similar percentages of overweight and obesity among males and females (37% and 32% for males versus 21% and 22% for females, respectively) (7). The possible reasons behind the higher rates of overweight and obesity in Kuwait than in other countries may include the differences in economic development between the countries. Kuwait is an affluent country that has seen rapid socio-economic growth and has the highest socioeconomic status of all the countries included in the Arab comparison study (231). Another explanation for the higher rates of overweight and obesity include differences between PA, SB and dietary habits, puberty timing and genetic variability (178).

Compared to the rates of overweight and obesity around the world, the findings in this study suggest that Kuwait has the highest prevalence of adolescent overweight and obesity. A recent systematic review of 40 studies, including data on several countries in each continent, suggested that the prevalence of overweight and obesity was highest in America, Oceania and Europe (6). Kuwait was not included in the systematic review which used the same reference data to define overweight and obesity among adolescents in the age range of 10-19 years; the review suggested that the prevalence of overweight and obesity was lowest in certain parts of Asia (total prevalence was less than 10% in Iran and China) (6). The prevalence of overweight and obesity was approximately 30% among American adolescents, and 22-25% of European adolescents (with the exception of Czech Republic and Italy, where it is 14% and 18% respectively) (6). In Australia and Oceania the prevalence of overweight including obesity was 34% and 23% respectively (6). Asian adolescents (the Middle East included as part of Asia) had a wide range of overweight and obesity (6). Using the IOTF cut-offs, the prevalence ranged from 5% in China (Far East) to 36% in Bahrain (Middle East) (6).The higher rates of overweight and obesity may be explained by methodological differences between the studies and the differences pertaining to the characteristics of the samples including differences in PA, SB and dietary habits, genetic variability and puberty timing (178).

Distribution of body fat percentage

Gender differences were evident with regards to body fat percentage data. Boys showed relatively higher percentile values compared to girls. Body fat percentage data at the 95th percentile were noticeably higher in males (40.3% to 60.0%) compared to females (41.0% to 53.2%). This is the first study, to the best of our knowledge that estimated the body fat percentiles in a sample of Kuwaiti adolescents as measured by bio-impedance. The findings in this study are partially consistent with previous studies. A study aimed at producing body fat percentage reference data for Turkish children and adolescents reported that girls had higher body fat percentage than boys at the 50th percentile (253), which is consistent with findings in this study. The Turkish study revealed that body fat percentage values were the highest among 14 year old girls and declined by the age of 17 years (253), these data support findings in this study. While the analyses in this study showed that body fat percentage was higher among males than females at the age of 17 years, this is different to results in the Turkish study, whereby, girls had higher BFP at the age of 17 years (253). The disagreement between the findings in this study and the Turkish study may be a result of methodological differences. Although both studies used bio-impedance to calculate body fat percentage, the Turkish study utilized a different device to the one used in this study. Furthermore, this study used the Clasey et al (58). validated algorithm to calculate body fat percentage, which may not have been the case with the Turkish study since the algorithm was not specified (253). Additionally, the Turkish study requested the participants to empty their bladders and refrain from food, drink an hour prior to measurement (253). These precautionary measures were not taken and were not logistically possible in the present study.

A study conducted in the UK to produce body fat reference curves for children aged 4-18 years found no gender differences in the body fat curves until the age of puberty whereby boys show a decline in body fat while girls continue to gain (254). The body fat percentage data in this analysis showed that males body fat percentage declined at the age of 15 years but continued increasing thereafter. Similarly, girls showed a decline by the age of 15 which was more or less sustained thereafter. It is plausible that the inconsistencies are due to methodological issues and differences in the sample characteristics between the UK and this study. The UK study collected body fat percentage data from Caucasian children and utilised a different bio-impedance device to analyse body fat composition (255). Despite these differences, it is plausible that a real difference in body fat percentage data is evident among Kuwaiti adolescent males at the age of 15-17 years when compared with UK adolescents.

Distribution of waist circumference and abdominal obesity

Male adolescents had higher waist circumference than females. Waist circumference increased with age in both genders. At the age of 12, 13 and 16 years, males had higher percentages in the $\geq 90^{th}$ waist circumference percentile. For girls, at the ages of 14, 15 and 17 had higher percentages in the $\geq 90^{th}$ waist circumference percentile. This study found significant gender differences in the prevalence of abdominal obesity (defined as a waist circumference ≥90^{th} percentile) according to waist circumference, using the Jackson et al. waist circumference percentiles (250). The overall prevalence of abdominal obesity in this study was highest at the age of 13 years for males (13%); the percentage of females with abdominal obesity was highest at the age of 14 years (10%). Findings in this study are corroborated with the results of the Jackson et al. study that established the waist circumference percentiles specifically for Kuwaiti children and adolescents, reveals similar results (250). The Jackson et al. study found that significant gender differences existed in the prevalence abdominal obesity and that the percentage of males with abdominal obesity was higher than that of females at most ages (250). The average percentage of males with abdominal obesity in the age range of 5-18 years was 12% and for females was 8% (250). In addition, the study by Jackson et al. (250) included a wider age range beginning with children as young as 5 years old (250).

With regard to the gender differences in waist circumference and the prevalence of normal and abdominal obesity, the findings in this study are somewhat similar to those in neighbouring countries in the Middle East and in Western countries. A recent study assessed cardiometabolic risk factors among Saudi children and adolescents reported significant gender differences in waist circumference and the prevalence of normal and abdominal obesity (256). The Saudi study reported the overall prevalence of abdominal obesity as 31% and the higher rate in females than males (40% versus 24%, respectively) (256). While the overall percentage of abdominal obesity reported in the study is somewhat similar to that in this study, a possible explanation for the discrepancy in the percentage of abdominal obesity by gender between this study and the Saudi study is the cut-off used to define abdominal obesity. The Saudi study used the de Ferranti et al. (257) cut-off, which defined abdominal obesity at ≥75^{th} percentile and included a wider age range (6-17 years old) (256, 257). The differences pertaining to the characteristics of the samples, including differences in PA, SB and dietary habits, puberty timing and genetic admixtures may also explain the discrepancy between the findings in this study and those in the Saudi study. Studies conducted in America and Canada have found gender differences in the prevalence of central obesity and higher waist circumference percentiles in male children and adolescents than in female adolescents at most ages (258, 259).

This study found the highest percentage of participants with central obesity was among 13 year old boys (37%), but for girls, 12 year olds had the highest percentage of abdominal obesity (10 %). For both boys and girls the percentage of participants with abdominal obesity more or less started to decline with age (except at the age of 16). These findings are similar to those of the previous study conducted in Kuwait, which reported that, while the percentage of male children who have abdominal obesity remained more or less constant, there was a substantial decrease in the percentage of girls with a waist circumference in the ≥90th percentile (250). These findings may be attributed to gender related maturation.

6.5.2 The distribution of blood pressure

The analyses exploring the distribution of BP among adolescents showed males had relatively higher systolic BP levels compared to females. These findings are supported by previous studies. A study conducted in Tunisia to examine BP and associated factors systolic BP was higher among Tunisian boys (260). The maximum percentile values, among males were at the age of 15 & 17 years, whilst in females the values were highest at 14 & 15 years. A recent systematic review examining the prevalence of high BP among 122,053 adolescents reported results of meta-regression analyses, whereby the pooled-prevalence of high BP was 11.2%, 13% for boys, and 9.6% for girls (261). The review highlights that the heterogeneity in the estimates of high BP among boys is attributed to dissimilar methods of BP measurement and depended on the year in which the survey was carried out (261). Despite these inconsistencies, the data indicates that high BP is more prominent among boys than girls, and that the technique of BP measurement plays an significant role in the overall heterogeneity of the high BP estimation distributions, predominantly in boys (261).

6.5.5 Strengths, limitations and implications of the study

The present study has several strengths: it is the first study in Kuwait and the Middle East that described three different adiposity indices. In addition to covering a wide age range, the study utilised the Jackson et al. (250) age and gender specific waist circumference percentiles established for Kuwaiti adolescents. Furthermore, this study provides a unique insight into the adiposity profiles and BP levels among Kuwaiti adolescents. At the same time, this study has several limitations. Unlike BMI, there are no established, standardised body fat reference curves. The cut points used to define over-fat and obesity according to body fat percentage are derived from studies involving Caucasian children and adolescents (58), therefore, may not be applicable to Kuwaiti youth. Similarly, there are no BP reference curves established for the child or adolescent population in Kuwait. Blood pressure reference curves for children and adolescents are age, gender and height specific. Consequently, existing child and adolescent BP reference curves (derived from studies conducted in Western countries) are inappropriate for use among children and adolescents in Kuwait. The findings in this study and the limitations presented imply that researchers interested in assessing adiposity and BP among children and adolescents in Kuwait or the Middle East would greatly benefit from establishing standardised reference curves for body fat percentage and BP. If established, these reference curves would allow researchers to make use of valuable, fairly inexpensive and accessible tools to measure adiposity and BP. Moreover, it would improve the interpretation and understanding of the adiposity and BP profiles of youth in Kuwait.

6.5.6 Conclusion

Overweight and obesity are highly prevalent among adolescents in this study, compared with other countries in the Middle East, the Arab region and around the world. The next chapter examines some of the potential explanations for the high levels of overweight, obesity and blood pressure amongst Kuwaiti adolescents by investigating the associations between these and PA and SB.

Chapter 7: The association of physical activity, sedentary behaviour with adiposity and blood pressure

7.1 Introduction

The rise in the prevalence of obesity among children and adolescents is a public health issue that is well documented (262). Obesity is linked to several chronic conditions including hypertension, insulin resistance, dyslipidaemia and pulmonary problems (10, 11, 263). Cardiovascular disease is the leading cause of death among adults in Kuwait (74). The rise in the prevalence of obesity among young people have been largely attributed to environmental and behavioural factors (5, 264).

A recent study conducted in the US assessing obesity, abdominal obesity, PA and caloric intake suggested that obesity and abdominal obesity were associated with reduced PA rather than increased caloric intake in adults (265). Similarly, a consequence of obesity is a reduction in the daily PA performed by children and adolescents (266). Although there is accumulating evidence to suggest that PA may have beneficial effects on the risk factors of cardiovascular disease (metabolic syndrome components) in youth (267), a recent systematic review has suggested that more evidence is needed to support the view that excessive body weight is a cause or effect of reduced levels of PA (101).

There is growing concern that SB has an adverse effect on the current and prospective health of young people (103). Although the existing evidence is inconsistent, current literature suggests that self-reported screen time is associated positively with adiposity (107, 268, 269). Other studies suggest that accelerometer based sedentary time is associated with adiposity, but this association is not independent of MVPA (108, 270).

The few studies that have examined the association between PA and SB with adiposity in the Middle East vary with respect to methodology and critical findings (98, 112). The studies rely solely on self-reported measures of PA and SB. Methodological discrepancies and the limitations of self-reported measures are possible explanation for the inconsistencies seen in the literature relating PA, SB with adiposity. Therefore building on this evidence, more research (accelerometer based PA, SB and multiple adiposity indices) is warranted to elucidate the association of PA, SB and adiposity among adolescents in the Middle East. To address gaps in the literature, the association between PA, SB with three adiposity indices and BP is presented in this chapter.

7.2 Objectives and hypotheses

7.2.1 Objectives

1. To examine the association between PA and the different indicators of adiposity among school age adolescents in Kuwait.
2. To examine the association between SB and the different indicators of adiposity among school age adolescents in Kuwait.
3. To examine the association between PA with blood pressure.
4. To examine the association between SB with blood pressure.

7.2.2 Hypotheses

1. PA is inversely associated with adiposity among adolescents.
2. SB is associated with adiposity among adolescents independent of PA.
3. PA is inversely associated blood pressure among adolescents.
4. SB is associated with blood pressure among adolescents independent of PA.

7.3 Method

7.3.1 Study design, participants and sampling procedure

For information on the design, recruitment and sampling procedure, refer to the general methodology chapter (Chapter 3, section 3.1, page 72).

7.3.2 Data collection

For detailed information on data collection, refer to the general methodology chapter (Chapter 3, section 3.3, pages 78-83 and section 3.5, pages 92-98) and is summarised in the following sections.

7.3.3 Data processing

Questionnaire-derived physical activity and sedentary behaviour variables:
For details on the questionnaire-derived MVPA and SB variables, refer to Chapter 4, section 4.3.3, page 103-104

Accelerometer-derived physical activity and sedentary behaviour variables:
For details on accelerometer-derived MVPA and SB variables, refer to Chapter 4, section 4.3.3, page 104).

BMI status derived variable:
Refer to Chapter 6, section 6.3.3, page 167-168, for details on BMI derived variable

Body fat composition derived variable:
Refer to Chapter 6, section 6.3.3, page 168, for information on BFP derived variable

7.3.4 Statistical analyses

Key descriptive statistics

The data were explored to assess the distribution of categorical or continuous variables. First, to describe the SHAAK variables used in this study, frequencies and percentages were used for the categorical variables and median and inter-quartile range for the continuous variables. Gender differences were assessed by Chi-square for the categorical variables and by Mann-Whitney for the continuous variables.

Statistical approach to explore possible confounders

Bivariate correlations were used to determine whether there were any baseline differences across the study's conditions in terms of sociodemographic, health-related variables as well as adiposity and BP measures (271). The Spearman Rho and its two-tailed p-value were used to assess the correlation between certain potential confounders associated with the adiposity indices and with blood pressure.

Multiple linear regression analysis:

To examine the association between each of the adiposity indices and blood pressure with MVPA or SB, multiple linear regression analyses were performed to determine the linear trend p values. Preliminary 1-way analysis of variance analyses revealed significant gender interactions between sex and each adiposity measure and BP, therefore, all analyses were stratified by sex. Prior to analysis, regression assumptions were checked. To improve normality, skewed variables were log transformed before analysis (accelerometer based MVPA) and outliers outside four standard deviations from the mean were removed (47 cases).

The potential confounding variables shown to be associated with exposures and outcomes were controlled for. To determine whether MVPA was associated with each of the adiposity indices and BP, a series of linear regression models was run, with socio-demographic factors, dietary habits and lifestyle factors incrementally adjusted for in sequence to allow for the impact of each group of factors on the association between MVPA and adiposity (or BP) to be documented. To minimise the effects of collinearity and before multiple linear regression, the Spearman Rho and its two-tailed p-value were used to assess the correlation between certain explanatory variables (e.g. age and school grade or fresh fruit and fresh fruit juice) associated with the adiposity indices and with BP. If the bivariate correlations were strong ($r = 0.7$-0.9), one demographic (e.g. age) or one variable in dietary habits (e.g. fresh fruit portions) was used in the model (see correlation matrix results, Appendix 11).

Statistical models were run for each outcome variable (BMI, body fat percent, waist circumference and systolic BP) and exposure (fruit portions, vegetable portions, smoking, SES status, MVPA and SB). Models were also adjusted for accelerometer wear time.

The first model included MVPA minutes per day, age, gender and accelerometer wear time (for models with accelerometry as the main exposure variable). The second model included all of the variables in the first model plus portions of fruit and vegetables per day, SES status and smoking (cigarettes per week). The third model included all of the variables from the second model plus accelerometer based SB as appropriate. The analyses were repeated with SB as the main exposure variable to determine whether SB was associated with each of the adiposity indices (repeated with systolic BP as the outcome variable). Results are presented as unstandardized regression coefficients (B) and 95% confidence intervals (C.I.).

Statistical models were also run for each outcome variable (BMI, body fat percent, waist circumference and systolic BP) and accelerometer based counts per valid minute as the exposure, the results of the analysis are presented in Appendix 12.
Statistical significance was set at the 5% level in all analyses.

7.4 Results

For details on response rate and missing data, refer to Chapter 3, section 3.1, page 72.

7.4.1 Descriptive statistics of the study variables

Descriptive statistics of the variables are presented in Table 7.1. Approximately 90% of participants were non-smokers, while 7% of the males smoked more than six cigarettes per week. Two or more servings of fruit and vegetables were consumed by a similar percentage of participants per day, 19% and 20% respectively. With the exception of smoking, soft drink consumption, BMI, waist circumference, BP and accelerometer based MVPA and SB, girls and boys were similar in each of the other variables.

Table 7.1 Descriptive statistics of the study variables by gender (n=589)

Categorical variables	[a]	Male n (%)	Female n (%)	p
Smoking habit	[39]			0.01*
I have never smoked		175 (66.5)	268 (93.4)	
Tried once before		35 (13.3)	17 (5.9)	
Used to smoke but no longer do		28 (10.6)	2 (0.7)	
1 – 6 cigarettes per week		6 (2.3)	0 (0.0)	
More than 6 cigarettes per week		19 (7.2)	0 (0.0)	
Frequency of fruit consumption per day (not including juice)	[24]			0.24
I do not know		47 (17.3)	46 (15.7)	
Less than once per week		29 (10.7)	38 (13.0)	
Less than once per day but more than once per week		59 (21.7)	45 (15.4)	
Once per day		92 (33.8)	102 (34.8)	
Twice or more per day		45 (16.5)	62 (21.2)	
Frequency of vegetables consumption per day (not including potatoes)	[24]			0.36
I do not know		47 (17.3)	33 (11.3)	
Less than once per week		37 (13.6)	40 (13.7)	
Less than once per day but more than once per week		44 (16.2)	50 (17.1)	
Once per day		91 (33.5)	108 (36.9)	
Twice or more per day		53 (19.5)	62 (21.2)	
Frequency of fruit juice intake per day (not including nectar based juice)	[26]			0.29
I do not know		41 (15.1)	56 (19.2)	
Less than once per week		25 (9.2)	38 (13.1)	

Less than once per day but more than once per week		49 (18.0)	52 (17.9)	
Once per day		81 (29.8)	73 (25.1)	
Twice or more per day		76 (27.9)	72 (24.7)	
Frequency of soft drink consumption per day	[9]			0.04*
I do not know		32 (11.9)	25 (8.5)	
Less than once per week		38 (14.1)	57 (19.4)	
Less than once per day but more than once per week		58 (21.6)	69 (23.5)	
Once per day		86 (32.0)	67 (22.8)	
Twice or more per day		55 (20.4)	76 (25.9)	
Continuous variables	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Age (years)	[17]	15.0 (3.0)	14.0 (3.0)	0.24
BMI	[12]	24.6 (10.3)	23.4 (7.7)	0.01*
Waist circumference (cm)	[21]	83.2 (26.6)	76.5 (16.5)	0.01*
Body fat percentage	[5]	40.1 (17.9)	40.3 (13.5)	0.35
Systolic blood pressure (mmHg)		117.0 (21.0)	101.0 (16.0)	0.01*
Accelerometer based physical activity and sedentary behaviour	**[a]**	**Median (IQR)**	**Median (IQR)**	**p**
Moderate to vigorous physical activity minutes/day	[121]	19.0 (20.6)	8.8 (10.9)	0.01*
Sedentary hours/day	[121]	8.4 (2.2)	9.5 (2.2)	0.01*

[a] value represents number of participants with missing or invalid data for given variable (%) percentage within gender

*Significant gender difference at p <0.05 assessed by chi-square for categorical, and by Mann-Whitney U test for continuous variables IQR: Inter-quartile range

7.4.2 Association of MVPA with adiposity indices and blood pressure

Table 7.2 presents the multivariable-adjusted associations between accelerometer based MVPA and three adiposity indices in boys. Accelerometer based MVPA was not associated with the BMI, body fat percentage or waist circumference.

Table 7.2 Multivariable-adjusted associations between moderate-to-vigorous-physical activity and adiposity outcomes in boys

	Model 1	**Model 2**	**Model 3**
Moderate-to-vigorous physical activity	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
	BMI Score outcome		
Accelerometer-based moderate-to-vigorous physical activity† minutes/day	-0.79 (-3.66, 2.08)	-0.75 (-3.66, 2.17)	-0.42 (-3.49, 2.65)
	Body fat percentage outcome		
Accelerometer-based moderate-to-vigorous physical activity † minutes/day	-0.20 (-0.27, 1.85)	-0.11 (-0.42, 1.97)	0.75 (-0.35, 2.04)
	Waist circumference outcome		
Accelerometer-based moderate-to-vigorous physical activity † minutes/day	-1.72 (-5.55, 1.11)	-1.80 (-5.45, 1.15)	-1.66 (-6.02, 1.35)

†Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05 Beta coefficient represent change in the outcome per minute of the exposure variable Accelerometer based MVPA variables are log transformed
Model 1:adjusted for, age, accelerometer wear time and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score
Mode l 3: included variables from the second model plus accelerometer based SB
(n=205) : accelerometer based linear regression

Table 7.3 presents the multivariable-adjusted associations between accelerometer based MVPA and three adiposity indices in girls. Accelerometer based MVPA was not associated with the BMI, body fat percentage or waist circumference.

Table 7.3 Multivariable-adjusted associations between moderate-to-vigorous-physical activity and adiposity outcomes in girls

	Model 1	Model 2	Model 3
Moderate-to-vigorous physical activity	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
	BMI Score outcome		
Accelerometer based moderate-to-vigorous physical activity † minutes/day	-0.69 (-2.58, 1.19)	-0.52 (-2.50, 1.45)	-1.00 (-3.15, 1.15)
	Body fat percentage outcome		
Accelerometer based moderate-to-vigorous physical activity † minutes/day	-0.51 (-3.67, 2.65)	-0.19 (-3.41, 3.02)	-0.99 (-4.48, 2.50)
	Waist circumference outcome		
Accelerometer based moderate-to-vigorous physical activity† minutes/day	0.92 (-1.16, 3.00)	0.02 (-1.99, 3.03)	-1.13 (-1.48, 3.23)

†Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05
Beta coefficient represent change in the outcome per minute of the exposure variable
Accelerometer based MVPA variables are log transformed
Model 1:adjusted for, age, accelerometer wear time and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score
Model3: included variables from the second model plus accelerometer based sedentary behaviour
(n=228) : accelerometer based linear regression

Table 7.4 presents the multivariable-adjusted associations between accelerometer based MVPA and systolic BP level (mmHg). Accelerometer based MVPA was not associated with systolic BP level (mmHg). Age and smoking were significant in all the models with accelerometer based MVPA.

Table 7.4 Multivariable-adjusted associations moderate-to-vigorous-physical activity and systolic blood pressure outcome in boys and girls

	Model 1	**Model 2**	**Model 3**
	Boys		
Moderate-to-vigorous physical activity	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based moderate-to-vigorous physical activity† minutes/day	0.90 (-4.14, 5.95)	1.30 (-3.68, 5.29)	2.26 (-2.99, 7.51)
	Girls		
Moderate-to-vigorous physical activity	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based moderate-to-vigorous physical activity† minutes/day	0.30 (-3.36, 3.97)	0.38 (-3.45, 4.21)	1.28 (-2.93, 5.49)

†Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05
Beta coefficient represent change in the outcome per minute of the exposure variable
Accelerometer based MVPA variables are log transformed
Model 1: adjusted for age, height and accelerometer wear time
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score.
Model3: included variables from the second model plus sedentary behaviour or accelerometer based sedentary behaviour as appropriate
(n=205) : for accelerometer based linear regression in boys, (n=211): for accelerometer based linear regression in girls

7.4.3 Association of sedentary behaviour with adiposity indices and blood pressure

Table 7.5 presents the multivariable-adjusted associations between accelerometer based SB and three adiposity indices in boys. Accelerometer based SB was not associated with BMI, body fat percentage or waist circumference. Age was significant in all models with BMI and body fat percentage for accelerometer based SB models.

Table 7.5 Multivariable-adjusted associations between sedentary behaviour and adiposity outcomes in boys

	Model 1	**Model 2**	**Model 3**
Sedentary behaviour	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
	BMI Score outcome		
Accelerometer-based sedentary behaviour† minutes/day	0.01 (-0.01, 0.01)	0.00 (-0.00, 0.01)	0.00 (-0.01, 0.01)
	Body fat percentage outcome		
Accelerometer-based sedentary behaviour† minutes/day	0.00 (-0.00, 0.01)	0.00 (-0.01, 0.01)	0.00 (-0.01, 0.02)
	Waist circumference outcome		
Accelerometer-based sedentary behaviour† minutes/day	0.02 (-0.02, 0.05)	0.02 (-0.02, 0.05)	0.01 (-0.01, 0.05)

†Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05
Beta coefficient represent change in the outcome per minute of the exposure variable for models
Model 1: Independent variables were sedentary behaviour minutes per day, age, accelerometer wear time and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score.
Model 3: included variables from the second model plus accelerometer based MVPA as appropriate, (accelerometer based MVPA variables are log transformed)
(n=205) : for accelerometer based linear regression

Table 7.6 presents the multivariable-adjusted associations between accelerometer based SB and three adiposity indices in girls. Accelerometer based SB was not associated BMI, body fat percentage or waist circumference. Age was significant in all models with BMI and body fat percentage.

Table 7.6 Multivariable-adjusted associations between sedentary behaviour and adiposity outcomes in girls

	Model 1	**Model 2**	**Model 3**
Sedentary behaviour	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
		BMI Score outcome	
Accelerometer-based sedentary behaviour† minutes/day	0.01 (-0.01, 0.01)	0.01 (-0.01, 0.01)	0.01 (-0.01, 0.01)
		Body fat percentage outcome	
Accelerometer-based sedentary behaviour† minutes/day	0.01 (-0.02, 0.02)	0.01 (-0.02, 0.02)	0.01 (-0.02, 0.02)
		Waist circumference outcome	
Accelerometer-based sedentary behaviour† minutes/day	-0.01 (-0.02, 0.01)	-0.01 (-0.03, 0.01)	-0.01 (-0.03, 0.01)

†Linear regression for participants with 1 valid day accelerometry data *Significant p value <0.05
Beta coefficient represent change in the outcome per minute of the exposure variable for models using accelerometer based
Model 1: Independent variables were sedentary behaviour minutes per day, age, accelerometer wear time (for models with accelerometer based variables as main exposure) and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score.
Model 3: included variables from the second model plus accelerometer based MVPA as appropriate, (accelerometer based MVPA variables are log transformed)
(n=228) : for accelerometer based linear regression

Table 7.7 presents the multivariable-adjusted associations between accelerometer based SB and systolic BP level (mmHg) in boys and girls. Accelerometer based SB was not associated with systolic BP. Age was significant in all models with systolic BP for accelerometer based SB models.

Table 7.7 Multivariable-adjusted associations between sedentary behaviour and systolic blood pressure outcome in boys and girls

	Model 1	**Model 2**	**Model 3**
	Boys		
Sedentary behaviour	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based sedentary behaviour † minutes/day	0.01 (-0.01, 0.02)	0.01 (-0.01, 0.02)	0.01 (-0.01, 0.03)
	Girls		
Sedentary behaviour	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based sedentary behaviour † minutes/day	0.01 (-0.01, 0.02)	0.01 (-0.01, 0.02)	0.01 (-0.01, 0.02)

†Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05
Beta coefficient represent change in the outcome per minute of the exposure variable for models using accelerometer
Model 1: adjusted for age, height and accelerometer wear time
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score.
Model3: included variables from the second model plus self-reported MVPA or accelerometer based MVPA as appropriate.
(n=205) : for accelerometer based linear regression in boys, (n=211): for accelerometer based linear regression in girls

7.5 Discussion

7.5.1 Association of moderate-to-vigorous physical activity with adiposity

Association of MVPA with BMI

This study found that accelerometer based MVPA was not associated with the BMI in boys or girls. The findings in this study are somewhat different from the results shown in other studies (conducted mostly in Western countries). A systematic review aimed at investigating the effect of PA on levels of adiposity in adolescents suggested that most observational studies showed that PA had a significant negative association with BMI (272). Although the review suggested that few experimental studies did show a favourable effect of PA on adiposity, it reported also that in some studies these outcomes depended on gender and ethnicity (272). Therefore, the review concluded that the current literature was sparse; most studies using self-reported PA had methodological limitations, including but not limited to the units of measurement used to calculate MVPA (metabolic equivalents, minutes of MVPA, kilocalories, etc.) and that there was a social desirability bias (272). As a result, the dose-response effect of self-reported PA practice on the BMI remains unclear.

The present study found that accelerometer based MVPA was not associated with the BMI. A recent systematic review to assess the associations between objectively measured habitual PA and adiposity in children and adolescents has suggested that cross-sectional studies (conducted mostly in Western countries) consistently report significant, negative associations between objectively measured PA and adiposity (78% of the studies) (102). The studies included in the review point to 'strong evidence' that an association exists with higher levels of habitual PA being associated with lower measures or indices of adiposity (102).

Discrepancies between the findings in this study and other cross-sectional studies conducted in the West may result from the differences in the levels of PA adolescents engage in, geographical locations between the studies, differences in the sample characteristics, methodological differences such as the accelerometer device used, the different cut off points used, classification of non-wear time, etc. and the statistical analyses used to examine the association between PA and BMI. In addition, the systematic review has suggested that publication bias may have influenced the literature with regard to the associations between habitual PA and adiposity in young people (102).

Studies conducted in Kuwait and its neighbouring countries report dissimilar findings to this study. Al-Haifi et al. (98) recently in a study that assessed the relative contributions of PA, SB, and dietary habits to the prevalence of obesity among Kuwaiti adolescents (98). The study suggested that self-reported MVPA was negatively associated with overweight and obesity (defined according to BMI) for both males and females (98). Both this study and the Kuwaiti study used the same reference to define overweight and obesity among adolescents (Cole et al. (42)) and similar questions to assess self-reported MVPA. However, a possible explanation for the discrepancy between the findings in this study and the other study may result from differences in the statistical analyses. Whereas this study examined the association of self-reported MVPA with BMI while adjusting for a series of potential confounders of MVPA and BMI including age, gender, SES status and portions of fruit and vegetables, the Al-Haifi et al. study examined the univariate association between self-reported MVPA and BMI and did not adjust for potential confounders of MVPA and BMI (98).

A recent study conducted in Iran to estimate the prevalence of overweight and obesity and their association with self-reported PA among Iranian adolescents aged 12-17 years has suggested that moderate self-reported levels of leisure-time and sport PA were positively associated with overweight and obesity (86). Discrepancies between the findings in this study and the Iranian study may result from methodological differences, such as the questions used to assess MVPA and the reference used to define the BMI score. To define overweight and obesity, the Iranian study used CDC reference data which may not have been suitable to apply to a Middle Eastern population (86). In addition, the Iranian study used the Baecke questionnaire (a questionnaire devised to estimate habitual PA among adults) to collect data on PA and it may have not been appropriate for use among adolescents (87).

Association of MVPA with body fat percentage

This study found that accelerometer based MVPA was not associated with the percentage of body fat percentage. The findings in this study are supported by a systematic review that examined objectively measured PA and fat mass in children (273). The meta-analysis of prospective studies suggest no association between objectively measured PA and fat mass after adjustment for bias (pooled correlation was -0.01, 95%CI: -0.18-0.16) (273). The meta-analysis concluded that objectively measured PA is not a key determinant of weight gain children (273). Another systematic review aimed at investigating the effect of PA on levels of adiposity in adolescents suggested that according to most observational studies PA had a significant negative association with adiposity, including the body fat percentage (272). The intervention studies not only studied PA but also examined other factors such as diet, therefore, the actual impact of PA and duration and frequency required to achieve beneficial results remains vague (272). The main limitations relate to a lack of validity in the measurement of both PA and body fat composition (272). The systematic review found that, on the basis of the current available evidence, the literature offers limited support for a causal link between MVPA and body fat composition in adolescence.

Accelerometer based MVPA was not associated with the body fat percentage. A recent systematic review which included studies conducted mostly in Western countries examined the associations between objectively measured habitual PA and adiposity in children consistently reported significant, negative associations between objectively measured PA and adiposity (102). When the systematic review classified the results by outcome measure, significant negative associations between habitual PA and adiposity were found in 76% of the studies that used more precise body composition methods, such as bio-impedance and DEXA, as opposed to 81% of studies that used simple proxies for adiposity, such as BMI as their outcome measure (102).

A possible explanation for the discrepancies between the findings in this study and other cross-sectional studies conducted primarily in the West may result from the differences in PA levels, cultural differences, differences in the sample characteristics, methodological differences such as the accelerometer device used, different cut off points used, classification of non-wear time, etc. and the statistical analyses used to examine the association between MVPA and body fat percentage.

Association of MVPA with waist circumference

The analyses revealed that and accelerometer based data was not associated with waist circumference in boys and girls. The findings in this study differ from a recent study that assessed accelerometer based MVPA and cardiometabolic risk factors in children and adolescents (100). The study used pooled data from 14 studies covering 20,871 children aged 4-18 years of age from the International Children's Accelerometry database (100). The study suggested that the total minutes per day spent on MVPA were negatively associated with waist circumference (100). A recent systematic review to examine the associations between objectively measured habitual PA and adiposity in children and adolescents suggested that cross-sectional studies (primarily in Western countries) consistently reported significant negative associations between objectively measured PA and adiposity (including waist circumference) (274).

A study conducted in Iran to determine the association of PA and metabolic syndrome (including waist circumference) in a large nationally representative sample of children aged 6-18 years suggested that the prevalence of metabolic syndrome (including waist circumference) was higher in those subjects with lower PA (15.1% vs.14.2% and 13.1%, respectively in the 1st, 2nd and 3rd tertiles of PA) (275). A likely explanation for the inconsistency between the findings in this study and the Iranian study are methodological differences, including the questions used to estimate PA among adolescents, the reference data used to define waist circumference adiposity and differences in the sample characteristics. The Iranian study assessed PA by a scaled questionnaire organized into nine different metabolic equivalent (MET) levels ranging from sleep/rest (0.9 METs) to high-intensity physical activities (16 METs) prepared by Aaddahl et al. to estimate PA among adults (275, 276). Furthermore, the Iranian study defined metabolic syndrome (including waist circumference) on the basis of criteria analogous to those of adults (275, 277).

7.5.2 Association of moderate-to-vigorous physical activity with systolic blood pressure

Accelerometer based MVPA was not associated with systolic BP level (mmHg) in this study. The findings in this study are not supported by a recent study assessing accelerometer based MVPA and cardiometabolic risk factors (including systolic BP) in children and adolescents (100). The study suggested that MVPA (minutes per day) was negatively associated with systolic blood pressure (100). An explanation for the inconsistency between the findings in this study and those in the International Children's Accelerometry Database study lies in possible methodological differences, including the classification of non-wear time (60 minutes of consecutive zeros, allowing for 2 minutes of nonzero interruptions), and the minimum number of minutes required for a day to be considered valid (500 minutes) (100). Furthermore, the study pooled accelerometry data from studies conducted in Australia, Brazil, USA and Europe, hence, the difference in levels of PA and differences in the sample characteristics may explain the discrepancies between the findings in this study and those in the International Children's Accelerometry Database study (100).

7.5.3 Association of sedentary behaviour with adiposity

Association of SB with BMI

In this study accelerometer based SB was not associated with BMI. The outcomes in this study do not coincide with the findings from studies conducted mainly in Western countries, which suggest that self-reported SB has a positive association with BMI (106, 278). A recent systematic review assessing SB and health indicators in school-aged youth, suggested a dose-response association between higher SB and adverse health outcomes (including BMI) in girls and boys (through qualitative analysis of 232 studies) (103). A literature review that included cross-sectional, longitudinal and interventional studies among children and adolescents (aged 2-18 years), suggested that 15 of the 27 cross-sectional studies (including youth above the age of ten years), found a positive association between TV and the risk of overweight/obesity in both sexes and three studies reported a positive association between TV or video games only in girls (105). The review emphasised the importance of methodological issues that may explain the lack of association in some studies and the development of a common definition of SB to be used in future studies that will allow the comparison of SB in different countries (105).

A meta-analysis that examined the association between screen time (media use), adiposity in children and youth suggested that based on data from 52 samples, a fully corrected, sample-weighted, effect size between TV viewing and adiposity was 0.066 (Pearson r) (279). The meta-analysis study recognized that a relationship appears to exist between TV viewing and body fatness, however, that it is possibly too small to be of significant clinical relevance (279).

A study of the association between indicators of screen time and adiposity indices in Portuguese children suggested that TV viewing for more than two hours per day was associated with adiposity (according to BMI score) (107). The study is supported by other studies conducted mainly in Western countries that examined the association of self-reported SB and adiposity (23, 278). The study concluded that utilising a single measure of adiposity (for example BMI) or a single measure of SB (for example TV viewing) may be behind the null association seen between SB and adiposity in some studies (107).

The results in this study are consitent with those in a recent study to assess the relative contribution of self-reported SB to the prevalence of obesity (according to BMI) among adolescents aged 14-19 years (98). The Kuwaiti study suggested that SB such as watching TV and using the computer were not associated with overweight or obesity (98). A possible explanation may be that the Kuwaiti study used screen time alone as the measure of SB, which may not be an adequate marker of daily inactivity as previous studies have suggested (279). Inconsistent with the findings in the present study, a study to assess the dietary, lifestyle and socio-economic correlates of overweight and obesity in Lebanese children and adolescents suggested that self-reported SB was associated with overweight and obesity (280). However, the Lebanese study which used the WHO reference data to define overweight and obesity did not provide details of the questions used to estimate the SB of the participants (280).

The present study found that accelerometer based SB was not associated with BMI. The findings in this study are inconsistent to those studies conducted mainly in Western countries (128, 281, 282). A study from the USA about the association of SB and obesity in a large cohort of children suggested that, while SB was associated with obesity, this association ceased when 15 minutes of MVPA per day was additionally controlled for in the models (108). These findings suggest that SB was positively associated with obesity but that this association is not independent of MVPA (108). Discrepancies between the findings in this study and other cross-sectional studies conducted in the West may result from the systematic bias evident in this study, whereby, participant with higher SB time wore the accelerometer for longer periods. This may have reduced the variability of SB data among the participants and may help explain the lack of association between the accelerometer based SB and BMI. Furthermore, methodological differences such as the accelerometer device used, different cut off points used (the USA study used ≤199 cpm as the SB cut point), classification of non-wear time, etc. and the statistical analyses used to examine the association between SB and BMI may explain the discrepancy between findings in this study and other studies using objective measures of SB.

Association of SB with body fat percentage

The present study found that accelerometer based SB was not associated with body fat percentage. A recent systematic review aimed at investigating the effect of SB on levels of adiposity in adolescents suggested that most observational studies showed that SB had a significant positive association with adiposity including body fat percentage (278). Even though most of the studies reviewed showed the harmful effects of SB on body fat composition, the current literature on this issue is limited and methodological pitfalls are evident. The main limitations relate to a lack of validity in the measurement of both SB and body fat composition; the evaluation of confounders (such as MVPA) should also be considered (278). Furthermore, observational evidence between SB and adiposity often depends on the type of SB and the age groups studied (278) and the type of adiposity markers

(107). In addition, few studies have assessed the association of accelerometer based SB with body fat percentage (measured by bio-impedance). However, the findings in this study are supported by previous studies that have found minimal or no association between accelerometer based SB and body fat percentage (283, 284).

Association of SB with waist circumference

Accelerometer based SB was not associated with waist circumference in this study after adjustments of several confounding factors and independent of daily MVPA. Previous papers that studied the association of accelerometer based SB and cardiovascular risk (including waist circumference) are supported by the findings in this study (100). To date, the evidence linking accelerometer based SB with cardiometabolic risk (including waist circumference) among children and adolescents has been contradictory. Therefore it is unclear if an association exists only in some populations or if the inconsistencies are due to differing methodological or analytical methods. The evidence supporting the lack of an association between accelerometer based SB (100, 270, 282, 285) and cardiometabolic risk appears to be stronger than the evidence supporting a relationship (229, 286).

The findings in this study are supported to some extent by studies conducted in Kuwait and its neighbouring countries. A recent study conducted in Kuwait to assess the relative contributions of PA, SB, and dietary habits to the prevalence of obesity among Kuwaiti adolescents suggested that self-reported SB was not associated with waist circumference among Kuwaiti adolescents aged 14-19 years (98). Studies conducted of children and adolescents in Western countries suggest that there is consistent evidence of a relationship between SB (TV viewing and screen-time in particular) and adiposity (including waist circumference) (103).

7.5.4 Association of sedentary behaviour with systolic blood pressure

Accelerometer based was not associated with systolic BP level in this study. These findings are somewhat inconsistent with the findings from other studies conducted in mainly Western countries. The International Children’s Accelerometry Database study assessed the accelerometer based MVPA, SB and cardiometabolic risk factors and suggested that, while SB (in minutes per day) was significantly positively associated with systolic BP, this association was not independent of time spent in MVPA (100). A possible explanation for the incongruity between the findings in this study and the ICAD study lies in methodological differences including the different cut off points used to define MVPA (>3000 cpm), classification of non-wear time (60 minutes of consecutive zeros, allowing for 2 minutes of nonzero interruptions) and the minimum number of minutes required for a day to be considered valid (500 minutes) (100).

These findings are somewhat different from those in studies from neighbouring countries. A study conducted in the United Arab Emirates to determine the prevalence of metabolic syndrome and check the association of lifestyle factors with metabolic syndrome suggested that self-reported screen time (>two hours per day) had a positive association with metabolic syndrome (including BP) (118). Possible explanation for the difference between the findings in this study and the Emirati study include important methodological differences, such as the methods used to estimate SB. The Emirati study asked participants to estimate the time spent watching TV, on computer game use and video viewing for the past 30 days (118). In addition the Emirati study used the definition of high BP as ≥130/80 mmHg, which is the cut off used for adults (118). With regard to the statistical approach the Emirati study did not add MVPA as a potential confounder in the multi-variable adjusted model to investigate the association between self-reported SB and metabolic syndrome, which may have resulted in confounding bias, as previous research has suggested (100, 118). Another possible explanation for the inconsistency between the findings in this study and those of the Emirati study may be related to hormonal differences, such as testosterone and sex hormone binding globulin, between males and females, and differences in the sample characteristics (118).

7.5.5 Strengths, limitations and implications of the study

The present study has several strengths: it is the first study in Kuwait and the Middle East to use accelerometer based methods to assess the levels of PA and SB. This study differs from other studies in the Middle East in terms of both methodology and critical findings. In addition to covering a wide age range, this study provides a unique insight into the association of MVPA and SB with adiposity and BP.

At the same time, this study has several limitations. First, its cross-sectional design gives it limited ability to make causal inferences; second, it did not include students from all the governorates of Kuwait, thereby reducing the power of the study and limiting its representativeness. For accelerometer based measures, to maximize the use of the collected data this study included only participants with at least one valid day of accelerometry data. However, to get a better idea of children's and adolescents' PA and SB profiles, studies recommend including participants with at least 4 valid days of accelerometry data (224). As a result, the weekday and weekend PA and SB patterns were not differentiated, previous studies had advised (224). Moreover, accelerometer based sedentary time was correlated with accelerometer wear time and the uniaxial accelerometer used may not have differentiated between sitting and standing, thereby adding measurement error that attenuates the true associations. Pubertal development (a factor which influences physiological processes (225)) was not assessed.

7.5.6 Conclusion

Accelerometer based PA was not associated with adiposity or blood pressure in either sex in this study. Accelerometer based SB was not associated with any of the three adiposity indices in either sex. Accelerometer based MVPA was not associated with adiposity or BP. Even though findings in the present study are subject to critical interpretation, policymakers in Kuwait can make use of this information to develop effective interventions programs to reduce SB and promote PA among young people in Kuwait.

Chapter 8: Implications of this PhD work , future research directions, limitations and conclusions

8.1 Key findings, their implications and future research directions

This thesis sought to fill certain gaps in the existing literature. The thesis assessed four broad aims by evaluating a combination of PA and SB methods of assessment and by including three adiposity indices as well as BP. This chapter concludes the work by summarising the key findings, indicating possible lines for future research, highlighting the main limitations of the thesis and drawing some conclusions.

8.1.1 Adherence with wearing the accelerometers and the criterion validity of self-reported physical activity and sedentary behaviour against accelerometry

Measuring PA and SB is challenging particularly in young populations. Most of the studies relating PA and SB to obesity or other cardiovascular health outcomes have relied on self-reported PA and SB data. This however, is problematic, since adolescents are not as accurate in reporting their PA and SB levels as objective PA, SB measures are. To the best of the PhD candidate's knowledge, SHAAK is the first study to use accelerometry as an objective measure in assessing PA and SB among adolescents in the Middle East. The adherence to wearing the accelerometers and the correlates of accelerometer wear time were explored in Chapter 4. The analysis revealed that adherence with wearing the accelerometer is subject to gradual attrition as the measurement week progresses. The adherence rates of the participants varied from 63% for at least three days and 83% for at least one valid day. Participants with higher accelerometer based SB were more likely to meet the criteria for accelerometer wearing time. These findings have several implications.

First, accelerometry has a great potential as an objective measure of PA and SB in studies in the Middle East and can be used for children and adolescents in a wide age range. However, the adherence rates for wearing the accelerometer were lower than those in studies conducted in the West. This finding indicates that ways to improve accelerometer adherence need to be developed for future PA and SB research in the Middle East. Ways to improve adherence to wearing the accelerometers include the provision of incentives for participants who provide more than three of valid days accelerometer data, asking the parents and teachers to remind the participants and sending the participants an SMS message every morning (152, 287). In combination, these methods may prove to be more effective at raising the adherence to wearing the accelerometer, and hence, provide a better idea of the objectively measured habitual PA and SB of young people.

Chapter 4 examined the demographic, anthropometric and PA and SB correlates of accelerometer wear time. The analysis revealed moderate correlations between accelerometer based SB and accelerometer wear times in boys and girls. This research highlighted the risk of introducing a systematic bias to the study sample (a moderately positive correlation between average accelerometer wearing time and the average daily SB time), which impacted on the interpretation of the SB outcomes in subsequent chapters and possibly concealed the association between accelerometer based SB and adiposity or BP. Consequently, the research implies that exploring the characteristics associated with accelerometer wear time is valid, in view of the limited research available in the field.

It remains uncertain whether self-reported measures can be relied upon as evidence in the association of PA, SB and health outcomes. Current studies assessing the criterion validity in the Middle East between self-reported and objective PA and SB parameters are very limited; therefore, this aim was explored in Chapter 4. The data suggested that the self-reported MVPA questionnaire was not correlated with the accelerometer based MVPA. The data suggested a weak correlation between self-reported MVPA and total counts per valid day. Furthermore, the data showed that self-reported data had a weak correlation with the accelerometer based SB data. The findings in Chapter 4 corroborated previous findings that self-reported and objective measures of PA are incongruent (82). Although, the data highlight the need for accurate, valid measures of PA and SB, this should not be interpreted as support for the notion that self-reported PA data is invalid or unimportant. On the contrary, the research implies that self-reported and objective measures of PA and SB measure different aspects of PA and SB. A complex construct, PA encompasses different dimensions (including MVPA and PA energy expenditure), multiple contexts (for example transportation and occupation) and different types of PA such as muscle strengthening, aerobic and bone improvement (288). The complexity of this construct and the wide variety of applications for PA measurement in epidemiological, clinical and intervention research suggest that a single, comprehensive measure of PA may in fact not be achievable (288). While it is apparent that continued methodological research is essential, improvements are being made with approaches that combine self-reporting with objective measures, including accelerometers, heart rate monitoring (with the self-reporting of purpose and context in 'real time') and geographical location sensors (288). In the meantime, it is important for researchers using self-reported measures of PA in future studies, to understand that self-reported PA may not accurately reflect the details of behaviour being sought (288). These findings further corroborates that the assessment of SB requires more research. SB is multifaceted and to provide an overall estimate of time in SB, the combination of self-reporting, accelerometers/inclinometers and heart rate monitoring would be useful in future studies assessing SB (289).

8.1.2 Self-reported and objectively assessed physical activity and sedentary behaviour and their socio-demographic correlates

In recent years the literature concerned with the levels of PA and SB among adolescents in the Middle East has grown, but many gaps remain in our knowledge. Our current understanding of the reasons why some adolescents in the Middle East are more physically active than others or more sedentary than others is limited. Therefore, Chapter 5 aimed to describe the self-reported and accelerometer based PA and SB profiles of adolescents in Kuwait and examined the sociodemographic correlates of accelerometer based PA and SB.

Four hypotheses were tested, as reported in Chapter 5. The data supported the first two hypotheses. The school sample of Kuwaiti adolescents did not meet the PA recommendations and SB guidelines set out by international agencies. In fact, the accelerometer based PA levels were among the lowest of those that were compared to levels in Western countries. The data also supported the third hypothesis, since age had a positive association with accelerometer based SB. The fourth hypothesis was rejected since SES was not associated with PA or SB. These findings have important implications for PA and SB research in the Middle East, and for Kuwait in particular. Adolescence is a crucial stage where individuals develop their own behaviours and lifestyles, which track into adulthood (14). This research indicates that the PA and SB profiles of this sample of adolescents in Kuwait are grim and in need of major public health intervention. A major public health plan is needed to promote PA and reduce SB among adolescents in Kuwait particularly among older girls. First, the derived PA and SB profiles can act as a general template during the planning of the PA and SB intervention programme. In terms of total PA volume, the compliance of adolescents with the latest PA guidelines for young people is a realistic, PA-related goal. Particular domains of PA, such as transport may be target periods for the enhancement of PA. The importance of the time spent in school should also be emphasised, because research has shown that substantial amounts of PA can be performed during there (290). Research has suggested that, that all the various PA policies examined mandatory physical education, active commuting and classroom activity breaks have the greatest effect in promoting PA (290). The information generated from this research can be used by policymakers in Kuwait along with feasibility, population reach and cost estimates to identify the best options for PA promotion among young people in Kuwait. Moreover, policymakers in Kuwait ought to determine the potential barriers to PA in Kuwait. Several hurdles including various cultural norms in Kuwaiti society, the harsh climate and parental concerns may have played a crucial role in discouraging the levels of PA and encouraging SB among adolescents. Other potential barriers and feasible solutions may be ascertained through questionnaires and focus group discussions with parents, teachers and young people. Equally, an action plan should be devised to displace SB with more active substitutes or simply reduce the amounts of time spent on popular SB pursuits for example limiting TV viewing and computer use to less than two hours per day. Not only might this increase the opportunity to be more active but it might possibly impact on the pursuit of unfavourable dietary habits (291). Furthermore, the targeted profiling of distinct age groups (older adolescent girls) would permit a more efficient allocation of human and time resources during the PA and SB intervention programme. The current PA and SB levels of adolescents cause concern and the data underscore the need to explore other potential correlates of PA and SB.

The findings in this study have important implications for PA and SB research in the Middle East owing to the inconsistency of the self-reported and objective measures. In Chapter 5 it was evident that adolescents are inaccurate in their estimations of PA and SB when compared to objectively measured PA and SB. They both over-estimated (PA) and under-estimated (SB) when they self-reported these two totals compared with the data from accelerometer based PA and SB. These findings highlight the need for researchers studying PA and SB to be aware that the closeness of the relationship between self-reported PA, SB and health-related outcomes may be over-estimated (or under-estimated) in studies based on self-reporting.

8.1.3 Prevalence of adolescents overweight, obesity and the body fat percentage, waist circumference and blood pressure percentiles

Growing evidence suggests that obesity is increasingly prevalent in Arab countries including Kuwait. What are less evident are the studies evaluating the multiple indices of adiposity or cardiometabolic risk (BP). The lack of multiple measures of adiposity may provide an insight into the null associations between them and the PA and SB reported in recent studies. As a result, Chapter 6 described the prevalence of overweight and obesity and the distribution of adiposity using three indices of adiposity. The distribution of BP was also explored in Chapter 6.

In Chapter 6, the previous findings describing the prevalence of overweight and obesity in Kuwait were corroborated. In this sample of adolescents, the prevalence of overweight and obesity, compared to these in neighbouring countries, was among the highest. An urgent plan of action to combat and prevent obesity in Arab countries, most urgently Kuwait should be developed and implemented (7). Obesity has become a major public health problem in Kuwait, creating an economic and health burden on governmental services (33). The lack of PA and increasing rates of SB are implicated as more influential contributors to this problem (33). However, new high quality research is warranted, which examines the association of PA and SB with adiposity, using large, nationally representative samples, comprehensive, valid measures of PA, SB and several adiposity indices. In the present research body fat percentages and waist circumferences increased with age and were markedly higher among males. These findings emphasise that multiple indices of adiposity and BP are important markers of health and cardiometabolic risk factors among adolescents in Kuwait. Such relatively simple health indicators have potential use in clinical and epidemiological settings.

8.1.4 The association of physical activity, sedentary behaviour with adiposity and blood pressure

It is uncertain why there has been mixed support for the association between PA and SB and obesity or adverse cardiometabolic outcomes. One possible explanation is the difference in methods used to assess PA and SB. Growing evidence suggests that accelerometer based PA and SB measures are cross-sectionally linked to better health outcomes. Less understood are the specific health parameters that are associated with increased PA levels or reduced SB. Therefore, Chapter 7 aimed at exploring the association of PA with multiple indices of adiposity as well as BP. Furthermore, the association of SB (independent of PA) with the adiposity indices and BP was explored in Chapter 7. The analysis tested four hypotheses. The four hypotheses tested in Chapter 7 were rejected. These results corroborate previous observational and experimental findings. Taken together, not all the hypotheses were supported by the data. Nonetheless, this work has shed light on previously unexplored associations between objectively measured PA, SB measures. Current evidence suggests that the association between PA and SB and cardiometabolic health outcomes is equivocal (103, 292). Therefore, to decisively test the hypothesis that reduced PA and elevated SB time leads to adverse health outcomes in young people, researchers need to overcome several challenges (293). These include, designing methodologically sound, robust studies, improving the measurement of exposure and determining the effects of PA and SB (293). To surmount the first hurdle, it will be necessary to explore the short- and long- term effects of different SB patterns through controlled experimental study designs so as to update the intervention programmes concerning the maximum duration of intervals of SB, optimal length and intensity of the breaks in SB (293).

The second challenge is to measure adequately the time spent in PA and SB. This depends on the specific focus of the research, for example, whether it is concerned with sitting per se or with other specific types of SB (293). Currently most evidence describes SB based on self-reported TV viewing or screen time (TV and personal computer use) which is a poor indicator of total SB time in young people (104, 294). Accelerometers and inclinometers are objective measures of PA and SB which represent an advance in the research examining the association between PA and SB and health outcomes. However these devices do not discriminate between specific types of SB such as the use of computers or watching TV or reading. In addition, the evidence for a standard protocol for reducing accelerometer data is limited (295). This represents a major obstacle in finding the true association between PA and SB and adverse health outcomes and makes comparisons with other studies difficult (293).

The last obstacle to overcome, is finding whether SB is associated with negative health independent of PA. While several studies adjust for MVPA, few have adjusted for light PA (including the present study). Additionally, studies assessing SB ought to differentiate between different SB patterns. Studies that have assessed the association of SB with cardiometabolic risk factors among adults reveal uninterrupted, prolonged sitting to be the culprit associated with adverse health outcomes and not total SB time which may very well be the case for young people as well (293, 296, 297). The aforementioned concerns may very well be likely explanations for the null association between SB with adiposity and blood pressure found in the present study.

The poor exposure to daily MVPA among adolescents in Kuwait may very well be a possible explanation for the null association between PA with adiposity and BP found in the present study. This may be a result of several factors, including culturally related aspects (limited opportunities for PA, parental support for educational achievement) and the ease of acquiring technologically advanced gadgets (involving digital media). Although current research suggests inconsistent evidence on the association between SB and adverse health outcomes (293), in light of the findings in the present study, there may be no harm in developing guidelines to reduce SB (focusing most on leisure-time SB patterns) and policymakers in Kuwait should bear in mind the evidence gathered in the present study.

8.2 Methodological limitations

The findings in this study have to be interpreted in light of their limitations. First of all, this study is cross-sectional in design, so casual inferences cannot be made. Second, due to time constraints data, were not sought from all the governorates in Kuwait, thereby reducing the power of the study and its representativeness. Some of the analytical choices made in this study were data driven, namely the inclusion of participants with at least one valid day of accelerometer data in all the analyses. To obtain a better idea of habitual PA and SB among young people, previous studies recommend at least five to seven valid days (including one weekend day) of accelerometer data (139, 159). Furthermore, the study did not differentiate weekday and weekend patterns as advised by the previous literature (159). Future research should also consider the need to examine the importance of impact on health outcomes of all intensities of PA, above all light-intensity and standing, since individuals may be more willing to trade SB activities with standing or light-intensity activities and the rapid advance of objective measures of PA and SB shows potential in exploring daily PA in depth (298). The uniaxial accelerometer used in this study does not differentiate between sitting and standing, which may have affected SB outcomes. Last, pubertal development (a factor which influences physiological processes (225)) was for cultural reasons not assessed in this study.

8.3 Conclusions

This thesis attempted to shed light on previously unexplored aspects of the PA and SB of young people in Kuwait. Each of the chapters included in this thesis suggests a number of different avenues for future research. It is important to be aware that young people's estimation of PA and SB may be biased. However, combining different measures of PA and SB is more informative than relying on either one alone and is warranted for future studies assessing PA and SB levels among adolescents in the Middle East. More up-to-date ways of measuring PA, SB such as accelerometers have potential use in future studies in this region. The PA and SB levels evident in this study shed light on the importance of devising an immediate, action plan to promote PA and reduce SB levels among adolescents in Kuwait.

Chapter 9 : Epilogue

The Study of Health and Activity among Adolescents in Kuwait was a novel venture within the context of Kuwait and the Middle East. As this was the first study to use accelerometry to assess PA and SB, the project highlighted several key learning issues. The aim of this chapter is to outline the accelerometry related limitations and difficulties encountered throughout the research process. This chapter is divided into four sections. The first section describes the issues related to linking the accelerometer data with the participant. The second section covers the difficulties encountered during the accelerometer handling procedure. The third section outlines the issues of accelerometer turnover, adherence and retrieval. The last section submits some conclusions.

9.1 Linking the accelerometer data with the participant

During the initial months of the data collection, the researcher realised that the first method chosen to link the accelerometer data with the participants' self-administered questionnaire was flawed. To begin with, each accelerometer bore a sticker marked with the serial number of participant's questionnaire. Upon returning the accelerometer, the researcher would download the accelerometer data to the computer software and enter the questionnaire serial number manually in the file created for his/her data. This method proved faulty because it was noted that some participants returned the accelerometer without its serial number sticker. As a result, the researcher would refer to the document that contained the participant's name, the accelerometer device number (a number found encased inside the device) and the serial number of the questionnaire kept for accelerometer retrieval purposes. This method proved tedious and time consuming. For this reason, the day before the next school field visit, the researcher pre-recorded the questionnaires with their appropriate serial number and registered the same questionnaire serial number to the accelerometer during the initialisation process. Then the researcher placed the stickers with the designated serial numbers beside accelerometers so that each one would be handed to the participant whose serial number matched it. This method proved more efficient than the previous method had, because it relied on the sticker only on the day of the field visit and not for the linking process afterwards and it did not require the serial number to be retrospectively entered on the computer software. Researchers who contemplate a study using accelerometry in the Middle East may want to consider the issue of linkage, in particular if the sample size is large, and to make use of the solution suggested above.

9.2 Accelerometry handling issues

It was noted that the girls in particular were self-conscious about wearing the accelerometers over their clothing (as Middle Eastern culture requires). They preferred wearing the accelerometer under their clothing. Furthermore, the accelerometers continuously emitted flashes of light as a reminder, when they were taken off, to put them on again. However, the girls relayed that they were aware that the accelerometers were flashing under their clothing and did not like it. However, the flashing light can be turned off during the accelerometer initialisation process. Future researchers conducting PA studies in the Middle East may want to take this matter into consideration as well. It should be noted that, this concern applied to girls alone. It was not an issue with the boys, who had no problem with the accelerometers over or under their clothing and did not complain of the flashing light.

9.3 Accelerometer turnover, adherence and retrieval issues

Delays in the field work were primarily due to the long turnover rate of the accelerometers. According to studies conducted primarily in Western countries that use accelerometry, the turnover rate for accelerometers was anticipated to be two to three weeks. However, the findings in this study revealed that the turnover rate for accelerometers was at least three to four weeks. This may be due to the more relaxed and carefree nature of the students in Kuwait. Although the participants were reminded several times in the course of the data collection about the importance of returning the accelerometers on time, many failed to do so after one week. One solution for the poor accelerometer turnover rate was to increase the number of accelerometers and provide an incentive for any participant who returned theirs on time. The researcher had access at first to 60 accelerometers but this later (midway through data collection) increased to 120 accelerometers for the remainder of the study. Even so, despite the addition of the incentive and with double the number of accelerometers, the fieldwork for the sample size specified could not be completed within the given timeframe. In light of this, researchers attempting to conduct PA studies using accelerometry in the Middle East may wish to consider this issue and think about having a larger bank of accelerometers; or else they should attempt to reduce the turnover rate by other means.

Another difficulty encountered during the data collection was the low accelerometer adherence rate. The findings in this study revealed that the accelerometer adherence was lower than the adherence rates in studies conducted in Western countries. This was particularly apparent for adhering to it for seven days, the proposed wear time of the accelerometer. This study found that 11% had accelerometer data for seven valid days, which is a great deal lower than observations made in previous studies conducted in Western countries (where accelerometer adherence for seven valid days range from 50%-80%). Although the researcher added a midweek phone-call as a reminder to the participants to wear their accelerometers, future researchers may wish to think of adding a financial incentive to participants, earned by meeting the seven day wearing time criteria. Another solution that future researchers may consider is to involve the parents or the school in instilling the importance of wearing the accelerometer for the full week. This may entail awarding school merit marks to compliant participants or offering a financial incentive to schools or parents or both. It is worthwhile to experiment in future studies with these proposed solutions, to learn which ways of strengthening accelerometer adherence may work in Kuwait.

The last accelerometer related difficulty that the researcher faced during the data collection was returning the accelerometers on time. Studies conducted in Western countries tend to retrieve the accelerometers through the post or in boxes placed in the schools where participants could drop the accelerometers after use. However, before the present study began, these methods were both deemed unfeasible due to the unreliable state-run postal service in Kuwait and the impracticality of installing boxes in numerous classrooms in various schools. This issue was somewhat resolved by designating a series of school coordinators who would be responsible for the returning of the accelerometers. However, if a student repeatedly failed to return an accelerometer, the researcher was obliged to pay a visit to his/her home to retrieve it. Future researchers would do well to weigh up other options for dealing with this obstacle. Proposed solutions include involving the school and the parents after they had agreed to participate, by explaining to them before the data collection of the importance of adhering to the accelerometer wear time protocol and of returning of the devices on time. The study emphasised to the participants alone the importance of accelerometer adherence and return; hence, it may be inferred, that is future studies should also involve the schools and the parents.

9.4 Conclusion

As the first study to use accelerometry, this study found that it has great potential as an objective measure of PA and SB in studies based in the Middle East and may be used in a wide age range in children and adolescents. This work, within its limitations will contribute to a better understanding of the PA and SB patterns of young people. This chapter has set out some key accelerometry related issues learned during the research process and it is hoped, has provided an insightful view that help those who are considering a similar project in the same geographical and environmental setting.

References

1. Morris JN, Heady JA, Raffle PA, Roberts CG, Parks JW. Coronary heart-disease and physical activity of work. Lancet. 1953;265(6795):1053-7; contd.
2. Morris JN, Kagan A, Pattison DC, Gardner MJ. Incidence and prediction of ischaemic heart-disease in London busmen. Lancet. 1966;2(7463):553-9.
3. Janssen I, LeBlanc A. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. Int J Behav Nutr Phys Act. 2010;7:40.
4. Belanger M, Foster C. Worldwide prevalence of physical inactivity calls for worldwide actions. Prev Med. 2011;53(1-2):29-30.
5. Blair SN. Physical inactivity: the biggest public health problem of the 21st century. Br J Sports Med. 2009;43(1):1-2.
6. Bibiloni Mdel M, Pons A, Tur JA. Prevalence of overweight and obesity in adolescents: a systematic review. ISRN obesity. 2013;2013:392747.
7. Musaiger AO, Al-Mannai M, Tayyem R, Al-Lalla O, Ali EY, Kalam F, et al. Prevalence of Overweight and Obesity among Adolescents in Seven Arab Countries: A Cross-Cultural Study. J Obes. 2012;2012:981390.
8. Arslanian S. Type 2 diabetes in children: clinical aspects and risk factors. Horm Res. 2002;57 Suppl 1:19-28.
9. Moussa MA, Alsaeid M, Abdella N, Refai TM, Al-Sheikh N, Gomez JE. Prevalence of type 2 diabetes mellitus among Kuwaiti children and adolescents. Med Princ Pract. 2008;17(4):270-5.
10. Han JC, Lawlor DA, Kimm SY. Childhood obesity. Lancet. 2010;375(9727):1737-48.
11. Organization WH. Population-based prevention strategies for childhood obesity: report of a WHO forum and technical meeting, Geneva, 15-17 December 2009. 2010.
12. Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. Obes Rev. 2004;5:4-85.
13. Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. Obes Rev. 2003;4(4):195-200.
14. Jose KA, Blizzard L, Dwyer T, McKercher C, Venn AJ. Childhood and adolescent predictors of leisure time physical activity during the transition from adolescence to adulthood: a population based cohort study. Int J Behav Nutr Phys Act. 2011;8:54.
15. Campbell KJ, Crawford DA, Salmon J, Carver A, Garnett SP, Baur LA. Associations between the home food environment and obesity-promoting eating behaviors in adolescence. Obesity (Silver Spring). 2007;15(3):719-30.
16. Schwarz SW, Peterson J. Adolescent obesity in the United States: Facts for policymakers. 2010.
17. Loos RJ, Bouchard C. Obesity--is it a genetic disorder? J Intern Med. 2003;254(5):401-25.
18. Hill JO, Wyatt HR, Peters JC. Energy balance and obesity. Circulation. 2012;126(1):126-32.
19. Boreham C, Riddoch C. The physical activity, fitness and health of children. J Sports Sci. 2001;19(12):915-29.
20. Ekelund U, Anderssen SA, Froberg K, Sardinha LB, Andersen LB, Brage S. Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: the European youth heart study. Diabetologia. 2007;50(9):1832-40.
21. Sardinha L, Baptista F, Ekelund U. Objectively measured physical activity and bone strength in 9-year-old boys and girls. Pediatrics. 2008;122:e728 - 36.

22. Pate RR, Mitchell JA, Byun W, Dowda M. Sedentary behaviour in youth. Br J Sports Med. 2011;45(11):906-13.
23. Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. International journal of obesity (2005). 2005;29 Suppl 2:S84-96.
24. Al Baho A. GLOBAL SCHOOL–BASED HEALTH SURVEY.
25. Matthews C, Hagstromer M, Pober D, Bowles H. Best Practices for Using Physical Activity Monitors in Population-Based Research. Med Sci Sports Exerc. 2012;44:S68 - S76.
26. Al-Hazzaa HM, Musaiger AO. Arab Teens Lifestyle Study (ATLS): objectives, design, methodology and implications. Diabetes Metab Syndr Obes. 2011;4:417-26.
27. Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. Public Health Rep. 1985;100(2):126-31.
28. NICE CfPHEa, Care NCCfP. Obesity: the prevention, identification, assessment and management of overweight and obesity in adults and children. 2006:12-20.
29. Ridley K, Ainsworth B, Olds T. Development of a compendium of energy expenditures for youth. Int J Behav Nutr Phys Act. 2008;5:45.
30. Active SAS. A report on physical activity for health from the four home countries' Chief Medical Officers. The Department of Health. 2011.
31. WHO. Global recommendations on physical activity for health: Geneva: World Health Organisation; 2010.
32. CDC. Atlanta, GA: National Center for Health Statistics and that National Center for Chronic Disease Prevention and Health Promotion; 2000.
33. Musaiger AO, Al Hazzaa HM, Al-Qahtani A, Elati J, Ramadan J, Aboulella NA, et al. Strategy to combat obesity and to promote physical activity in Arab countries. Diabetes Metab Syndr Obes. 2011;4:89-97.
34. Pate R, O'Neill J, Lobelo F. The evolving definition of "sedentary". Exerc Sport Sci Rev. 2008;36:173 - 8.
35. Sedentary Behaviour Research N. Letter to the editor: standardized use of the terms "sedentary" and "sedentary behaviours". Appl Physiol Nutr Metab. 2012;37(3):540-2.
36. Biddle S, Gorely T, Marshall S, Murdey I, Cameron N. Physical activity and sedentary behaviors in youth: issues and controversies. J R Soc Health. 2004;124:29 - 33.
37. Craig R, Mindell J, Hirani V. Health Survey for England 2008. Volume 1: Physical Activity and Fitness. Health Survey for England. 2009:8-395.
38. Copperman RB, Bhat CR. Exploratory analysis of children's daily time-use and activity patterns: Child development supplement to US Panel Study of Income Dynamics. Transportation Research Record: Journal of the Transportation Research Board. 2007;2021(1):36-44.
39. Lubans DR, Hesketh K, Cliff DP, Barnett LM, Salmon J, Dollman J, et al. A systematic review of the validity and reliability of sedentary behaviour measures used with children and adolescents. Obes Rev. 2011;12(10):781-99.
40. Billewicz W, Kemsley W, Thomson A. Indices of adiposity. Br J Prev Soc Med. 1962;16(4):183-8.
41. Duren DL, Sherwood RJ, Czerwinski SA, Lee M, Choh AC, Siervogel RM, et al. Body composition methods: comparisons and interpretation. Journal of diabetes science and technology. 2008;2(6):1139-46.
42. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ. 2000;320:1240-3.
43. Neovius M, Linne Y, Barkeling B, Rossner S. Discrepancies between classification systems of childhood obesity. Obes Rev. 2004;5(2):105-14.

44. Lindsay RS, Hanson RL, Roumain J, Ravussin E, Knowler WC, Tataranni PA. Body mass index as a measure of adiposity in children and adolescents: relationship to adiposity by dual energy x-ray absorptiometry and to cardiovascular risk factors. J Clin Endocrinol Metab. 2001;86(9):4061-7.
45. Pietrobelli A, Faith M, Allison D, Gallagher D, Chiumello G, Heymsfield S. Body mass index as a measure of adiposity among children and adolescents: a validation study. J Pediatr. 1998;132:204 - 10.
46. Taylor RW, Jones IE, Williams SM, Goulding A. Body fat percentages measured by dual-energy X-ray absorptiometry corresponding to recently recommended body mass index cutoffs for overweight and obesity in children and adolescents aged 3-18 y. Am J Clin Nutr. 2002;76(6):1416-21.
47. Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, et al. 2000 CDC Growth Charts for the United States: methods and development. Vital and health statistics Series 11, Data from the national health survey. 2002(246):1-190.
48. Organization WH. Physical status: The use of and interpretation of anthropometry, Report of a WHO Expert Committee. 1995.
49. Johnson NB, Hayes LD, Brown K, Hoo EC, Ethier KA. CDC National Health Report: leading causes of morbidity and mortality and associated behavioral risk and protective factors--United States, 2005-2013. MMWR Surveill Summ. 2014;63 Suppl 4:3-27.
50. Yusuf S, Hawken S, Ounpuu S, Bautista L, Franzosi MG, Commerford P, et al. Obesity and the risk of myocardial infarction in 27,000 participants from 52 countries: a case-control study. Lancet. 2005;366(9497):1640-9.
51. Sardinha L, Teixeira P. Measuring adiposity and fat distribution in relation to health. Human Body Composition, 2nd ed Champaign, Ill, USA: Human Kinetics. 2005.
52. Gibson RS. Principles of nutritional assessment: Oxford university press; 2005.
53. McCarthy HD, Jarrett KV, Crawley HF. The development of waist circumference percentiles in British children aged 5.0-16.9 y. European journal of clinical nutrition. 2001;55(10):902-7.
54. Lohman TG, Going SB. Body composition assessment for development of an international growth standard for preadolescent and adolescent children. Food and nutrition bulletin. 2006;27(4 Suppl Growth Standard):S314-25.
55. Goran MI, Kaskoun MC, Carpenter WH, Poehlman ET, Ravussin E, Fontvieille A-M. Estimating body composition of young children by using bioelectrical resistance. Journal of Applied Physiology. 1993;75(4):1776-80.
56. Deurenberg P, Weststrate JA, Seidell JC. Body mass index as a measure of body fatness: age- and sex-specific prediction formulas. Br J Nutr. 1991;65(02):105-14.
57. Houtkooper LB, Going SB, Lohman TG, Roche AF, Van Loan M. Bioelectrical impedance estimation of fat-free body mass in children and youth: a cross-validation study. Journal of Applied Physiology. 1992;72(1):366-73.
58. Clasey JL, Bradley KD, Bradley JW, Long DE, Griffith JR. A new BIA equation estimating the body composition of young children. Obesity (Silver Spring). 2011;19(9):1813-7.
59. Force UPST. Screening and interventions for overweight in children and adolescents: recommendation statement. Pediatrics. 2005;116(1):205-9.
60. Wheeler S, Twist C. Methods of assessing body fatness among children: Implications for the National Child Measurement Programme. European Physical Education Review. 2010;16(1):81-93.
61. Sopher AB, Thornton JC, Wang J, Pierson RN, Heymsfield SB, Horlick M. Measurement of percentage of body fat in 411 children and adolescents: a comparison of dual-energy X-ray absorptiometry with a four-compartment model. Pediatrics. 2004;113(5):1285-90.
62. Heymsfield SB, Lichtman S, Baumgartner RN, Wang J, Kamen Y, Aliprantis A, et al. Body composition of humans: comparison of two improved four-compartment models that differ in

expense, technical complexity, and radiation exposure. The American journal of clinical nutrition. 1990;52(1):52-8.
63. Boeke CE, Oken E, Kleinman KP, Rifas-Shiman SL, Taveras EM, Gillman MW. Correlations among adiposity measures in school-aged children. BMC Pediatr. 2013;13:99.
64. Horan M, Gibney E, Molloy E, McAuliffe F. Methodologies to assess paediatric adiposity. Ir J Med Sci. 2014.
65. Mehio Sibai A, Nasreddine L, Mokdad AH, Adra N, Tabet M, Hwalla N. Nutrition transition and cardiovascular disease risk factors in Middle East and North Africa countries: reviewing the evidence. Ann Nutr Metab. 2010;57(3-4):193-203.
66. Mittal BV, Singh AK. Hypertension in the developing world: challenges and opportunities. Am J Kidney Dis. 2010;55(3):590-8.
67. Chen X, Wang Y. Tracking of blood pressure from childhood to adulthood: a systematic review and meta-regression analysis. Circulation. 2008;117(25):3171-80.
68. Sun C, Pezic A, Tikellis G, Ponsonby AL, Wake M, Carlin JB, et al. Effects of school-based interventions for direct delivery of physical activity on fitness and cardiometabolic markers in children and adolescents: a systematic review of randomized controlled trials. Obes Rev. 2013;14(10):818-38.
69. Beunza JJ, Martinez-Gonzalez MA, Ebrahim S, Bes-Rastrollo M, Nunez J, Martinez JA, et al. Sedentary behaviors and the risk of incident hypertension: the SUN Cohort. Am J Hypertens. 2007;20(11):1156-62.
70. Sugiyama T, Xie D, Graham-Maar RC, Inoue K, Kobayashi Y, Stettler N. Dietary and lifestyle factors associated with blood pressure among U.S. adolescents. J Adolesc Health. 2007;40(2):166-72.
71. Brion MA, Ness AR, Davey Smith G, Leary SD. Association between body composition and blood pressure in a contemporary cohort of 9-year-old children. J Hum Hypertens. 2007;21(4):283-90.
72. Herb M. Kuwait Politics Database. 2013.
73. Ramadan J, Vuori I, Lankenau B, Schmid T, Pratt M. Developing a national physical activity plan: the Kuwait example. Global health promotion. 2010;17(2):52-7.
74. Makboul KM E-SM, Sadek AA. Eastern Mediterranean Approach for control of Non communicable diseases. Survey of Risk Factors for Chronic Non Communicable Diseases. 2008.
75. Kennedy P. Kuwait pocket guide. Fares Al-Kuwait Center, Kuwait. 1998.
76. El-Dib MAB. Language learning strategies in Kuwait: Links to gender, language level, and culture in a hybrid context. Foreign Language Annals. 2004;37(1):85-95.
77. Wheeler DL. Global Culture or Culture Clash New Information Technologies in the Islamic World—A View From Kuwait. Communication Research. 1998;25(4):359-76.
78. Musaiger AO, Abuirmeileh NM. Food consumption patterns of adults in the United Arab Emirates. The journal of the Royal Society for the Promotion of Health. 1998;118(3):146-50.
79. White CJ, Robinson, Peter. <Gulf War Part 1: Operation Vantage.pdf>. Historical RFA. 2008.
80. Guthold R, Cowan M, Autenrieth C, Kann L, Riley L. Physical activity and sedentary behavior among schoolchildren: a 34-country comparison. J Pediatr. 2010;157:43 - U84.
81. Organization WH. Active living-the challenge ahead: Developing active living policies and programs in over 50 countries by the end of 2001. Geneva: WHO. 1999.
82. Adamo K, Prince S, Tricco A, Connor-Gorber S, Tremblay M. A comparison of indirect versus direct measures for assessing physical activity in the pediatric population: a systematic review. Int J Pediatr Obes. 2009;4:2 - 27.
83. Sylvia LG, Bernstein EE, Hubbard JL, Keating L, Anderson EJ. Practical guide to measuring physical activity. Journal of the Academy of Nutrition and Dietetics. 2014;114(2):199-208.

84. Fullerton S, Taylor AW, Dal Grande E, Berry N. Measuring physical inactivity: do current measures provide an accurate view of "sedentary" video game time? J Obes. 2014;2014:287013.
85. Al-Rukban MO. Obesity among Saudi male adolescents in Riyadh, Saudi Arabia. Saudi Med J. 2003;24(1):27-33.
86. Hajian-Tilaki K, Heidari B. Prevalences of overweight and obesity and their association with physical activity pattern among Iranian adolescents aged 12-17 years. Public Health Nutr. 2012;15(12):2246-52.
87. Baecke JA, Burema J, Frijters JE. A short questionnaire for the measurement of habitual physical activity in epidemiological studies. Am J Clin Nutr. 1982;36(5):936-42.
88. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Musaiger AO. Physical activity, sedentary behaviors and dietary habits among Saudi adolescents relative to age, gender and region. Int J Behav Nutr Phys Act. 2011;8:140.
89. Al-Hazzaa HM. Pedometer-determined physical activity among obese and non-obese 8- to 12-year-old Saudi schoolboys. J Physiol Anthropol. 2007;26(4):459-65.
90. Bassett Jr DR, John D. Use of pedometers and accelerometers in clinical populations: validity and reliability issues. Phys Ther Rev. 2010;15(3):135-42.
91. Uijtdewilligen L, Nauta J, Singh A, van Mechelen W, Twisk J, van der Horst K, et al. Determinants of physical activity and sedentary behaviour in young people: a review and quality synthesis of prospective studies. Br J Sports Med. 2011;45(11):896 - 905.
92. Van Der Horst K, Paw M, Twisk J, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. Med Sci Sports Exerc. 2007;39:1241 - 50.
93. Sterdt E, Liersch S, Walter U. Correlates of physical activity of children and adolescents: A systematic review of reviews. Health Educ J. 2013.
94. Gorely T, Marshall SJ, Biddle SJ. Couch kids: correlates of television viewing among youth. Int J Behav Med. 2004;11(3):152-63.
95. Hoyos Cillero I, Jago R. Systematic review of correlates of screen-viewing among young children. Preventive medicine. 2010;51(1):3-10.
96. Stalsberg R, Pedersen A. Effects of socioeconomic status on the physical activity in adolescents: a systematic review of the evidence. Scand J Med Sci Sports. 2010;20:368 - 83.
97. Shokrvash B, Majlessi F, Montazeri A, Nedjat S, Rahimi A, Djazayeri A, et al. Correlates of physical activity in adolescence: a study from a developing country. Global health action. 2013;6:20327.
98. Al-Haifi AR, Al-Fayez MA, Al-Athari BI, Al-Ajmi FA, Allafi AR, Al-Hazzaa HM, et al. Relative contribution of physical activity, sedentary behaviors, and dietary habits to the prevalence of obesity among Kuwaiti adolescents. Food and nutrition bulletin. 2013;34(1):6-13.
99. Strong W, Malina R, Blimkie C, Daniels S, Dishman R, Gutin B, et al. Evidence based physical activity for school-age youth. J Pediatr. 2005;146:732 - 7.
100. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. Jama. 2012;307(7):704-12.
101. Rauner A, Mess F, Woll A. The relationship between physical activity, physical fitness and overweight in adolescents: a systematic review of studies published in or after 2000. BMC Pediatr. 2013;13:19.
102. Jimenez-Pavon D, Kelly J, Reilly J. Associations between objectively measured habitual physical activity and adiposity in children and adolescents: systematic review. Int J Pediatr Obes. 2010;5:3 - 18.

103. Tremblay M, LeBlanc A, Kho M, Saunders T, Larouche R, Colley R, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. Int J Behav Nutr Phys Act. 2011;8:98.
104. Marshall S, Biddle S, Gorely T. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. Int J Obesity. 2004;28:1238 - 46.
105. Rey-Lopez JP, Vicente-Rodriguez G, Biosca M, Moreno LA. Sedentary behaviour and obesity development in children and adolescents. Nutr Metab Cardiovasc Dis. 2008;18(3):242-51.
106. Ekelund U, Brage S, Froberg K. TV viewing and physical activity are independently associated with metabolic risk in children: The European Youth Heart Study. PLoS Med. 2006;3:e488.
107. Stamatakis E, Coombs N, Jago R, Gama A, Mourao I, Nogueira H, et al. Associations between indicators of screen time and adiposity indices in Portuguese children. Prev Med. 2013;56(5):299-303.
108. Mitchell JA, Mattocks C, Ness AR, Leary SD, Pate RR, Dowda M, et al. Sedentary behavior and obesity in a large cohort of children. Obesity (Silver Spring). 2009;17(8):1596-602.
109. Ekelund U, Hildebrand M, Collings PJ. Physical activity, sedentary time and adiposity during the first two decades of life. Proc Nutr Soc. 2014;73(02):319-29.
110. Clemes SA, David BM, Zhao Y, Han X, Brown W. Validity of two self-report measures of sitting time. J Phys Act Health. 2012;9(4):533-9.
111. Al-Hazzaa HM, Al-Sobayel HI, Musaiger AO. Convergent validity of the Arab Teens Lifestyle Study (ATLS) physical activity questionnaire. International journal of environmental research and public health. 2011;8(9):3810-20.
112. Al-Hazzaa HM, Abahussain NA, Al-Sobayel HI, Qahwaji DM, Musaiger AO. Lifestyle factors associated with overweight and obesity among Saudi adolescents. BMC Public Health. 2012;12:354.
113. Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children aged 3-19 y. Am J Clin Nutr. 2000;72(2):490-5.
114. McCarthy HD, Ashwell M. A study of central fatness using waist-to-height ratios in UK children and adolescents over two decades supports the simple message--'keep your waist circumference to less than half your height'. International journal of obesity (2005). 2006;30(6):988-92.
115. Martinez-Gomez D, Tucker J, Heelan KA, Welk GJ, Eisenmann JC. Associations between sedentary behavior and blood pressure in young children. Arch Pediatr Adolesc Med. 2009;163(8):724-30.
116. Robinson JL, Winiewicz DD, Fuerch JH, Roemmich JN, Epstein LH. Relationship between parental estimate and an objective measure of child television watching. Int J Behav Nutr Phys Act. 2006;3:43.
117. de Moraes AC, Carvalho HB, Rey-Lopez JP, Gracia-Marco L, Beghin L, Kafatos A, et al. Independent and combined effects of physical activity and sedentary behavior on blood pressure in adolescents: gender differences in two cross-sectional studies. PLoS One. 2013;8(5):e62006.
118. Mehairi AE, Khouri AA, Naqbi MM, Muhairi SJ, Maskari FA, Nagelkerke N, et al. Metabolic syndrome among Emirati adolescents: a school-based study. PLoS One. 2013;8(2):e56159.
119. Atkin AJ, Gorely T, Clemes SA, Yates T, Edwardson C, Brage S, et al. Methods of Measurement in epidemiology: Sedentary Behaviour. Int J Epidemiol. 2012;41(5):1460-71.
120. Al-Isa AN. Factors associated with overweight and obesity among Kuwaiti kindergarten female teachers. Nutr Health. 2004;18(1):67-71.
121. El-Bayoumy I, Shady I, Lotfy H. Prevalence of obesity among adolescents (10 to 14 years) in Kuwait. Asia Pac J Public Health. 2009;21(2):153-9.

122. Owen C, Nightingale C, Rudnicka A, Cook D, Ekelund U, Whincup P. Ethnic and gender differences in physical activity levels among 9-10-year-old children of white European, South Asian and African-Caribbean origin: the Child Heart Health Study in England (CHASE Study). Int J Epidemiol. 2009;38(4):1082 - 93.
123. Toschke JA, von Kries R, Rosenfeld E, Toschke AM. Reliability of physical activity measures from accelerometry among preschoolers in free-living conditions. Clin Nutr. 2007;26(4):416-20.
124. Puyau M, Adolph A, Vohra F, Butte N. Validation and calibration of physical activity monitors in children. Obes Res. 2002;10:150 - 7.
125. Ekelund U, Yngve A, Brage S, Westerterp K, Sjostrom M. Body movement and physical activity energy expenditure in children and adolescents: how to adjust for differences in body size and age. Am J Clin Nutr. 2004;79(5):851-6.
126. Ott AE, Pate RR, Trost SG, Ward DS, Saunders RP. The use of uniaxial and triaxial accelerometers to measure children's" free-play" physical activity. Pediatric Exercise Science. 2000;12(4):360.
127. Griffiths LJ, Cortina-Borja M, Sera F, Pouliou T, Geraci M, Rich C, et al. How active are our children? Findings from the Millennium Cohort Study. BMJ Open. 2013;3(8):e002893.
128. Carson V, Janssen I. Volume, patterns, and types of sedentary behavior and cardio-metabolic health in children and adolescents: a cross-sectional study. BMC Public Health. 2011;11.
129. Matthews C, Chen K, Freedson P, Buchowski M, Beech B, Pate R, et al. Amount of time spent in sedentary behaviors in the united states, 2003-2004. Am J Epidemiol. 2008;167:875 - 81.
130. Sherar L, Griew P, Esliger D, Cooper A, Ekelund U, Judge K, et al. International children's accelerometry database (ICAD): design and methods. BMC Public Health. 2011;11(1):485.
131. Evenson K, Catellier D, Gill K, Ondrak K, McMurray R. Calibration of two objective measures of physical activity for children. J Sports Sci. 2008;26(14):1557 - 65.
132. Trost S, Loprinzi P, Moore R, Pfeiffer K. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc. 2011;43(7):1360 - 8.
133. Biddle SJ, Gorely T, Pearson N, Bull FC. An assessment of self-reported physical activity instruments in young people for population surveillance: Project ALPHA. Int J Behav Nutr Phys Act. 2011;8:1.
134. Riddoch CJ, Leary SD, Ness AR, Blair SN, Deere K, Mattocks C, et al. Prospective associations between objective measures of physical activity and fat mass in 12-14 year old children: the Avon Longitudinal Study of Parents and Children (ALSPAC). Bmj. 2009;339:b4544.
135. Stensel D, Gorely T, Edited by: Smith Alan L BS. Youth health outcomes. In Youth physical activity and sedentary behavior: challenges and solutions. Champaign, IL: Human Kinetics. 2008:31 - 57.
136. Warren JM, Ekelund U, Besson H, Mezzani A, Geladas N, Vanhees L. Assessment of physical activity - a review of methodologies with reference to epidemiological research: a report of the exercise physiology section of the European Association of Cardiovascular Prevention and Rehabilitation. Eur J Cardiovasc Prev Rehabil. 2010;17(2):127-39.
137. Biddle SJ, Gorely T, Marshall SJ. Is television viewing a suitable marker of sedentary behavior in young people? Ann Behav Med. 2009;38(2):147-53.
138. Moore JB, Hanes JC, Jr., Barbeau P, Gutin B, Trevino RP, Yin Z. Validation of the Physical Activity Questionnaire for Older Children in children of different races. Pediatr Exerc Sci. 2007;19(1):6-19.
139. Corder K, Ekelund U, Steele R, Wareham N, Brage S. Assessment of physical activity in youth. J Appl Physiol. 2008;105(3):977 - 87.
140. Rowlands A. Accelerometer assessment of physical activity in children: An update. Pediatr Exerc Sci. 2007;19(3):252 - 66.

141. Saunders T, Prince S, Tremblay M. Clustering of children's activity behaviour: the use of self-report versus direct measures. International Journal of Behavioral Nutrition and Physical Activity. 2011;8(1):48.
142. Simons M, Bernaards C, Slinger J. Active gaming in Dutch adolescents: a descriptive study. Int J Behav Nutr Phys Act. 2012;9:118.
143. Simons M, de Vet E, Brug J, Seidell J, Chinapaw MJ. Active and non-active video gaming among Dutch adolescents: Who plays and how much? J Sci Med Sport. 2013.
144. Forshee RA, Anderson PA, Storey ML. The role of beverage consumption, physical activity, sedentary behavior, and demographics on body mass index of adolescents. Int J Food Sci Nutr. 2004;55(6):463-78.
145. Kim Y, Lee JM, Peters BP, Gaesser GA, Welk GJ. Examination of different accelerometer cut-points for assessing sedentary behaviors in children. PLoS One. 2014;9(4):e90630.
146. Dancy C, Reidy J. Statistics without maths for psychology. Harlow: Pearson Education Limited. 2004.
147. Mattocks C, Ness A, Leary S, Tilling K, Blair S, Shield J, et al. Use of accelerometers in a large field-based study of children: protocols, design issues, and effects on precision. J Phys Act Health. 2008;5:S98 - S111.
148. Treuth M, Schmitz K, Catellier D, McMurray R, Murray D, Almeida M, et al. Defining accelerometer thresholds for activity intensities in adolescent girls. Med Sci Sports Exerc. 2004;36:1259 - 66.
149. Van Coevering P, Harnack L, Schmitz K, Fulton J, Galuska D, Gao S. Feasibility of using accelerometers to measure physical activity in young adolescents. Med Sci Sports Exerc. 2005;37(5):867 - 71.
150. De Meester F, De Bourdeaudhuij I, Deforche B, Ottevaere C, Cardon G. Measuring physical activity using accelerometry in 13-15-year-old adolescents: the importance of including non-wear activities. Public Health Nutr. 2011;14(12):2124 - 33.
151. Riddoch C, Mattocks C, Deere K, Saunders J, Kirkby J, Tilling K, et al. Objective measurement of levels and patterns of physical activity. Arch Dis Child. 2007;92:963 - 9.
152. Sirard JR, Slater ME. Compliance with wearing physical activity accelerometers in high school students. J Phys Act Health. 2009;6 Suppl 1:S148-55.
153. Rich C, Cortina-Borja M, Dezateux C, Geraci M, Sera F, Calderwood L, et al. Predictors of non-response in a UK-wide cohort study of children's accelerometer-determined physical activity using postal methods. BMJ Open. 2013;3(3).
154. Toftager M, Kristensen P, Oliver M, Duncan S, Christiansen L, Boyle E, et al. Accelerometer data reduction in adolescents: effects on sample retention and bias. International Journal of Behavioral Nutrition and Physical Activity. 2013;10(1):140.
155. Wells SL, Kipping RR, Jago R, Brown J, Hucker D, Blackett A, et al. Characteristics associated with requested and required accelerometer wear in children. BMJ Open. 2013;3(8).
156. Sallis J, Saelens B. Assessments of physical activity by self-report: Status, limitations and future direction. Research Quarterly for Exercise and Sport. 2000;71(2):S1-S14.
157. Anderson C, Hagstromer M, Yngve A. Validation of the PDPAR as an adolescent diary: effect of accelerometer cut points. Med Sci Sports Exerc. 2005;37:1224 - 30.
158. Saelens BE, Seeley RJ, van Schaick K, Donnelly LF, O'Brien KJ. Visceral abdominal fat is correlated with whole-body fat and physical activity among 8-y-old children at risk of obesity. Am J Clin Nutr. 2007;85(1):46-53.
159. Ojiambo R, Cuthill R, Budd H, Konstabel K, Casajus JA, Gonzalez-Aguero A, et al. Impact of methodological decisions on accelerometer outcome variables in young children. Int J Obes. 2011;35(S1):S98-S103.

160. Argiropoulou EC, Michalopoulou M, Aggeloussis N, Avgerinos A. Validity and reliability of physical activity measures in greek high school age children. J Sports Sci Med. 2004;3(3):147-59.
161. Ekelund U, Neovius M, Linne Y, Rossner S. The criterion validity of a last 7-day physical activity questionnaire (SAPAQ) for use in adolescents with a wide variation in body fat: the Stockholm Weight Development Study. International journal of obesity (2005). 2006;30(6):1019-21.
162. Kohl HW, Fulton JE, Caspersen C. Assessment of physical activity among children and adolescents: a review and synthesis. Preventive Medicine. 2000;31(null):S54-S76.
163. Moy KL, Scragg RK, McLean G, Carr H. The New Zealand Physical Activity Questionnaires: validation by heart-rate monitoring in a multiethnic population. J Phys Act Health. 2008;5 Suppl 1:S45-61.
164. Kim Y, Beets M, Welk G. Everything you wanted to know about selecting the "right" Actigraph accelerometer cut-points for youth, but ... : a systematic review. J Sci Med Sport. 2012;15(4):311 - 21.
165. Trost SG, Loprinzi PD, Moore R, Pfeiffer KA. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc. 2011;43:1360-8.
166. Catellier DJ, Hannan PJ, Murray DM, Addy CL, Conway TL, Yang S, et al. Imputation of missing data when measuring physical activity by accelerometry. Med Sci Sports Exerc. 2005;37(11 Suppl):S555-62.
167. Hardy LL, Bass SL, Booth ML. Changes in sedentary behavior among adolescent girls: a 2.5-year prospective cohort study. J Adolesc Health. 2007;40(2):158-65.
168. Wen LM, van der Ploeg HP, Kite J, Cashmore A, Rissel C. A validation study of assessing physical activity and sedentary behavior in children aged 3 to 5 years. Pediatr Exerc Sci. 2010;22(3):408-20.
169. Marshall SJ, Biddle SJH, Sallis JF, McKenzie TL, Conway TL. Clustering of sedentary behaviors and physical activity among youth: a cross-national study. Pediatr Exerc Sci. 2002;14:401-17.
170. Bringolf-Isler B, Mader U, Ruch N, Kriemler S, Grize L, Braun-Fahrlander C. Measuring and validating physical activity and sedentary behavior comparing a parental questionnaire to accelerometer data and diaries. Pediatr Exerc Sci. 2012;24(2):229-45.
171. Health USDo, Services H. 2008 Physical activity guidelines for Americans. Washington, US Department of Health and Human Services2008.
172. Tremblay MS, Warburton DE, Janssen I, Paterson DH, Latimer AE, Rhodes RE, et al. New Canadian physical activity guidelines. Appl Physiol Nutr Metab. 2011;36(1):36-46; 7-58.
173. Health Do. Start active, stay active: a report on physical activity from the four home countries' Chief Medical Officers. 11-7-0011.
174. Baquet G, Stratton G, Van Praagh E, Berthoin S. Improving physical activity assessment in prepubertal children with high-frequency accelerometry monitoring: a methodological issue. Prev Med. 2007;44(2):143-7.
175. Ekelund U, Tomkinson G, Armstrong N. What proportion of youth are physically active? Measurement issues, levels and recent time trends. Br J Sports Med. 2011;45:859 - 65.
176. Barlow SE. Expert committee recommendations regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity: summary report. Pediatrics. 2007;120 Suppl 4:S164-92.
177. Behbehani K. Kuwait national programme for healthy living: first 5-year plan (2013-2017). Med Princ Pract. 2014;23 Suppl 1:32-42.
178. Musaiger AO. Overweight and obesity in eastern mediterranean region: prevalence and possible causes. J Obes. 2011;2011:407237.
179. Baranowski T, Jago R. Understanding the mechanisms of change in children's physical activity programs. Exerc Sport Sci Rev. 2005;33:163 - 8.

180. Biddle S, Atkin A, Cavill N, Foster C. Correlates of physical activity in youth: a review of quantitative systematic reviews. Int Rev Sport Exerc Psychol. 2011;4(1):25 - 49.
181. Ball K, Cleland VJ, Timperio AF, Salmon J, Crawford DA. Socioeconomic position and children's physical activity and sedentary behaviors: longitudinal findings from the CLAN study. J Phys Act Health. 2009;6(3):289-98.
182. Koller T, Morgan A, Guerreiro A, Currie C, Ziglio E. Addressing the socioeconomic determinants of adolescent health: experiences from the WHO/HBSC Forum 2007. International journal of public health. 2009;54 Suppl 2:278-84.
183. Nam CB, Terrie EW. Measurement of socioeconomic status from United States census data. Measures of socioeconomic status. 1982:29-42.
184. Musaiger AO, Bader Z, Al-Roomi K, D'Souza R. Dietary and lifestyle habits amongst adolescents in Bahrain. Food & nutrition research. 2011;55.
185. Al-Hazzaa HM, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Alahmadi MA, Musaiger AO. Association of dietary habits with levels of physical activity and screen time among adolescents living in Saudi Arabia. Journal of human nutrition and dietetics : the official journal of the British Dietetic Association. 2014;27 Suppl 2:204-13.
186. Al-Hazzaa HM, Musaiger AO, Arab Teens Lifestyle Study Research G. Physical activity patterns and eating habits of adolescents living in major Arab cities. The Arab Teens Lifestyle Study. Saudi Med J. 2010;31(2):210-1.
187. Boyce W, Torsheim T, Currie C, Zambon A. The Family Affluence Scale as a Measure of National Wealth: Validation of an Adolescent Self-Report Measure. Soc Indic Res. 2006;78(3):473-87.
188. Sallis J, Zakarian J, Hovell M, Hofstetter C. Ethnic, socioeconomic, and sex differences in physical activity among adolescents. J Clin Epidemiol. 1996;49:125 - 34.
189. Nader P, Bradley R, Houts R, McRitchie S, O'Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. JAMA. 2008;300:295 - 305.
190. Slootmaker SM, Schuit AJ, Chinapaw MJ, Seidell JC, van Mechelen W. Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. Int J Behav Nutr Phys Act. 2009;6:17.
191. Klesges LM, Baranowski T, Beech B, Cullen K, Murray DM, Rochon J, et al. Social desirability bias in self-reported dietary, physical activity and weight concerns measures in 8- to 10-year-old African-American girls: results from the Girls health Enrichment Multisite Studies (GEMS). Preventive Medicine. 2004;38, Supplement:78-87.
192. Brustad RJ. Attraction to physical activity in urban schoolchildren: parental socialization and gender influences. Res Q Exerc Sport. 1996;67(3):316-23.
193. Health Survey for England 2008: physical activity and fitness. (2008).
194. Klinker CD, Schipperijn J, Christian H, Kerr J, Ersboll AK, Troelsen J. Using accelerometers and global positioning system devices to assess gender and age differences in children's school, transport, leisure and home based physical activity. Int J Behav Nutr Phys Act. 2014;11:8.
195. Babey SH, Hastert TA, Huang W, Brown ER. Sociodemographic, family, and environmental factors associated with active commuting to school among US adolescents. J Public Health Policy. 2009;30 Suppl 1:S203-20.
196. Trapp GS, Giles-Corti B, Christian HE, Bulsara M, Timperio AF, McCormack GR, et al. Increasing children's physical activity: individual, social, and environmental factors associated with walking to and from school. Health Educ Behav. 2012;39(2):172-82.
197. van Sluijs EM, Fearne VA, Mattocks C, Riddoch C, Griffin SJ, Ness A. The contribution of active travel to children's physical activity levels: cross-sectional results from the ALSPAC study. Prev Med. 2009;48(6):519-24.

198. Slater A, Tiggemann M. Gender differences in adolescent sport participation, teasing, self-objectification and body image concerns. J Adolesc. 2011;34(3):455-63.
199. De Cocker K, Ottevaere C, Sjostrom M, Moreno LA, Warnberg J, Valtuena J, et al. Self-reported physical activity in European adolescents: results from the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study. Public Health Nutr. 2011;14(2):246-54.
200. Song M, Carroll DD, Fulton JE. Meeting the 2008 physical activity guidelines for Americans among U.S. youth. Am J Prev Med. 2013;44(3):216-22.
201. Collings P, Wijndaele K, Corder K, Westgate K, Ridgway C, Dunn V, et al. Levels and patterns of objectively-measured physical activity volume and intensity distribution in UK adolescents: the ROOTS study. International Journal of Behavioral Nutrition and Physical Activity. 2014;11(1):23.
202. Riddoch C, Andersen L, Wedderkopp N, Harro M, Klasson-Heggebo L, Sardinha L, et al. Physical activity levels and patterns of 9-and 15-yr-old European children. Med Sci Sports Exerc. 2004;36(1):86 - 92.
203. Martinez-Gomez D, Welk GJ, Calle ME, Marcos A, Veiga OL. Preliminary evidence of physical activity levels measured by accelerometer in Spanish adolescents: the AFINOS Study. Nutr Hosp. 2009;24(2):226-32.
204. Blaes A, Baquet G, Van Praagh E, Berthoin S. Physical activity patterns in French youth--from childhood to adolescence--monitored with high-frequency accelerometry. Am J Hum Biol. 2011;23(3):353-8.
205. Guinhouya BC, Samouda H, de Beaufort C. Level of physical activity among children and adolescents in Europe: a review of physical activity assessed objectively by accelerometry. Public Health. 2013;127(4):301-11.
206. Freedson P, Sirard J, Debold E. Calibration of the Computer Science and Applications, Inc. (CSA) accelerometer. Med Sci Sports Exerc. 1997;29:S45.
207. Al-Hazzaa HM, Alahmadi MA, Al-Sobayel HI, Abahussain NA, Qahwaji DM, Musaiger AO. Patterns and Determinants of Physical Activity Among Saudi Adolescents. J Phys Act Health. 2013.
208. Sallis J, Prochaska J, Taylor W. A review of correlates of physical activity of children and adolescents. Med Sci Sports Exerc. 2000;32:963 - 75.
209. Welk GJ. Physical activity assessments for health-related research2002. null p.
210. Norman GJ, Schmid BA, Sallis JF, Calfas KJ, Patrick K. Psychosocial and environmental correlates of adolescent sedentary behaviors. Pediatrics. 2005;116(4):908-16.
211. Larouche R, Chaput JP, Leduc G, Boyer C, Belanger P, LeBlanc AG, et al. A cross-sectional examination of socio-demographic and school-level correlates of children's school travel mode in Ottawa, Canada. BMC Public Health. 2014;14(1):497.
212. Sisson S, Church T, Martin C. Profiles of sedentary behavior in children and adolescents: The US National Health and Nutrition Examination Survey, 2001-2006. Int J Ped Obesity. 2009;4:353 - 59.
213. Babey S, Hastert T, Wolstein J. Adolescent sedentary behaviors: correlates differ for television viewing and computer use. J Adol Health. 2013;52:70 - 6.
214. Laurson KR, Eisenmann JC, Welk GJ, Wickel EE, Gentile DA, Walsh DA. Combined influence of physical activity and screen time recommendations on childhood overweight. J Pediatr. 2008;153(2):209-14.
215. te Velde SJ, De Bourdeaudhuij I, Thorsdottir I, Rasmussen M, Hagstromer M, Klepp KI, et al. Patterns in sedentary and exercise behaviors and associations with overweight in 9-14-year-old boys and girls--a cross-sectional study. BMC Public Health. 2007;7:16.
216. Devis-Devis J, Peiro-Velert C, Beltran-Carrillo VJ, Tomas JM. Screen media time usage of 12-16 year-old Spanish school adolescents: Effects of personal and socioeconomic factors, season and type of day. J Adolesc. 2009;32(2):213-31.

217. Olds T, Wake M, Patton G, Ridley K, Waters E, Williams J, et al. How do school-day activity patterns differ with age and gender across adolescence? J Adolesc Health. 2009;44(1):64-72.
218. Wight VR, Price J, Bianchi SM, Hunt BR. The time use of teenagers. Soc Sci Res. 2009;38(4):792-809.
219. Fairclough SJ, Boddy LM, Hackett AF, Stratton G. Associations between children's socioeconomic status, weight status, and sex, with screen-based sedentary behaviours and sport participation. Int J Pediatr Obes. 2009;4(4):299-305.
220. Hoyos Cillero I, Jago R, Sebire S. Individual and social predictors of screen-viewing among Spanish school children. Eur J Pediatr. 2011;170(1):93-102.
221. Ruiz JR, Ortega FB, Martinez-Gomez D, Labayen I, Moreno LA, De Bourdeaudhuij I, et al. Objectively measured physical activity and sedentary time in European adolescents: the HELENA study. Am J Epidemiol. 2011;174(2):173-84.
222. Drenowatz C, Eisenmann JC, Pfeiffer KA, Welk G, Heelan K, Gentile D, et al. Influence of socio-economic status on habitual physical activity and sedentary behavior in 8- to 11-year old children. BMC Public Health. 2010;10:214.
223. Coombs N, Shelton N, Rowlands A, Stamatakis E. Children's and adolescents' sedentary behaviour in relation to socioeconomic position. Journal of epidemiology and community health. 2013;67(10):868-74.
224. Trost S, Pate R, Freedson P, Sallis J, Taylor W. Using objective physical activity measures with youth: how many days of monitoring are needed? Med Sci Sports Exerc. 2000;32(2):426 - 31.
225. Dorn LD. Measuring puberty. J Adolesc Health. 2006;39(5):625-6.
226. Atkin AJ, Gorely T, Clemes SA, Yates T, Edwardson C, Brage S, et al. Methods of Measurement in epidemiology: sedentary Behaviour. Int J Epidemiol. 2012;41(5):1460-71.
227. Klitsie T, Corder K, Visscher TL, Atkin AJ, Jones AP, van Sluijs EM. Children's sedentary behaviour: descriptive epidemiology and associations with objectively-measured sedentary time. BMC Public Health. 2013;13:1092.
228. Raymond SU, Leeder S, Greenberg HM. Obesity and cardiovascular disease in developing countries: a growing problem and an economic threat. Curr Opin Clin Nutr Metab Care. 2006;9(2):111-6.
229. Martinez-Gomez D, Eisenmann J, Gomez-Martinez S. Sedentary behavior, adiposity, and cardiovascular risk factors in adolescents. The AFINOS study. Rev Esp Cardiol (English Edition). 2010;63:277 - 85.
230. World Health Organization. Global strategy for non-communicable disease prevention and control (Draft). Geneva: WHO. 1997;WHO document(WHO/NCD/GS/97.1).
231. World Development Indicators Database. http://siteresourcesworldbankorg/DATASTATISTICS/Resources/GNIPCpdf. 2011.
232. Popkin BM. The nutrition transition: an overview of world patterns of change. Nutr Rev. 2004;62(7 Pt 2):S140-3.
233. Galal O. Nutrition-related health patterns in the Middle East. Asia Pac J Clin Nutr. 2003;12(3):337-43.
234. Al-Isa AN. Are Kuwaitis getting fatter? Nutr Health. 2003;17(3):185-97.
235. Nacheva V. Dasman Center Raises Nutrition Awareness. 2009.
236. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. The Lancet. 2002;360(9331):473-82.
237. Lissau I, Overpeck MD, Ruan W, Due P, Holstein BE, Hediger ML. BOdy mass index and overweight in adolescents in 13 european countries, israel, and the united states. Arch Pediatr Adolesc Med. 2004;158(1):27-33.

238. Anderson PM, Butcher KE. Childhood obesity: trends and potential causes. Future Child. 2006;16(1):19-45.
239. Sinaiko AR, Caprio S. Insulin resistance. J Pediatr. 2012;161(1):11-5.
240. Sinaiko AR. Metabolic syndrome in children. J Pediatr (Rio J). 2012;88(4):286-8.
241. Magnussen CG, Koskinen J, Chen W, Thomson R, Schmidt MD, Srinivasan SR, et al. Pediatric metabolic syndrome predicts adulthood metabolic syndrome, subclinical atherosclerosis, and type 2 diabetes mellitus but is no better than body mass index alone: the Bogalusa Heart Study and the Cardiovascular Risk in Young Finns Study. Circulation. 2010;122(16):1604-11.
242. Din-Dzietham R, Liu Y, Bielo MV, Shamsa F. High blood pressure trends in children and adolescents in national surveys, 1963 to 2002. Circulation. 2007;116(13):1488-96.
243. Gilmer TP, O'Connor PJ, Sinaiko AR, Kharbanda EO, Magid DJ, Sherwood NE, et al. Impact of hypertension on healthcare costs among children. Am J Manag Care. 2014;20(8):622-8.
244. Falkner B. Hypertension in children and adolescents: epidemiology and natural history. Pediatr Nephrol. 2010;25(7):1219-24.
245. Feber J, Ahmed M. Hypertension in children: new trends and challenges. Clin Sci (Lond). 2010;119(4):151-61.
246. Jago R, Harrell JS, McMurray RG, Edelstein S, El Ghormli L, Bassin S. Prevalence of abnormal lipid and blood pressure values among an ethnically diverse population of eighth-grade adolescents and screening implications. Pediatrics. 2006;117(6):2065-73.
247. Bao W, Threefoot SA, Srinivasan SR, Berenson GS. Essential hypertension predicted by tracking of elevated blood pressure from childhood to adulthood: the Bogalusa Heart Study. Am J Hypertens. 1995;8(7):657-65.
248. Berenson GS, Srinivasan SR, Bao W, Newman WP, 3rd, Tracy RE, Wattigney WA. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. The Bogalusa Heart Study. N Engl J Med. 1998;338(23):1650-6.
249. Falkner B, Daniels SR. Summary of the Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents. Hypertension. 2004;44(4):387-8.
250. Jackson RT, Al Hamad N, Prakash P, Al Somaie M. Waist circumference percentiles for Kuwaiti children and adolescents. Public Health Nutr. 2011;14(1):70-6.
251. Cole TJ, Green PJ. Smoothing reference centile curves: the LMS method and penalized likelihood. Stat Med. 1992;11(10):1305-19.
252. Al-Sendi AM, Shetty P, Musaiger AO. Prevalence of overweight and obesity among Bahraini adolescents: a comparison between three different sets of criteria. European journal of clinical nutrition. 2003;57(3):471-4.
253. Kurtoglu S, Mazicioglu MM, Ozturk A, Hatipoglu N, Cicek B, Ustunbas HB. Body fat reference curves for healthy Turkish children and adolescents. Eur J Pediatr. 2010;169(11):1329-35.
254. Navti LK, Samani-Radia D, David McCarthy H. Children's body fatness and prevalence of obesity in relation to height for age. Ann Hum Biol. 2014;41(1):84-90.
255. McCarthy HD, Cole TJ, Fry T, Jebb SA, Prentice AM. Body fat reference curves for children. International journal of obesity (2005). 2006;30(4):598-602.
256. Al-Hussein FA, Tamimi W, Al Banyan E, Al-Twaijri YA, Tamim H. Cardiometabolic risk among Saudi children and adolescents: Saudi childrens overweight, obesity, and lifestyles (S.Ch.O.O.Ls) study. Ann Saudi Med. 2014;34(1):46-53.
257. de Ferranti SD, Gauvreau K, Ludwig DS, Neufeld EJ, Newburger JW, Rifai N. Prevalence of the metabolic syndrome in American adolescents: findings from the Third National Health and Nutrition Examination Survey. Circulation. 2004;110(16):2494-7.

258. Fernandez JR, Redden DT, Pietrobelli A, Allison DB. Waist circumference percentiles in nationally representative samples of African-American, European-American, and Mexican-American children and adolescents. J Pediatr. 2004;145(4):439-44.
259. Katzmarzyk PT. Waist circumference percentiles for Canadian youth 11-18y of age. European journal of clinical nutrition. 2004;58(7):1011-5.
260. Aounallah-Skhiri H, El Ati J, Traissac P, Ben Romdhane H, Eymard-Duvernay S, Delpeuch F, et al. Blood pressure and associated factors in a North African adolescent population. a national cross-sectional study in Tunisia. BMC Public Health. 2012;12:98.
261. de Moraes AC, Lacerda MB, Moreno LA, Horta BL, Carvalho HB. Prevalence of high blood pressure in 122,053 adolescents: a systematic review and meta-regression. Medicine (Baltimore). 2014;93(27):e232.
262. Kosti RI, Panagiotakos DB. The epidemic of obesity in children and adolescents in the world. Cent Eur J Public Health. 2006;14(4):151-9.
263. Biro F, Wien M. Childhood obesity and adult morbidities. Am J Clin Nutr. 2010;91:1499S - 505S.
264. Hill JO, Melanson EL. Overview of the determinants of overweight and obesity: current evidence and research issues. Med Sci Sports Exerc. 1999;31(11 Suppl):S515-21.
265. Ladabaum U, Mannalithara A, Myer PA, Singh G. Obesity, abdominal obesity, physical activity, and caloric intake in US adults: 1988 to 2010. Am J Med. 2014;127(8):717-27.e12.
266. Tremblay MS, Willms JD. Is the Canadian childhood obesity epidemic related to physical inactivity? Int J Obes Relat Metab Disord. 2003;27(9):1100-5.
267. Andersen LB, Riddoch C, Kriemler S, Hills AP. Physical activity and cardiovascular risk factors in children. Br J Sports Med. 2011;45(11):871-6.
268. Falbe J, Rosner B, Willett WC, Sonneville KR, Hu FB, Field AE. Adiposity and Different Types of Screen Time. Pediatrics. 2013;132(6):e1497-e505.
269. Mitchell JA, Rodriguez D, Schmitz KH, Audrain-McGovern J. Greater screen time is associated with adolescent obesity: A longitudinal study of the BMI distribution from Ages 14 to 18. Obesity. 2013;21(3):572-5.
270. Colley RC, Garriguet D, Janssen I, Wong SL, Saunders TJ, Carson V, et al. The association between accelerometer-measured patterns of sedentary time and health risk in children and youth: results from the Canadian Health Measures Survey. BMC Public Health. 2013;13:200.
271. Leary SD, Ness AR, Smith GD, Mattocks C, Deere K, Blair SN, et al. Physical activity and blood pressure in childhood: findings from a population-based study. Hypertension. 2008;51(1):92-8.
272. Reichert FF, Baptista Menezes AM, Wells JC, Carvalho Dumith S, Hallal PC. Physical activity as a predictor of adolescent body fatness: a systematic review. Sports Med. 2009;39(4):279-94.
273. Wilks DC, Sharp SJ, Ekelund U, Thompson SG, Mander AP, Turner RM, et al. Objectively measured physical activity and fat mass in children: a bias-adjusted meta-analysis of prospective studies. PLoS One. 2011;6(2):e17205.
274. Dencker M, Andersen LB. Health-related aspects of objectively measured daily physical activity in children. Clinical physiology and functional imaging. 2008;28(3):133-44.
275. Kelishadi R, Razaghi EM, Gouya MM, Ardalan G, Gheiratmand R, Delavari A, et al. Association of physical activity and the metabolic syndrome in children and adolescents: CASPIAN Study. Horm Res. 2007;67(1):46-52.
276. Aadahl M, Jorgensen T. Validation of a new self-report instrument for measuring physical activity. Med Sci Sports Exerc. 2003;35(7):1196-202.
277. Lorenzo C, Williams K, Hunt KJ, Haffner SM. The National Cholesterol Education Program–Adult Treatment Panel III, International Diabetes Federation, and World Health Organization

definitions of the metabolic syndrome as predictors of incident cardiovascular disease and diabetes. Diabetes care. 2007;30(1):8-13.
278. de Rezende LF, Rodrigues Lopes M, Rey-Lopez JP, Matsudo VK, Luiz Odo C. Sedentary behavior and health outcomes: an overview of systematic reviews. PLoS One. 2014;9(8):e105620.
279. Marshall SJ, Biddle SJ, Gorely T, Cameron N, Murdey I. Relationships between media use, body fatness and physical activity in children and youth: a meta-analysis. Int J Obes Relat Metab Disord. 2004;28(10):1238-46.
280. Nasreddine L, Naja F, Akl C, Chamieh MC, Karam S, Sibai AM, et al. Dietary, lifestyle and socio-economic correlates of overweight, obesity and central adiposity in Lebanese children and adolescents. Nutrients. 2014;6(3):1038-62.
281. Chaput JP, Lambert M, Mathieu ME, Tremblay MS, J OL, Tremblay A. Physical activity vs. sedentary time: independent associations with adiposity in children. Pediatric obesity. 2012;7(3):251-8.
282. Chinapaw MJ, Yildirim M, Altenburg TM, Singh AS, Kovacs E, Molnar D, et al. Objective and self-rated sedentary time and indicators of metabolic health in Dutch and Hungarian 10-12 year olds: the ENERGY-Project. PLoS One. 2012;7(5):e36657.
283. Pratt C, Webber LS, Baggett CD, Ward D, Pate RR, Murray D, et al. Sedentary activity and body composition of middle school girls: the trial of activity for adolescent girls. Res Q Exerc Sport. 2008;79(4):458-67.
284. Altenburg TM, Hofsteenge GH, Weijs PJ, Delemarre-van de Waal HA, Chinapaw MJ. Self-reported screen time and cardiometabolic risk in obese Dutch adolescents. PLoS One. 2012;7(12):e53333.
285. Steele R, van Sluijs E, Cassidy A, Griffin S, Ekelund U. Targeting sedentary time or moderate- and vigorous-intensity activity: independent relations with adiposity in a population-based sample of 10-y-old British children. Am J Clin Nutr. 2009;90:1185 - 92.
286. Sardinha LB, Andersen LB, Anderssen SA, Quiterio AL, Ornelas R, Froberg K, et al. Objectively measured time spent sedentary is associated with insulin resistance independent of overall and central body fat in 9- to 10-year-old Portuguese children. Diabetes Care. 2008;31(3):569-75.
287. Belton S, O'Brien W, Wickel EE, Issartel J. Patterns of non-compliance in adolescent field based accelerometer research. J Phys Act Health. 2013;10(8):1181-5.
288. Troiano RP. Can there be a single best measure of reported physical activity? Am J Clin Nutr. 2009;89(3):736-7.
289. Biddle S, Cavill N, Ekelund U, Gorely T, Griffiths M, Jago R, et al. Sedentary behaviour and obesity: review of the current scientific evidence. United Kingdom-Department of Health: Department for Children SaF. 2010.
290. Bassett DR, Fitzhugh EC, Heath GW, Erwin PC, Frederick GM, Wolff DL, et al. Estimated energy expenditures for school-based policies and active living. Am J Prev Med. 2013;44(2):108-13.
291. Gebremariam MK, Bergh IH, Andersen LF, Ommundsen Y, Totland TH, Bjelland M, et al. Are screen-based sedentary behaviors longitudinally associated with dietary behaviors and leisure-time physical activity in the transition into adolescence? Int J Behav Nutr Phys Act. 2013;10:9.
292. Chinapaw M, Proper K, Brug J. Relationship between young people's sedentary behaviour and biomedical health indicators; a systematic review of prospective studies. Obes Rev. 2011;12:621 - 5.
293. Chinapaw M, Altenburg T, Brug J. Sedentary behaviour and health in children - evaluating the evidence. Prev Med. 2015;70:1-2.
294. Verloigne M, Van Lippevelde W, Maes L, Yildirim M, Chinapaw M, Manios Y, et al. Self-reported TV and computer time do not represent accelerometer-derived total sedentary time in 10 to 12-year-olds. Eur J Public Health. 2013;23(1):30-2.

295. Chinapaw MJ, de Niet M, Verloigne M, De Bourdeaudhuij I, Brug J, Altenburg TM. From sedentary time to sedentary patterns: accelerometer data reduction decisions in youth. PLoS One. 2014;9(11):e111205.
296. Altenburg TM, Rotteveel J, Dunstan DW, Salmon J, Chinapaw MJ. The effect of interrupting prolonged sitting time with short, hourly, moderate-intensity cycling bouts on cardiometabolic risk factors in healthy, young adults. Journal of applied physiology (Bethesda, Md : 1985). 2013;115(12):1751-6.
297. Dunstan DW, Kingwell BA, Larsen R, Healy GN, Cerin E, Hamilton MT, et al. Breaking up prolonged sitting reduces postprandial glucose and insulin responses. Diabetes Care. 2012;35(5):976-83.
298. Smith L, Ekelund U, Hamer M. The Potential Yield of Non-Exercise Physical Activity Energy Expenditure in Public Health. Sports Medicine. 2015:1-4.
299. Riley M, Bluhm B. High blood pressure in children and adolescents. Am Fam Physician. 2012;85(7):693-700.
300. Update on the 1987 Task Force Report on High Blood Pressure in Children and Adolescents: a working group report from the National High Blood Pressure Education Program. National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents. Pediatrics. 1996;98(4 Pt 1):649-58.

Appendices

Appendix 1 Literature review methodology

Review methodology

Population

The population under focus were children and adolescents of school age.

Databases and search strategies

The literature searches involved electronic (Pubmed) and manual sources.

The literature search conducted through Pubmed used the following [MeSH] and title/abstract (tiab) search terms:

- "physical activity" or synonymous
- "sedentary behaviour" or synonymous
- "accelerometry" or synonymous
- "child" or synonymous
- "adolescent" or synonymous
- "Middle East" or synonymous
- "sociodemographic correlates" or synonymous
- "obesity/overweight" or synonymous
- "adiposity indices" or synonymous
- "blood pressure" or synonymous

In the first stage, each term was entered separately and subsequently combined with corresponding synonyms through Pubmed 'Advanced' method using the Boolean operator (OR). Secondly, according to the objectives of SHAAK, the combination of relevant terms were entered through Pubmed 'Advanced' method using the Boolean operator (AND).

The following five general search structures corresponding to the objectives of SHAAK were entered in the 'Advanced' Pubmed search:

1. (“physical activity” or synonymous) OR (“sedentary behaviour” or synonymous) AND (“accelerometry” or synonymous) AND (“child/adolescent or synonymous) AND (“Middle East” or synonymous)
2. (“physical activity” or synonymous) OR (“sedentary behaviour” or synonymous) AND (“sociodemographic correlates” or synonymous) AND (“child/adolescence” or synonymous) AND (“Middle East” or synonymous)
3. (“obesity/overweight” or synonymous) AND (“childhood/adolescence” or synonymous) AND (“Middle East” or synonymous)
4. (“physical activity” or synonymous) OR (“sedentary behaviour” or synonymous) AND (“childhood/adolescence” or synonymous) AND (“adiposity indicators” or synonymous) AND (“Middle East” or synonymous)
5. (“physical activity” or synonymous” OR (“sedentary behaviour” or synonymous” AND (“childhood/adolescence” or synonymous) AND (“blood pressure” or synonymous) AND (“Middle East” or synonymous)

Manual sources

- Reference lists of identified papers

The retrieval of studies from reference lists of other published material was in progress until the last stage of this upgrade report.

Search results

Electronic searches were updated in August 2014. The electronic searches yielded the following results which are presented in Table 1.

Table 1. Pubmed strategy and search results:

General structure number	Search Terms [MeSH] and (tiab)	No. of search hits

1 (only self report)	Search ((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti])) AND (((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND (((((self report*[tiab]) OR self administer*[tiab]) OR activity diar*[tiab]) OR activity log*[tiab]) OR questionairre*[tiab])) AND (((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab])	29
1*	((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti])) AND (((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND ((((actigraph*[tiab]) OR heart rate monitor*[tiab]) OR pedomet*[tiab]) OR acceleromet*[tiab])) AND (((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab])	6
1**	(((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND (((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR	335

	sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND ((((actigraph*[tiab]) OR heart rate monitor*[tiab]) OR pedomet*[tiab]) OR acceleromet*[tiab])) AND (((((self report*[tiab]) OR self administer*[tiab]) OR activity diar*[tiab]) OR activity log*[tiab]) OR questionairre*[tiab])	
2	((((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND ((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND (((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab])) AND ((((((((((demographic factor*[tiab]) OR determinant*[tiab]) OR correlate*[tiab]) OR socioeconomic factor*[tiab]) OR biological factor*[tiab]) OR "Behavior"[Mesh]) OR "Adolescent Behavior"[Mesh]) OR "Health Behavior"[Mesh]) OR "social Behavior"[Mesh]) OR "Social Behavior"[Mesh]) OR "Life Style"[Mesh])	231
3	(((((("Obesity"[Mesh]) OR "Overweight"[Mesh]) OR obes*[tiab]) OR overweight[tiab])) AND (((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab])) AND (Search (((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])	45
4	((((((((((((((("Body Mass Index"[Mesh]) OR "Body Composition"[Mesh]) OR "Anthropometry"[Mesh]) OR "Waist Circumference"[Mesh]) OR "Skinfold Thickness"[Mesh]) OR body mass index[tiab]) OR body fat[tiab]) OR skin fold[tiab]) OR waist circumference[tiab]) OR abdominal obes*[tiab]) OR anthropomet*[tiab]) OR bioelectric impedance*[tiab]) OR bmi[tiab])) AND ((((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND ((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR	2

	excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND ((((actigraph*[tiab]) OR heart rate monitor*[tiab]) OR pedomet*[tiab]) OR acceleromet*[tiab])) AND (((((self report*[tiab]) OR self administer*[tiab]) OR activity diar*[tiab]) OR activity log*[tiab]) OR questionairre*[tiab]))))) AND ((((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab]) OR arab*[tiab])	
4**	(((((((((((((("Body Mass Index"[Mesh]) OR "Body Composition"[Mesh]) OR "Anthropometry"[Mesh]) OR "Waist Circumference"[Mesh]) OR "Skinfold Thickness"[Mesh]) OR body mass index[tiab]) OR body fat[tiab]) OR skin fold[tiab]) OR waist circumference[tiab]) OR abdominal obes*[tiab]) OR anthropomet*[tiab]) OR bioelectric impedance*[tiab]) OR bmi[tiab])) AND ((((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND (((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND ((((actigraph*[tiab]) OR heart rate monitor*[tiab]) OR pedomet*[tiab]) OR acceleromet*[tiab])) AND (((((self report*[tiab]) OR self administer*[tiab]) OR activity diar*[tiab]) OR activity log*[tiab]) OR questionairre*[tiab]))	123
5	((((Search (((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND (((((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR	0

	"Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh]))) AND ((((((((blood pressure[tiab]) OR "Blood Pressure"[Mesh]) OR "Hypertension"[Mesh]) OR "Prehypertension"[Mesh]) OR "Prehypertension"[tiab]) OR hypertension[tiab]) OR metabolic syndrome[tiab]) OR "Metabolic Syndrome X"[Mesh]))) AND ((((("Middle East"[Mesh]) OR "Arabs"[Mesh]) OR middle east[tiab]) OR arab countr*[tiab]) OR arab*[tiab])	
5**	Search (((((((((blood pressure[tiab]) OR "Blood Pressure"[Mesh]) OR "Hypertension"[Mesh]) OR "Prehypertension"[Mesh]) OR "Prehypertension"[tiab]) OR hypertension[tiab]) OR metabolic syndrome[tiab]) OR "Metabolic Syndrome X"[Mesh])) AND (((((((((((("Child"[Mesh]) OR "Adolescent"[Mesh])) OR youth[ti]) OR child*[ti]) OR teenage*[ti]) OR adolescen*[ti]) OR preschool*[ti]) OR young*[ti])) AND ((((((((((((((((((((("Motor Activity"[Mesh]) OR physical activity[ti]) OR physical fitness[ti]) OR "Physical Fitness"[Mesh]) OR excercise[ti]) OR physical inactivity[ti]) OR sedentary[ti]) OR "Television/utilization"[Mesh]) OR "Multimedia/utilization"[Mesh]) OR entertainment media[ti]) OR media use[ti]) OR active behaviour[ti]) OR inactive behaviour[ti]) OR inactive behavior[ti]) OR active behavior[ti]) OR sedentariness[ti]) OR sedentarism[ti]) OR sedentary behaviour[ti]) OR sitting[ti]) OR leisure time[ti]) OR computer use[ti]) OR sedentary behavior[ti]) OR "Mass Media/utilization"[Mesh]) OR "Leisure Activities"[Mesh])) AND ((((actigraph*[tiab]) OR heart rate monitor*[tiab]) OR pedomet*[tiab]) OR acceleromet*[tiab])) AND (((((self report*[tiab]) OR self administer*[tiab]) OR activity diar*[tiab]) OR activity log*[tiab]) OR questionairre*[tiab]))	12

*"Acceleromtry" and synonyms added to search

**"Middle East" and synonymous removed from search

Selection of studies

Different types of studies were considered corresponding to each objective of SHAAK.

The general inclusion and exclusion criteria for the core parts of this review were the following:

- Only children of school age (4 years) and adolescents less than 19 years of age were considered for inclusion in the review.
- When no studies in the Middle East or Arab countries were identified, studies from other countries were considered. A search without Middle East (or synonymous) was carried out, and priority was given to meta-analysis and systematic review articles. Grey literature was reviewed as well for relevant studies in the Middle East or Arab countries.
- Only evidence dated 10 years or less was included in the main parts of the review, meaning studies that were published prior to 2003 were excluded

Appendix 2 KIMS ethical approval letter

JOINT COMMITTEE FOR THE PROTECTION OF HUMAN SUBJECTS IN RESEARCH OF THE HEALTH SCIENCES CENTRE (HSC) & KUWAIT INSTITUTE FOR MEDICAL SPECIALIZATION (KIMS)

Ref. No.: VDR/JC/505
Date: April 8, 2012

To: **Dr. Rawan Hashem**
PhD Student
Population Health and Epidemiology Dept.
University College London (UCL) - UK

Dr. Ibrahim A. Hadi
Secretary General
Kuwait Institute For Medical Specializations(KIMS)

From: **Dr. Ibrahim Hadi**
Secretary General
KIMS

10/04/2012

Sub: **Project title: Study of Health and Activity Among Adolescents in Kuwait**

The above mentioned project, has been reviewed and approved by the Joint Committee for the Protection of Human Subjects in Research of the HSC and KIMS according to regulations.

Best regards.

NR

تلفون: 25319481 (965) – فاكس: 25318455 - ص.ب 24923 الصفاة، الرمز البريدي: 13110 الكويت
Tel. (965) 25319481 – Fax. 25318455 – P.O.Box: 24923 Safat, Code No. 13110, Kuwait

Appendix 3 Assent form

اللجنة المشتركة لأخلاقيات البحث العلمي

لمركز العلوم الطبية ومعهد الكويت للاختصاصات الطبية

إقرار موافقة (للأطفال من عمر 7 – 17)

عنوان المشروع:

دراسة عن الصحة والنشاط بين المراهقين في الكويت.

1. ماذا سيحدث لي في هذه الدراسة؟

تهدف هذه الدراسة الى جمع بعض المعلومات عن صحة ونشاط المراهقين في الكويت. المعلومات سوف تستخدم لاستحداث طرق جديدة وأفضل لمساعدة الناس على المحافظة على صحتهم وتوفير الخدمات اللازمة للأشخاص الذين يعانون من الاعتلال في الصحة و يحتاجون إلى علاج في بعض الأحيان.خلال الدراسة سوف نسألك بعض الأسئلة عنك شخصيا وعن عائلتك وكذلك عن عاداتك الغذائية ومدي ممارستك للأنشطة اليومية ، و بعد انتهاء المقابلة سنجري لك (الممرض\الممرضة) بعض القياسات مثل الطول و الوزن و محيط الخصر و الحوض و سمك الجلد بواسطة آلة صغيرة ، كما سوف نزودك بجهاز صغير لقياس مدي نشاطك اليومي (أكتيجراف)، الذي سيتم به قياس وتسجيل نشاطك اليومي . وسوف يطلب منك ارتداء الجهاز أثناء مده استيقاظك و لمدة 7 أيام. الرجاء وضع الجهاز المزود على خصرك بواسطة الحزام المطاطي على الجانب الأيمن من جسمك و فوق الجانب الأيمن من الحوض. يستحسن أن ترتدي الجهاز تحت ملابسك. ارتدي الجهاز عند الاستيقاظ في الصباح، واخلعه عندما تذهب إلى النوم. الرجاء عدم ارتداء الجهاز عند الاستحمام أو السباحة حيث أن الماء يمكن أن يتلف الجهاز.

2. هل من الممكن أن يحدث لي أي سوء؟

من غير المحتمل أن يحدث لك مكروه اثر إجراء هذه الدراسة لأن الجهاز المزود (أكتيجراف)، لا يبث أي إشعاع أو تيار كهربائي أو اهتزاز أو حرارة و يمكن ارتداؤه تحت الملابس من غير الشعور بأي مضايقه.

3. هل من الممكن أن أستفيد من هذه الدراسة؟

إذا كنت ترغب، قد يكون لديك سجل القياسات و نتائج ضغط الدم الخاصة بك. الفوائد الأخرى للدراسة سوف تكون غير مباشرة وسيأتي في الوقت المناسب من حلال تحسين الصحة العامه و الخدمات الصحية التي تنجم عن هذه الدراسة.

4. هل أملك أي خيارات أخرى؟

هذه الدراسة ليست إلزامية، وتعتمد هذه الدراسة على التعاون الطوعي. و نجاح الدراسة يعتمد على تعاونكم في طلب المشاركة. كلما زاد عدد المشاركين كلما أثمرت الدراسة بنتائج أفضل. أنت حر بالانسحاب من الدراسة في أي وقت.

5. هل سيعلم أحد بمشاركتي في هذه الدراسة؟

لا أحد سيبلغ عن مشاركتكم في هذه الدراسة، ستبقى المعلومات في سرية و سيتم استخدام المعلومات التي تعطيها لأغراض البحث فقط .

6. ما سيحدث إن تعرضت للأذى؟

بالرغم من عدم احتمالية إصابتك بأي أذي أو أعراض مرضية نتيجة مشاركتك في هذه الدراسة إلا أنه قد تم إخبار والديك أو الوصي القانوني بأنه سيتم تقديم كافة السبل العلاجية لك في حالة إصابتك بأي أذى جراء مشاركتك في الدراسة

اللجنة المشتركة لأخلاقيات البحث العلمي

لمركز العلوم الطبية ومعهد الكويت للاختصاصات الطبية

إقرار موافقة (للأطفال من عمر 7 – 17)

7. مع من أستطيع التحدث عن هذه الدراسة؟

إذا كان لديك أسئلة أو مشاكل متعلقة بهذا البحث يمكنك التحدث مباشرة مع الباحث الرئيسي لتلك الدراسة (د. روان هاشم) والمبينة هواتفها في أسفل البيان ، أما إذا كان لديك أي سؤال عن الدراسة ، وكنت تريد التحدث إلي شخص اخر ليس جزءا من هذه الدراسة ، يمكنك الاتصال بمكتب العميد المساعد لشئون الأبحاث والدراسات العليا في كلية الطب ، مركز العلوم الطبية ، جامعة الكويت علي الأرقام التالية (25319481 – 24986132 – 24986155)

8. ماذا سيحدث إذا كنت لا أريد المشاركة؟

لن يحدث لك أي شيء إذا قررت عدم المشاركة في الدراسة ، كما يمكنك التوقف والانسحاب من الدراسة في أي وقت أو مرحلة من الدراسة أو عدم الإجابة عن الأسئلة التي لا ترغب بالإجابة عليها من دون أن تحدث لك أي مشكلة ، كما أنه سيتم معاملتك بنفس الطريقة التي كنت تعامل بها سواء رفضت أو قبلت المشاركة بالدراسة.

في حال الموافقة على المشاركة في هذه الدراسة:

الاسم: **التوقيع:**

التاريخ:

اسم الدكتور/الباحث: د. روان سيد هاشم

Appendix 4 Parental consent form

اللجنة المشتركة لأخلاقيات البحث العلمي

لمركز العلوم الطبية ومعهد الكويت للاختصاصات الطبية

إقرار موافقة (للبالغين)

كلية: جامعة كلية لندن

قسم : صحة عامة و الوبائيات

عنوان المشروع:

دراسة الصحة والنشاط لدي المراهقين في الكويت

الهدف من الدراسة:

تهدف هذه الدراسة إلى جمع بعض المعلومات عن صحة ونشاط المراهقين في الكويت. المعلومات سوف تستخدم لاستحداث طرق جديدة وأفضل لمساعدة الناس على المحافظة على صحتهم وتوفير الخدمات اللازمة للأشخاص الذين يعانون من الاعتلال في الصحة و يحتاجون إلى علاج في بعض الأحيان.

الإجراءات المتبعة:

سوف نسألك بعض الأسئلة عنك شخصيا وعن عائلتك ، تتضمن هذه الأسئلة الطول و الوزن و وظيفة أفراد الأسرة .

العينة الضابطة من المتطوعين:

لا يوجد عينة ضابطة .

☐ موافق اسم :............................. التوقيع:...........................

☐ غير موافق اسم :............................. التوقيع:...........................

د. روان جواد سيد هاشم

اسم الدكتور/الباحث : *Dr. Rawan J. K. S. Hashem*... التوقيع:...........................

رقم الهاتف:............................. التاريخ:..................

Appendix 5 Student information leaflet

دراسة عن الصحة والنشاط لدي المراهقين في الكويت.

الدراسة تهدف لجمع بعض المعلومات عن صحة ونشاط المراهقين في الكويت. هذه المعلومات سوف تستخدم لاستحداث طرق جديدة وأفضل لمساعدة الناس على المحافظة على صحتهم ولتوفر الخدمات اللازمة للأشخاص الذين يعانون من الاعتلال ، كما سوف نزودك بجهاز صغير لقياس مدي نشاطك اليومي (أكتيجراف)، الذي سيتم قياس وتسجيل نشاطك اليومي.

ما هو جهاز الأكتيجراف؟

الأكتيجراف هو جهاز صغير يقيس نشاطك اليومي. وهو يقيس حركات الجسم أثناء النشاط اليومي المعتاد مثل المشي و الركض. الجهاز لا يقيس أي معلومات أخرى و لا يضر المشارك.

ماذا أفعل عند استلام الجهاز؟

سوف يطلب منك ارتداء الجهاز أثناء مده استيقاظك ، لمدة 7 أيام. الرجاء وضع الجهاز المزود على خصرك بواسطة الحزام المطاطي على الجانب الأيمن من جسمك و فوق الجانب الأيمن من الحوض. يستحسن أن ترتدي الجهاز تحت ملابسك. ارتدي الجهاز عند الاستيقاظ في الصباح، واخلعه عندما تذهب إلى النوم. الرجاء عدم ارتداء الجهاز عند الاستحمام أو السباحة حيث أن الماء يمكن أن يتلف الجهاز.

ما أفعل بعد ارتداء الجهاز لمدة أسبوع؟

الباحث سوف يزور المدرسة لاستلام الجهاز من المشارك . الرجاء المحافظة على الجهاز حتى موعد الاستلام.

شكرا على تعاونكم

Appendix 6 Questionnaire

Study Of Health And Activity Among Adolescents In Kuwait

Questionnaire

<u>Please answer the following questions:</u>

<u>I want to ask you some questions about yourself:</u>

2) School Grade:

-7 ( ) -8 ( ) -9 ( ) -10 ( ) -11 ( ) -12 ( )

3) Date of birth: …../……../……

4) Gender:

Male ( ) Female ( )

<u>I want to ask you some questions about your family:</u>

5) What is your rank among brothers and sisters?

Firstborn ( ) Middle ( ) Youngest ( ) Only child ( )

6) How many people live in your home including you? (not including domestic maid/s) ……....

7) How many bedrooms does your home have altogether? ……………………..

8) Do you share your bedroom with a sibling or a family member? Yes ( ) No ( )

9) In your home do you live with ?

Parents and siblings only ( ) More than one family together eg. grandparents ( ) Father only or mother only ( )

10) Is your home ?

Rented ( ) Owned ( )

11) How many cars does your family own? …………….

12) How many people work in your home (including maids, driver, gardener, and cook) ?...........

13) Father education:

Illiterate ( ) Read and write ( ) Primary ( ) intermediate ( ) secondary ( ) university ( ) higher ( )

14) What is your fathers job?..

15) Mother education:

Illiterate ( ) Read and write ( ) Primary ( ) intermediate ( ) secondary ( ) university ( ) higher ( )

16) What is your mothers job?...

<u>I want to ask you some question about your health:</u>

17) Do you have allergies in your chest or asthma? Yes ( ) No ( ) Do not know ( )

18) Do you use an inhaler or nebulizer? Yes ( ) No ( ) Do not know ( )

19) Do you have high blood sugar or Diabetes ? Yes ( ) No ( ) Do not know ( )

20) Do you suffer from any other health related problem ? Yes ( ) No ( ) Do not know ( )

If yes mention the problem……………………………………………………………………………………………………

21) Did you suffer from any condition that has limited your physical activity the past week:……..

22) Are you currently on a diet? Yes ( ) No ( )

23) Did you ever go on a diet? Yes ( ) No ( ) If yes, mention why you stopped……………………..

I would like to ask you some questions about your daily activity:

25) How do you usually travel to and from school?

Car ( )

Bus ( )

Walking ( )

Other ( ) mention……………………

26) What do you usually during the first school break (even if its eating)?

Sit / talk / read ( )

Stand / Walk ( )

Run or play games ( )

27) What do you usually during the second school break (even if its eating)?

Sit / talk / read ( )

Stand / Walk ( )

Run or play games ( )

28) During PE classes how often do you get out of breath ?

Never ( )

Sometimes ( )

Most times ( )

I don't take part in PE ( )

29) During the week days how many times a week do you participate in sport or exercise after school?

I don't participate ( )

Once a week ( )

Twice a week ( )

Three times per week ( )

More than three times a week ( )

30) During the week end how many times a week do you participate in sport or exercise after school?

I don't participate ( )

Once a week ( )

Twice a week ( )

Sport and exercise last week:

31) Please tell us about all exercise and sports which you have done in the last week. Look first to see which sorts of exercise you did and tick them in the left hand column. Then tell us how many times you did each sort of exercise in the right hand column.

EXERCISE OR SPORT	TICK HERE IF YOU DID IT IN The LAST WEEK	HOW MANY TIMES DID YOU DO IT IN THE LAST WEEK?	How many hours and minutes did you do it the last week
Basketball			
Running or jogging			
Cycling			
Dance			
Football			
Gymnastics			
Martial arts (e.g karate)			
Tennis			
Swimming			
Volleyball			
Walking fast			
Other (please say what)_________			

I want to ask you some questions about your activities at home:

32) How many hours a day do you spend doing the following activities? Tick the right place

Activity	Don't do this activity	1 to 2 hours	2 to 3 hours	More than 3 hours
Watching TV				
Playing non active games eg. Playstation				
Playing active games eg. Wii				
Using computer				
Using social networks on mobile eg. facebook				
Doing homework				
Reading for leisure				

I want to ask about your waking up and bedtime hours:

33) On a week day, what time do you usually go to bed?...

34) On a week day, what time do you usually wake up?...

35) On the week end, what time do you usually go to bed?.......................................

36) On the week end, what time do you usually wake up ?..

I want to ask you some question about your food habits:

37) Please complete the following table by ticking the right box:

How often do you have ?	Every day of the week	Five or six times a week	Three of four times	Once or twice a week	Never
Breakfast					
Snacks (food between meals)					
Snack after dinner					

38) How many times do you eat fruit (not including juice)?

Twice or more per day ( )
Once a day ( )
Less than once a day but at least once a week ( )
Less than once a week ( )
I don't know ( )

39) How many times do you eat vegetables (not including potatoes)?

Twice or more per day ( )
Once a day ( )
Less than once a day but at least once a week ( )
Less than once a week ( )
I don't know ( )

40) How many times do you drink fresh fruit juice (not including nectar based)?

Twice or more per day ( )
Once a day ( )
Less than once a day but at least once a week ( )
Less than once a week ( )
I don't know ( )

41) How many times do you drink nectar based fruit juice?

Twice or more per day ( )
Once a day ( )
Less than once a day but at least once a week ( )
Less than once a week ( )
I don't know ( )

42) How many times do you drink soft drinks eg. Pepsi, cola, ?

Twice or more per day ( )
Once a day ( )
Less than once a day but at least once a week ( )
Less than once a week ( )
I don't know ( )

Smoking:

43) Do you currently smoke? Yes ( ) No ( )

44) Now read the following statements and tick the one that suits you, choose one only:
I usually smoke more than 6 cigarettes a week ( )
I usually smoke 1-6 cigarettes a week ( )
I used to smoke but no longer do ( )
I tried to smoke once before ( )
I have never smoked ( )

45) ***STRENGTHS AND DIFFICULTIES***

	Not True	Somewhat True	Certainly True
I am considerate of other people's feelings	☐	☐	☐
I am restless. I cannot stay still for long	☐	☐	☐
I get a lot of headaches, stomach-aches or sickness	☐	☐	☐
I usually share with others (food, games, pens etc.)	☐	☐	☐
I get very angry and often lose my temper	☐	☐	☐
I usually do as I am told	☐	☐	☐
I worry a lot	☐	☐	☐
I am helpful if someone is hurt, upset or feeling ill	☐	☐	☐
I am constantly fidgeting or squirming	☐	☐	☐
I have at least one good friend	☐	☐	☐
I fight a lot. I can make other people do what I want	☐	☐	☐
I am very often unhappy, down hearted or tearful	☐	☐	☐
Other people my age generally like me	☐	☐	☐
I am easily distracted, I find it difficult to concentrate	☐	☐	☐
I am nervous in new situations. I easily lose confidence	☐	☐	☐
I am kind to younger children	☐	☐	☐
I am often accused of lying or cheating	☐	☐	☐
Other children or young people pick on me or bully me	☐	☐	☐
I often volunteer to help others (parents, teachers, children)	☐	☐	☐
I think things out before acting	☐	☐	☐
I get on better with adults than with people my own age	☐	☐	☐
I have many fears, I am easily scared	☐	☐	☐
I see tasks through to the end. My attention is good.	☐	☐	☐

Measurements: All are taken twice except for weight and height

Weight / KG
Height / cm
Waist circumference / cm
Hip circumference/cm
Bioimpedance
Blood Pressure

Appendix 7 Physical examination measurement protocol

Measurement Protocols

Weight

Exclusion criteria: Weight is not measured for wheel chair bound individuals or persons who have difficulty standing steady; for the latter group, self reported weight is acceptable and it must be specified that it is self reported in the collection form.

Time of measurement: The measurement will take about 3 minutes.

Equipment

- An electronic scale that has been issued an examination certificate for medical use. This scale can be calibrated.
- Several calibrated weights (e.g. 10 kg or 20 kg each) that can be combined to give test weights between 50-100 kg.

Measurement Protocol

The scale should be placed on a hard floor surface (not on a floor which is carpeted or otherwise covered with soft material). If there is no such floor available, a hard wooden platform should be placed under the scale.

Calibration of scale

Calibration should be done at the beginning and end of each examination day.

The scale is checked using the standardized weights and calibration is corrected if the error is greater than 0.2 kg. The results of the checking and the recalibrations are recorded in a log book. The balanced beam scale is balanced with both sliding weights at zero and the balance bar aligned. To calibrate an electronic scale depends on the gravity in each location. Therefore its calibration is particularly important whenever a new examination site is set up.

Protocol for measuring weight

- Participants are asked to remove their heavy outer garments (jacket, coat) and shoes. They should empty their pockets.
- The participant stands in the centre of the platform, weight distributes evenly on both feet (standing off-centre may affect measurements).
- If the persons weight exceeds the maximum of the scale, the self-reported weight is acceptable and recorded on the questionnaire.
- The weight is recorded to the resolution the scale (the nearest 0.1 kg or 0.2 kg)

Height

Exclusion criteria: Height is not measured for wheel chair bound persons, persons who have difficulty standing straight or persons with a hairstyle that prevents proper use of the equipment (e.g. Afro or Mowhawk); for the latter group, self reported height is acceptable, and that is self-reported must be recorded on the data collection form.

Time of measurement: The measurement of height will take about 3 minutes.

Equipment

- The most reliable device for measuring height is the portable stadiometer. This device can be used in different settings, including ,mobile units, and it can be adjusted to surfaces that are not completely flat.
- Carpenters' level.
- Calibrated length rods of 150 and 200 cm.

Setting up the measurement site

For measuring height with the stadiometer, the highest rule is taped vertically to the hard flat wall surface with the base at floor level. A carpenter level is used to check the vertical placement of the rule.

The floor surface next to the height rule must be hard. If no such floor is available, a hard wooden platform should be placed under the base of the height rule.

Calibration of height rule

At the beginning and end of each examination day, the height rule should be checked with standardized rods and corrected if the error is greater than 2mm. The results of the checking and recalibrations are recorded in the log book.

Protocol for measuring height

1. Participants are asked to remove their shoes, heavy outer garments and hair ornaments.
2. The participant is asked to stand with his/her back to the height rule. The back of the head, back, buttocks, calves, and heels should be touching the stadiometer, feet together. The top of the external auditory meatus (ear canal) should be level with the inferior margin of the bony orbit (cheek bone). The participant is asked to look straight.
3. The head piece of the stadiometer or the sliding part of the measuring rod is lowered so that the hair is pressed flat.
4. Height is recorded to the resolution of the height rule (i.e. nearest millimetre/half a centimetre). If the participant is taller than the measurer, the measurer should stand on a platform so that he/she can properly read the height rule.

5. If the person is taller than the maximum height of the stadiometer, the self reported height is acceptable and recorded on the data collection form.
6. If a participant is excluded from height measurement, the reason should be recorded on the data collection form.

Blood Pressure

The measurement protocol for the automated blood pressure measurement device follows the WHO STEPS protocol.

Exclusion criteria: None

Time of measurement: It will take 15 minutes to measure the blood pressure.

Preparation For The Measurement

Basic conditions

Before the blood pressure is measured, the following conditions should be met:

1. The subject should abstain from eating, drinking (except water), smoking, or taking drugs that affect blood pressure, one hour before measurement.
2. Because a full bladder affects blood pressure, it should be emptied.
3. The subject should not undergo painful procedures or perform exercise one hour before measurement.
4. The subject should sit quietly for about 5 minutes.
5. The subject should remove outer garments and all other tight clothing. Sleeves should be rolled up so that the upper arm is bare. The remaining garments should not be constrictive, and the blood pressure cuff should be placed over the garment.
6. Blood pressure should be measured in a quiet room with comfortable temperature (the room temperature should be recorded).
7. The time of day should be recorded.
8. The person taking the actual measurement should be identified on data collection form.

Position Of The Subject

The subject should be in a sitting position so that the arm and back are supported. The subjects feet should be resting firmly on the floor, not dangling. If the subjects feet do not reach the floor, a platform should be used to support them. If the subject cannot sit and the measurement is taken on supine posture, this should be recorded. If the blood pressure is measured using the left arm, this should be recorded on the data collection form.

Position Of The Arm

The measurements should be made on the right arm whenever possible. If not possible (e.g. the arm has been amputated or Hs rashes, adhesive dressing, casts, open sores, hematomas, wounds, arterovenous shunt or any other intravenous access device), the left arm should be used, and this should be recorded on the data collection form.

The arm should be resting on the desk so that the antecubital fossa (a triangular cavity of the elbow joint tha contains a tendon of the biceps, the medial nerve, and the brachial artery) is at the level of the heart and palm is facing up. To achieve this position, either the chair should be adjusted or the arm on the desk should be raised (e.g. by using a pillow). The subject must always feel comfortable.

Selection of the cuff

The greatest circumference of the upper arm is measured using a non-elastic tape, with the arm relaxed and in the normal blood pressure measurement position (antecubital fossa at the level of the heart). The measurement should be read to the nearest centimeter and recorded.

Select the correct cuff for the arm circumference and record the size of the selected cuff. The width of the bladder of the cuff should be at least 40% of the arm circumference and the length of the bladder at least 80% of the arm circumference. In the EHRM protocol, instructions are provided on how to determine the correct arm circumference for the different cuff sizes, for example:

Arm circumference	Width of the bladder 0f the cuff
≤ 25 cm	8 cm
25 cm <arm circumference< 35cm	12 cm
≥ 35 cm	16 cm

The cuff should be placed on the arm so that its bottom edge is 2-3 cm above the antecubital fossa. The top edge of the cuff should not be restricted by clothing.

A set of 3-4 cuffs with different should be available and special attention should be paid to using the proper cuff width in relation to arm size. The length of the bladder should be enough to encircle at least 75-80% of the arm, and the arm circumference should be measured midway between the axilla and the antecubital space of the upper arm, with the arm relaxed and in the normal blood pressure measurement position (antecubital fossa at the level of the heart), using a non-elastic tape. The measurement should be read to the nearest centimeter and recorded on the data collection form.

Number of Measurements

Two measurements should be taken, one minute apart.

Automatic Blood Pressure Measurement

Equipment

For blood pressure the following equipment is required:

- Automated blood pressure measurement device
- 3-4 cuffs
- Non-elastic measuring tape

Measurement Protocol

1. Attach the air tube of the cuff to the air jack of the machine. The cuff must be airless.
2. Open the battery compartment and insert batteries or use the adapter.
3. Press the “On” button; all the symbols on the display will light up for approximately two seconds in order to check the display.
4. All of the symbols then disappear and the air release symbol begins to flash.
5. Wrap the cuff around the arm so that the colored band (indicating the centre of the bladder) is positioned 2-3 cm above the elbow joint on the inside of the arm.
6. Close the cuff with the fabric fastener. The green area of the cuff must cover the brachial artery.

7. Push the start button: the device automatically determines the correct level of inflation pressure.
8. When the target inflation values are reached, the air is automatically released. The value in the display counts downwards.
9. As soon as the monitor no longer detects the pulse, the symbol begins to flash.
10. When the monitor no longer detects the pulse while the cuff pressure is dropping, the systolic and diastolic pressure are displayed.
11. After one minute, the second measurement is made by repeating steps 7-10. The subject should not change position during this wait.
12. The subject may now be told the measurements

Waist and Hip circumferences

Exclusion criteria: Waist and hip circumferences are not measured for persons who are wheelchair bound or have difficulty standing straight. If the participant is immobile or refuses to have his/her waist or hip circumference measured, this fact should be recorded on the data collection form. Self-reported waist or hip circumference is not acceptable. If the waist or hip circumference exceeds the length of the tape, this fact should be recorded on the data collection form, together with the maximum length of the tape.

Time of measurements: The measurement will take about 5 minutes.

Equipment

- Constant tension tape, not stretchable

Measurement protocol

Setting up the measurement site

A private area is necessary for this measurement. This could be a separate room or screened-off area.

The full body length mirror is placed against the wall or, if it is a free-standing mirror, next to the spot where the measurement will be taken. Using the carpenters level. It should be verified that the gridlines on the mirror are horizontal.

Checking the tape

The length of the measuring tape is checked with the calibrated length rod (usually the 150 cm one) at least once per month. If the measuring tape is stretched, it should be replaced.

Protocol for measuring waist and hip circumferences

This measurement should ideally be taken without clothing, that is, directly over the skin.

If this is not possible, the measurement may be taken over light clothing, recording this fact on the data collection form. It must not be taken over thick or bulky clothing, which must be removed. If the participant reports that she is pregnant, the measurement is not taken.

Waist circumference

Position of waist circumference measurement

Waist circumference should be measured at a level midway between the lower rib margin and the iliac crest, with the tape wrapped around the body in a horizontal position.

Waist circumference measurement procedure

1. Participants are asked to remove their clothes, except for light underwear. If this is not possible, for example due to cultural reasons, the person should remove heavy outer garments, and this should be recorded on the data collection form; tight clothing, including belts, should be loosened and pockets emptied.
2. The measurer should stand at the side of the participant in order to have a clear view of the mirror.
3. Participants should be standing with their feet fairly close together (about 12-15 cm) with their weight equally distributed on each leg. Participants are asked to breathe normally; reading of the measurement should be taken at the end of gentle exhaling. This will prevent subjects from contracting their abdominal muscles or from holding their breath.
4. The measuring tape is held firmly, ensuring its horizontal position. If possible use the grid lines on the mirror to verify that the tape position is horizontal all around the waist. The tape should be loose enough to allow the observer to place one finger between the tape and the subjects body.

Waist circumference exceeds the length of the tape

If the waist circumference exceeds the length of the tape, this fact should be recorded on the data collection form together with the maximum length of the tape.

BodySTAT Bioimpedance Measurement

BODYSTAT 1500

Equipment: BODYSTAT 1500, body pads.

Restrictions: None unless participant has a pacemaker

Preparation:

- Participant should not be wearing shoes or socks.
- Ask the child to lie down comfortably on the couch (or table) provided. Arms should not be touching body sides, and legs should be slightly apart (to avoid conductivity in the wrong places).
- Explain to the child that you want to measure his/her body build with this special instrument, that your will put some pads on his/her hands and feet and connect them up- but that nothing will hurt.
- Place electrodes on RIGHT SIDED limbs, following picture guide
- All electrodes should have their protruding part (which does not stick down) facing to the right side of the body.
- Right hand, across and just behind the middle knuckle.
- Right wrist, across the back of the wrist and next to the ulna head.
- Right foot, immediately behind second toe.
- Right ankle, midway between the medial and lateral malleoli.
- The accurate positioning of the Wrist and the Ankle leads is especially important.
- Then attach the cables- one pair of cables to the arm, one pair of cables to the leg (doesn't matter which pair is which)
- However, it is essential that the RED lead is connected to the more distal point (i.e. the finger or the toe)
- The BLACK lead is connected to the proximal point (i.e. the wrist or the ankle)
- The Bodystat instrument should be turned on. Press the 'enter' (return) button twice to make the bioimpedance measurement.

Recording the Bodystat 1500 measurement

- The result will be either a 3 or 4 digit number. If value is a 3 digit number, please enter a leading zero (e.g. 930 becomes 0938)
- If it says "results not available" ignore and press return.
- Leaving the electrodes in situ, repeat the reading.

- Once the result is recorded, turn the Bodystat off. Disconnect the cables, and remove pads (or ask child to do so)

Bodystat 1500 Calibration

With the Bodystat set up and turned on, connect one pair of Bodystat leads (red and black) to the left hand terminal of the calibration device, and set the other set to the right hand terminal. Then set the instrument to record a bioimpedance value. It should read between 496 and 503 please record the result on the calibration sheet.

If it does not record in this range:-

Replace the lead wires with a spare set and recalibrate. If the calibration is then satisfactory, isolate the old lead wires for removal.

Replace the instrument battery and recalibrate. If the calibration is then satisfactory, isolate the old battery for removal.

If the calibration is still off, use the backup instrument, notify investigators.

Appendix 8 Main stage data collection protocol

SHAAK Protocol of Data collection and fieldwork

After experimentation during the May pilot, the research team devised a '4x4' method to help run data collection smoothly and efficiently. The following protocol describes this method in a detailed manner to aid in future field visits and to ensure consistency of field work.

The 4x4 protocol includes the following aspects:

- Initial school visit.
- Room setting and equipment set up.
- Designated tasks of the research team.
- Student preparation and separation into 2 groups.
- **Workflow of the data collection.**
- Concluding process

Initial school visit:

- Approx time to complete the initial visit is 3 hours
- The researcher visits the randomly picked school to prepare the principle about the date of the expected field work.
- The principle is briefed about the purpose of the study and is presented with the necessary approval forms from the Ministry of Health and Ministry of Education.
- The researcher asks the principle to allocate 2 classes from 2 different school grades, eg. Year 8 and Year 9 to be available on the field visit.
- The researcher asks permission to give the two allocated classes a brief talk about the nature and purpose of the study.
- In the class the researcher describes the nature of the study and its purpose, allowing questions from the students.
- At the end of the discussion, the researcher hands out assent forms to the students and asks them to have it signed if they are willing to participate in the study.

- The researcher then asks to take a look at the school clinic which is where the field work takes place.
- The researcher requests 8 chairs for the students to be available on the day of the visit.
- In addition, the researcher requests that a school coordinator be present to aid in escorting students to and from class on the day of the field visit.
- Finally the researcher thanks the principle and informs him/her of the time of arrival on day of field visit (approx 7.30am).

Room setting and equipment set up:

- Approx time to complete setting and set up is 30-40 mins.
- On the day of the field visit, at approx 8.00am, the research team starts the day by preparing the room for the arrival of the students.
- A sign with 'DO NOT ENTER..MEDICAL EXAMINATION TAKING PLACE' is placed on the door of the clinic.
- The 8 chairs are divided. Four chairs near door of the clinic and four towards the end of the room.
- A shoe bin is placed next to the door.
- 3 data collection stations are set up.
- Station 1: weight scale, stadiometer, body composition device placed on an examination bed.
- Station 2: set up behind a medical screen, it includes, skin fold calipers, measuring tapes and clothes pegs.
- Station 3: Two Blood Pressure devices, accelerometers and instruction leaflets.
- A pile of questionnaires and pens are placed near the chairs close to the door.
- A lap top with a an accelerometer hub is placed near the third station. The lap top contains the Actigraph software to use if the need arises.
- The general layout of the stations in the clinic should be logical and the stations placed in a way that minimizes students from facing each other or be close to each other.

Designated tasks of research team:

- Approx time to complete a group of 8 students is 60 minutes.
- Research team is made up of three personnel**: Supervisor**(myself), **Fieldworker 1** and **Fieldworker 2**.
- Station 1: **Field worker** 1 measures weight, height and body fat composition. **Field worker 1** usually finishes early. In that case he/she can help **Field worker 2** by measuring the body circumferences.
- Station 2: **Field worker 2** measures waist/hip circumferences, biceps, triceps, subscapular and suprailiac skin folds. This is done behind a medical screen to ensure privacy for the student. **Field worker 2** should minimize exposure by loosening the students school shirt and only exposing area to be measured by securing a peg in place.
- Station 3: **Supervisor** measures Blood pressure, resting heart rate of the student, then allows some time to explain in detail the purpose of accelerometer, including instructions of how to wear it, when to wear it and all other information student is required to know.
- After helping the student wear the belt, making sure they know how to wear it themselves, the **Supervisor** hands out an instructional leaflet about accelerometer use as well. It is the **Supervisors** responsibility to collect the completed questionnaires from the students once they have finished taking their measurements and making sure all the questions were answered.
- The **Supervisor** is also responsible to supervise the field workers, keep an eye on the students, make sure the team is running on schedule and contacting the school coordinator after data collection has been completed.

Student preparation and separation into 2 groups:

- Approx time to prepare and separate students is 5-7 mins.
- As soon as the group of 8 students enter the class, they are told to take off their socks/shoes and place them in the provided shoe bin near the door.
- The students are then greeted and seated in the provided chairs. The students are given questionnaires and pens. They are told to write their names and contact numbers on the cover page of the questionnaire.
- The 4 students who complete their contact details the quickest are told to go to the various stations to be measured. They are told to keep their questionnaires with them the entire time.
- The remaining 4 students are told to stay seated and to start completing the questionnaires. **They are told to take their time and understand the questions**. The students remain in their seats until the first group measurements are completed.
- Then the 2 groups switch places, the measured group sits down in the chairs near the door and the questionnaire group go to the different stations to be measured.

Work flow of the data collection:

- Stations 1 and 2 require only one student at a time, whereas, station 3 can take two students.
- It doesn't matter which station the student goes to first as long as the students goes through all 3 stations.
- The stations are placed in such a manner which allows the team to see what other members are doing while at the same time providing somewhat privacy for the student present at each station.
- At station 3 where 2 students are present, their seating arrangement enables the researcher to measure BP from right arm of both students, eg. Students seated with their backs to each other.

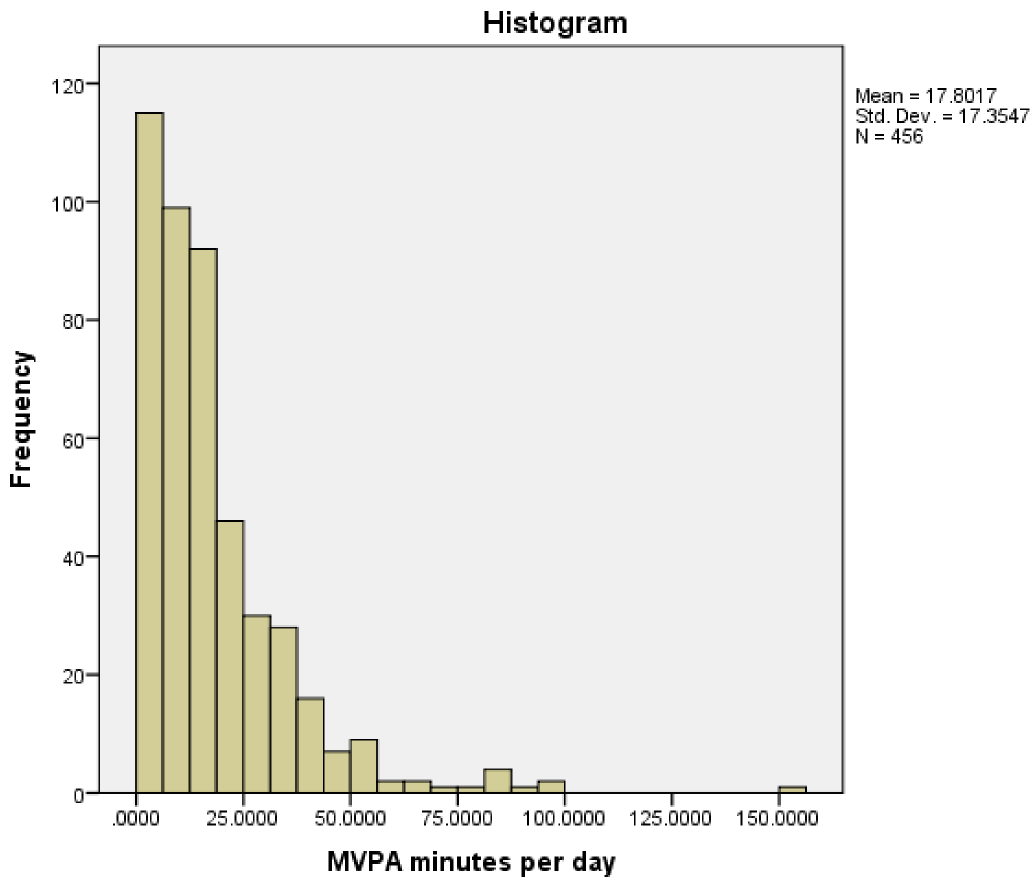
- **The 2 groups never mix, once the first group finishes, the second group takes their place.**

Concluding process:

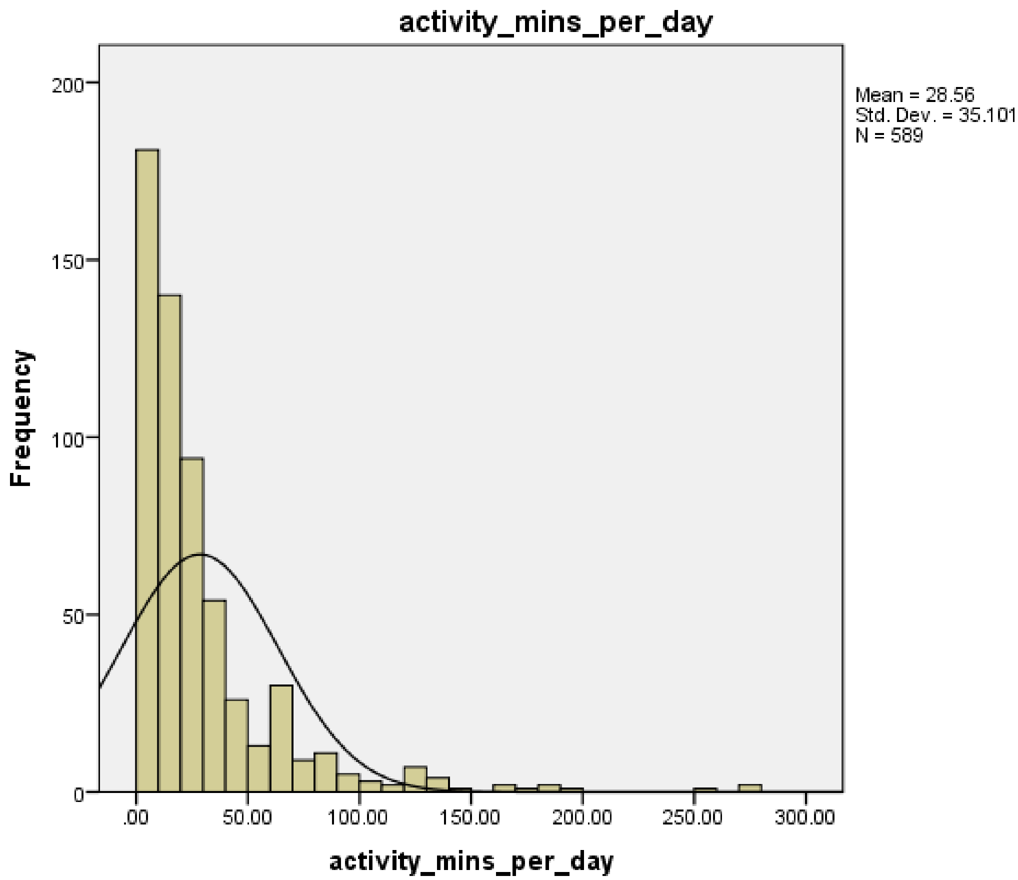
- Approx time to wrap up is 20-30 mins
- The research team packs up placing the equipment in their original boxes.
- The questionnaires are counted to make sure nothing is missing.
- The contact details are double checked.

Appendix 9 Histograms of the exposure and outcome continuous variables

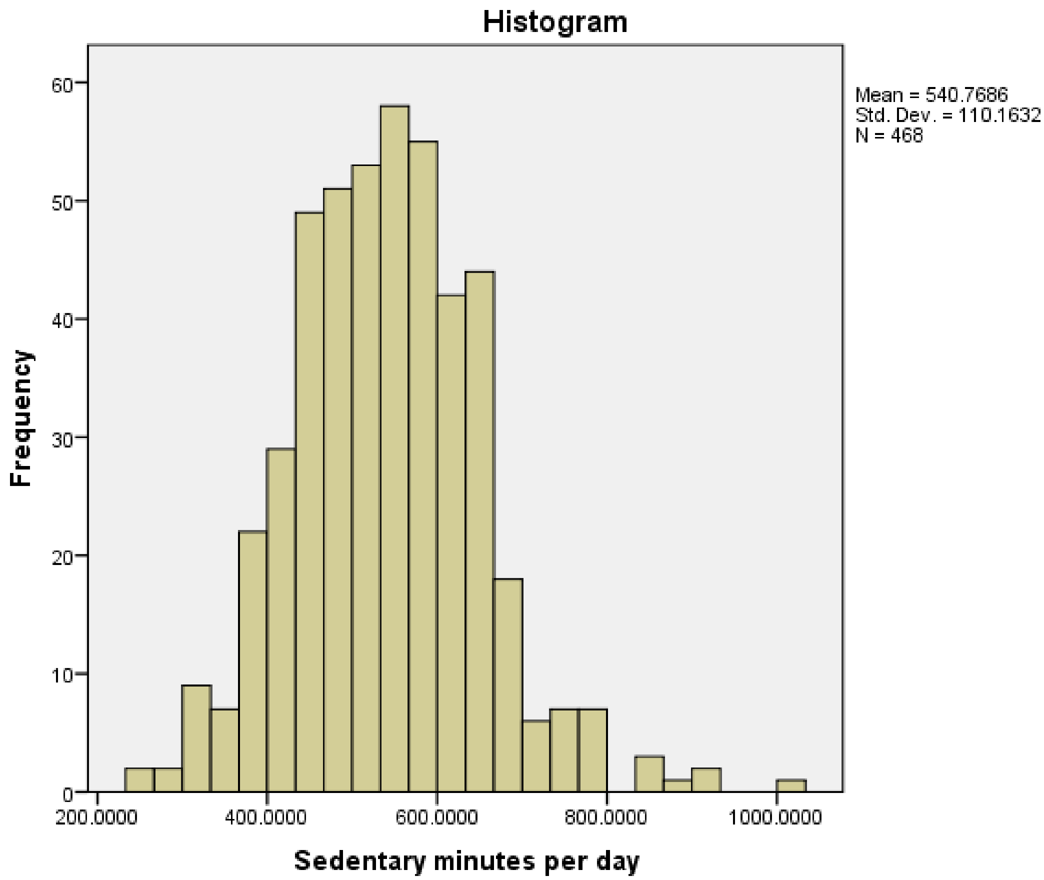
Accelerometer based MVPA



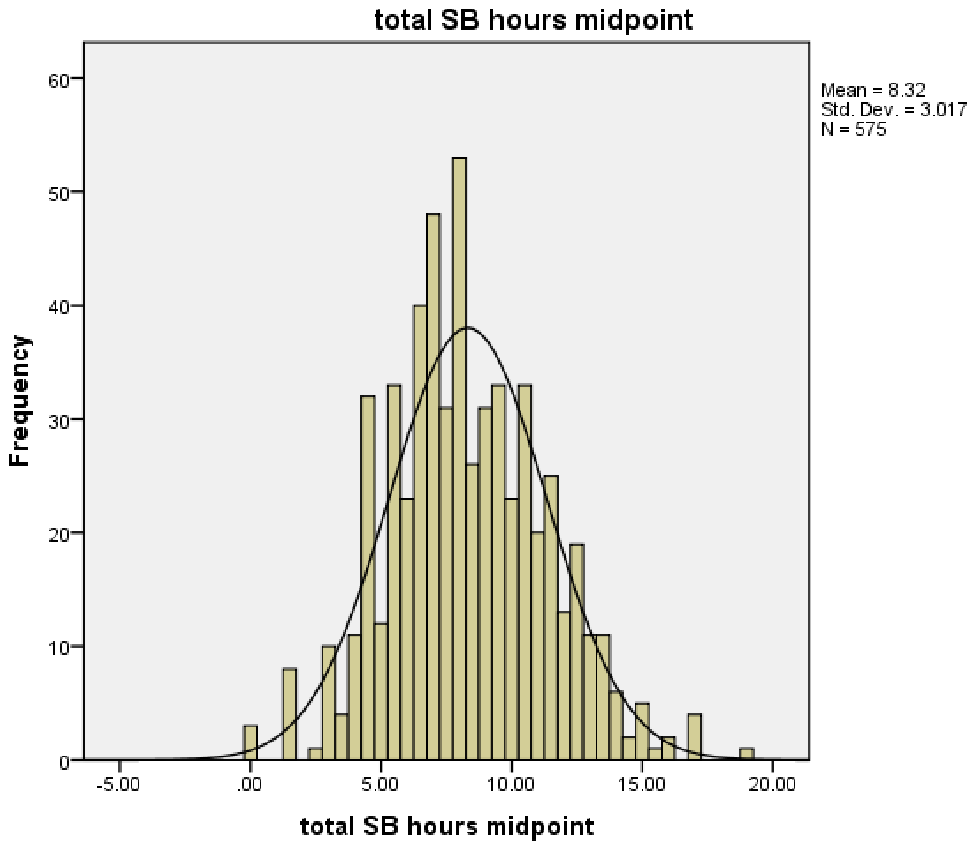
Self-reported MVPA



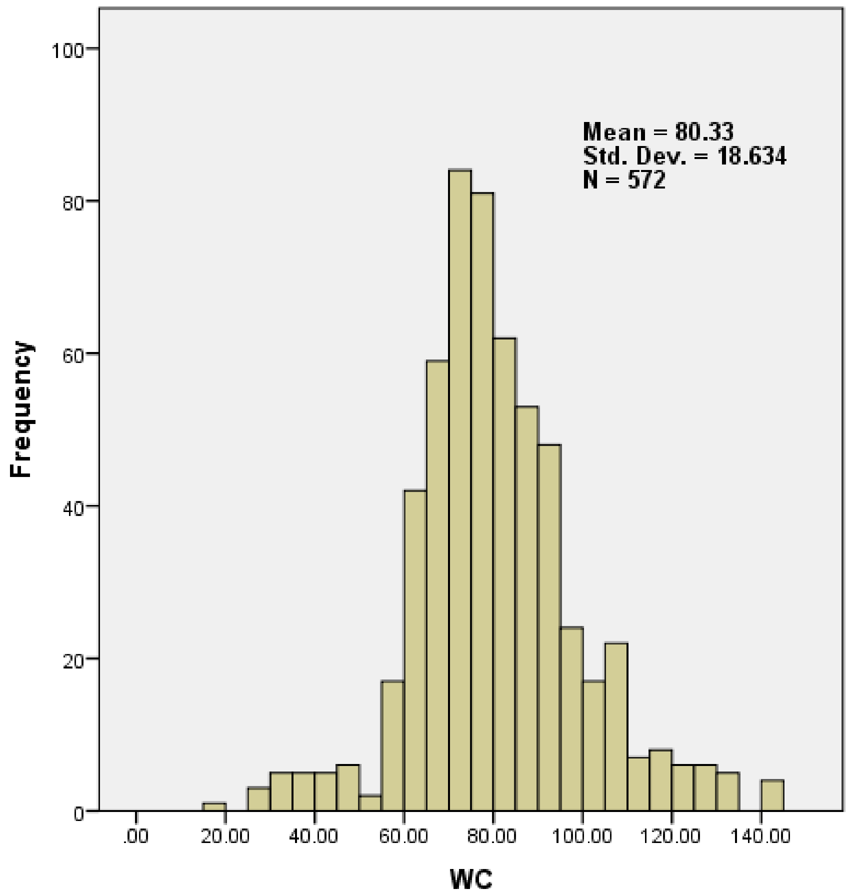
Accelerometer based SB



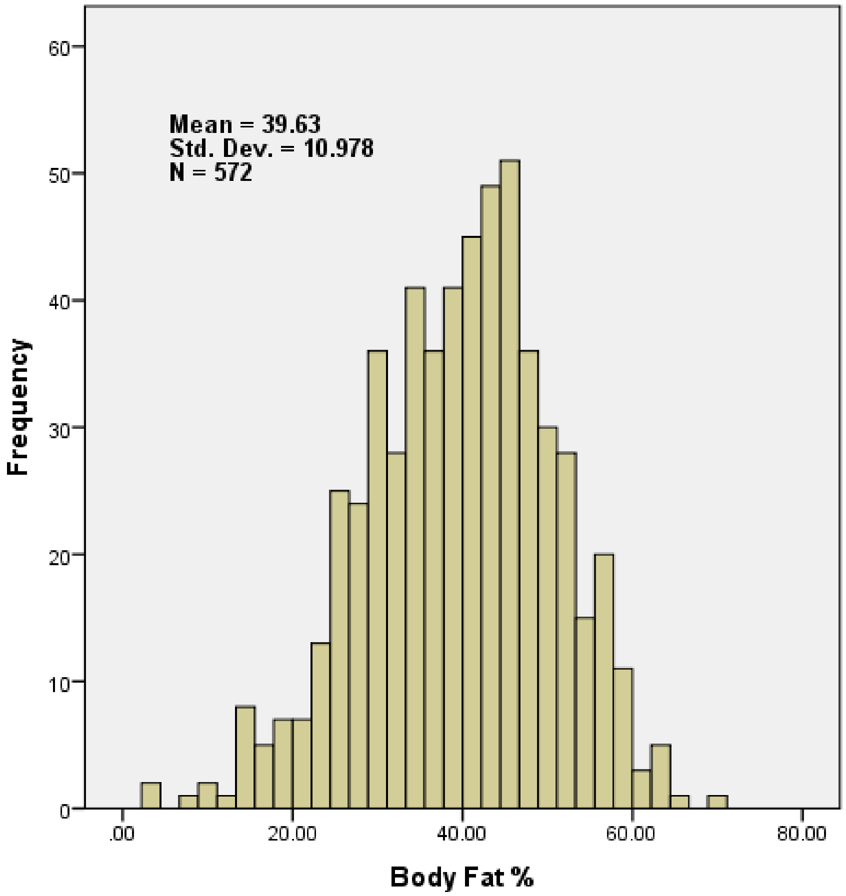
Self-reported SB



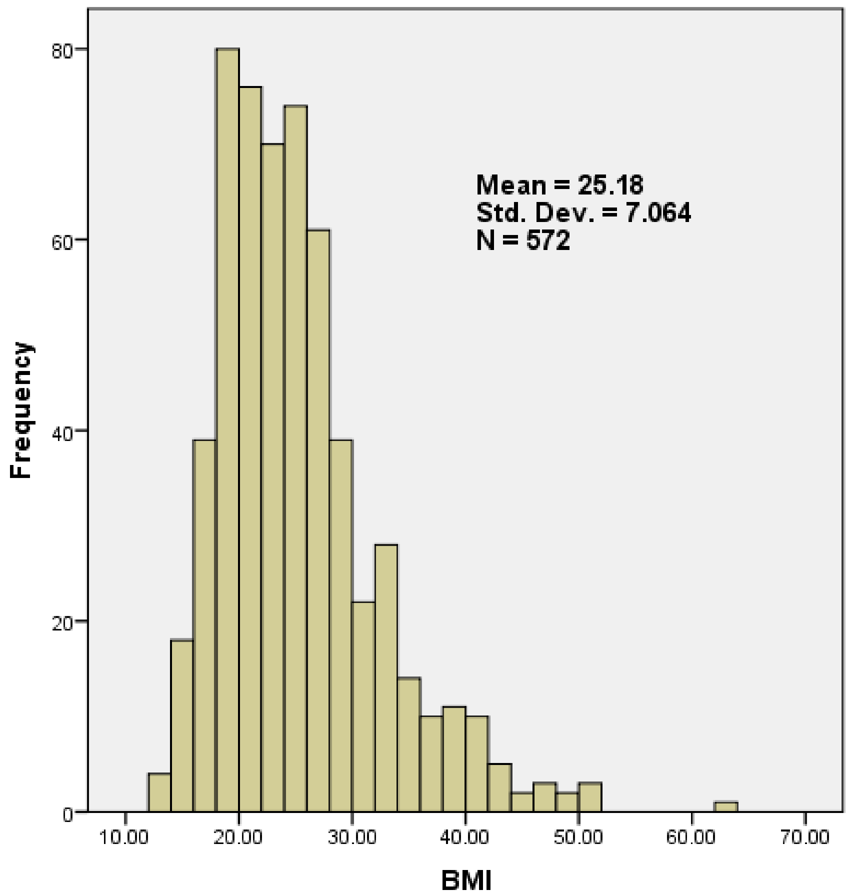
Waist circumference



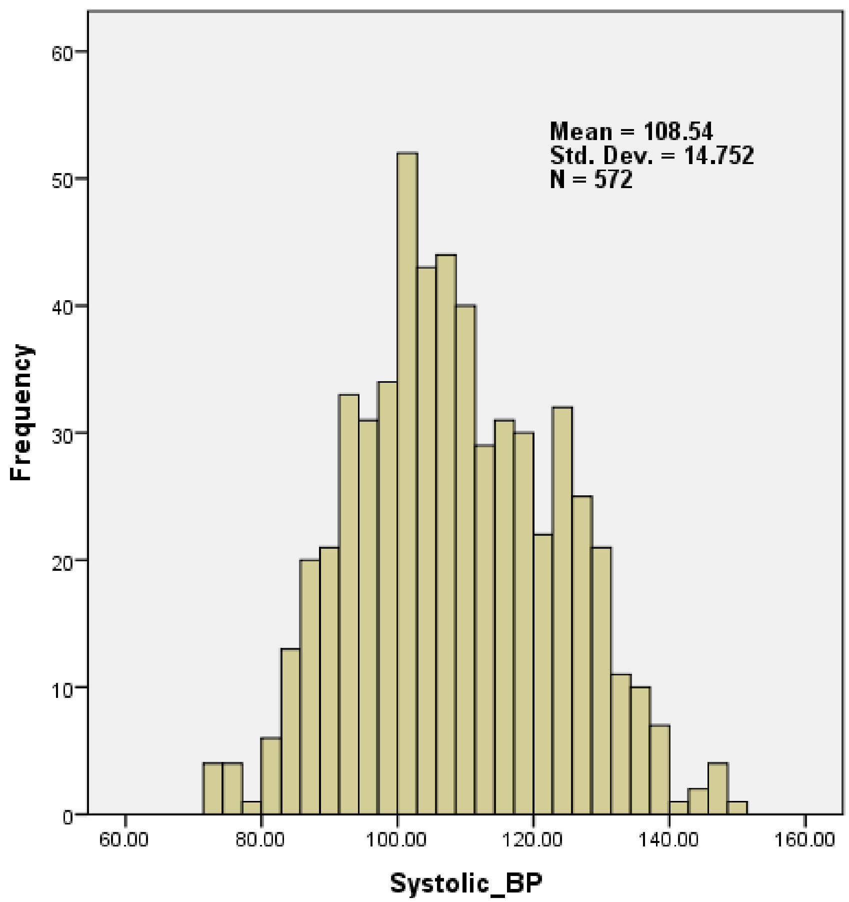
Body fat percentage



Body mass index



Systolic blood pressure



Appendix 10 Prevalence of high blood pressure

Blood pressure level derived variable:

The participants' BP levels were categorized as normal (<120/80) and high BP (≥120/80). The classification is partly based on the work of the National High Blood Pressure education programme (NHBPEP) working group on high BP in children and adolescents, its fourth report on the diagnosis, evaluation, and treatment of high BP in children and adolescents (299). This report is an update of the previous publication, Update on the Task Force Report (1987) on High Blood Pressure in Children and Adolescents (300). The recommendations on the diagnosis, evaluation, and treatment of hypertension in children and adolescents are based on English-language, peer-reviewed, scientific evidence (from 1997 to 2004) and the consensus expert opinion of the NHBPEP Working Group. However, hypertension in children and adolescents is defined as systolic and/or diastolic BP that is, on repeated measurement, at or above the 95th percentile for sex, age and height or ≥120/80 mmHg even if it is below the 95^{th} percentile.

Results

The prevalence of high BP levels by age and gender is presented in Table 6.6. For boys, the highest percentage of participants with high BP was among the 16 year olds (51.5%). The percentage of girls in the high BP category was highest among the 14 year olds. The 12 year old participants, both boys and girls, had the lowest percentage in the high BP category.

Table High blood pressure by age and gender

Age (years)	Male n (%)		Female n (%)	
	Normal	High blood pressure	Normal	High blood pressure
12	19 (86.4)	3 (13.6)	46 (93.9)	3 (6.1)
13	27 (50.0)	27 (50.4)	38 (77.6)	11 (22.4)
14	43 (75.4)	14 (24.6)	34 (68.0)	16 (32.0)
15	25 (53.2)	22 (46.8)	44 (83.0)	9 (17.0)
16	32 (48.5)	34 (51.5)	45 (93.8)	3 (6.3)
17	16 (55.2)	13 (44.8)	46 (95.8)	2 (4.2)
Total	162 (58.9)	113 (41.1)	253 (85.2)	44 (14.8)

Blood pressure levels in relation to the BMI status by age and gender are presented in Table 6.7. In both genders, the percentage of those with high blood pressure increased with BMI status: normal, overweight and obese. These percentages were significantly higher in males than females. The percentage of high blood pressure increased significantly as the BMI increased.

Blood pressure levels by BMI status by age and gender

Age (years)	BMI Status	Gender and Blood pressure levels: Males Normal n (%)	Males High BP n (%)	Females Normal n (%)	Females High BP n (%)
	Normal	7 (100.0)	0.0	30 (100.0)	0.0
12	**Overweight**	5 (83.3)	1(16.7)	11 (100.)	0.0
	Obese	7(77.8)	2(22.2)	5 (62.5)	3(37.5)
	Normal	12(75.0)	4(25.0)	23 (82.1)	5 (17.9)
13	**Overweight**	7 (43.8)	9 (56.3)	11 (68.8)	5 (6.3)
	Obese	8(36.4)	14 (63.6)	4 (80.0)	1 (20.0)
	Normal	18 (78.3)	5 (21.7)	14 (77.8)	4 (22.2)
14	**Overweight**	10 (66.7)	5 (33.3)	14 (63.6)	8 (36.4)
	Obese	15(78.9)	4 (21.1)	6 (60.0)	4 (40.0)
	Normal	15 (65.2)	8 (34.8)	22 (91.7)	2 (8.3)
15	**Overweight**	8 (53.3)	7 (46.7)	16 (88.9)	2 (11.1)
	Obese	2 (22.2)	7 (77.8)	6 (54.5)	5 (45.5)
	Normal	14 (56.0)	11 (44.0)	23 (95.8)	1 (4.2)
16	**Overweight**	7 (50.0)	7 (50.0)	12 (92.3)	1 (7.7)
	Obese	11 (40.7)	16 (59.3)	10 (90.9)	1 (9.1)
	Normal	12 (75.0)	4 (25.0)	26 (100.0)	0.0
17	**Overweight**	1 (25.0)	3 (75.0)	13 (100.0)	0.0
	Obese	3 (33.3)	6 (66.7)	7 (77.8)	2 (22.2)
	Normal	78 (70.9)	32 (29.1)	138 (92.0)	12 (8.0)
All ages	**Overweight**	38 (54.3)	32 (45.7)	77 (82.8)	16 (17.2)
	Obese	46 (48.4)	49 (51.6)	38 (70.4)	16 (29.6)
Total n (%)		**162 (58.9)**	**113 (41.1)**	**253 (85.2)**	**44(14.8)**
BMI status versus blood pressure level		**(p<0.001)***		**(p<0.001)***	

*Significant gender difference at p <0.05 assessed by chi-square for category

Appendix 11 Correlation matrix

	Gender	MVPA	Activity mins per day	Sedentary minutes per day	total SB hours midpoint	smoking	smoking ascending	fresh fruit not juice	veg not potatoe	fresh fruit juice	Nectar	soft drink	BMI	Systolic BP	WC	Body Fat %
Age																
Gender																
MVPA minutes per day	**															
Activity mins per day																
Sedentary minutes per day	**	**														
total SB hours midpoint	**		*													
smoking	**				**											
smoking ascending	**	**	**		**	**										
fresh fruit not juice		**	**		**		*									
veg not potatoe		**	**		**			**								
fresh fruit juice		**	**		**			**	**							
Nectar								**	**	**						
soft drink			*		**			**								
BMI	**				**	*						**				
Systolic BP	**	**		**	**	**	**						**			
WC	**	*	**		*	*							**	**		
Body Fat %					**							**	**	**	**	
SES scale		*	**		*								*	*	*	*
Sleep duration																

* Correlation is significant at the 0.05 level (2-tailed) ** Correlation is significant at the 0.01 level (2-tailed

Appendix 12 Association of accelerometer based counts per valid minute with adiposity indices and blood pressure

Table 1 presents the multivariable-adjusted associations between accelerometer based counts per valid minute (CPM) and three adiposity indices in boys. Accelerometer based CPM was not associated with the BMI, body fat percentage or waist circumference.

Table 1 Multivariable-adjusted associations between accelerometer based counts per valid minute and adiposity outcomes in boys

	Model 1	**Model 2**	**Model 3**
†CPM	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
	BMI Score outcome		
Accelerometer-based counts per valid minutes/day	-0.01 (-1.01, 0.05)	-0.25 (-1.21, 2.70)	-0.77 (-1.51, 1.06)
	Body fat percentage outcome		
Accelerometer-based counts per valid †† minutes/day	0.25 (-1.18, 1.85)	0.80 (-1.73, 2.33)	0.29 (-1.01, 2.92)
	Waist circumference outcome		
Accelerometer-based counts per valid †† minutes/day	0.91 (-3.22, 1.05)	0.88 (-3.11, 1.86)	0.45 (-2.62, 1.67)

†CPM: Counts per valid minute ††Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05 Beta coefficient represent change in the outcome per minute of the exposure variable
CPM variable is log transformed
Model 1:adjusted for, age, accelerometer wear time and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score
Model3: included variables from the second model plus accelerometer based SB as appropriate
(n=206) : number of participants included in linear regression analysis

Table 2 presents the multivariable-adjusted associations between accelerometer based CPM and three adiposity indices in girls. Accelerometer based CPM was not associated with the BMI, body fat percentage or waist circumference.

Table 2 Multivariable-adjusted associations between accelerometer based counts per valid minute and adiposity outcomes in girls

	Model 1	**Model 2**	**Model 3**
†CPM	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
	BMI Score outcome		
Accelerometer-based counts per valid †† minutes/day	-0.23 (-1.93, 2.47)	-0.26 (-2.09, 1.57)	-0.31 (-2.35, 1.71)
	Body fat percentage outcome		
Accelerometer-based counts per valid †† minutes/day	-0.44 (-2.97, 2.09)	-0.58 (-2.21, 2.04)	-1.02 (-2.98, 1.92)
	Waist circumference outcome		
Accelerometer-based counts per valid †† minutes/day	1.69 (-2.71, 3.00)	1.26 (-1.14, 3.66)	1.54 (-1.23, 3.32)

†CPM: Counts per valid minute ††Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05 Beta coefficient represent change in the outcome per minute of the exposure variable
CPM variable is log transformed
Model 1:adjusted for, age, accelerometer wear time and height (for models with waist circumference as outcome)
Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score
Model3: included variables from the second model plus accelerometer based sedentary behaviour as appropriate
(n=229) : number of participants included in linear regression analysis

Table 3 presents the multivariable-adjusted associations between accelerometer based CPM and systolic blood pressure in boys and girls. Accelerometer based CPM was not associated with the systolic blood pressure in boys or girls.

Table 3 Multivariable-adjusted associations between accelerometer based counts per valid minute and systolic blood pressure outcome in boys and girls

	Model 1	**Model 2**	**Model 3**
	Boys		
†CPM	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based counts per valid †† minutes/day	-0.86 (-5.61, 5.87)	-0.07 (-3.86, 5.70)	1.46 (-2.99, 5.84)
	Girls		
†CPM	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**	**Beta coefficient (95% CI)**
Accelerometer-based counts per valid †† minutes/day	-1.20 (-2.39, 3.99)	-0.56 (-2.90, 3.76)	0.09 (-2.61, 3.79)

†CPM: Counts per valid minute ††Linear regression for participants with 1 valid day accelerometry data; *Significant p value <0.05 Beta coefficient represent change in the outcome per minute of the exposure variable

CPM variables is log transformed

Model 1: adjusted for age, height and accelerometer wear time

Model 2: included variables from the first model plus portions of fruit and vegetables per day, smoking cigarettes per week and socioeconomic status score.

Model3: included variables from the second model plus accelerometer based sedentary behaviour

(n=206) : number of participants included in linear regression analysis in boys

(n=212): number of participants included in linear regression analysis in girls