Physical Activity and Fitness of Vietnamese Adolescents: Cultural, Environmental, and Socio-Economic Factors

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ABSTRACT

The available literature on physical activity (PA) and fitness in adolescents contains no studies on Vietnamese subjects. Given that habitual PA in adolescents is shaped by cultural and environmental context, such a study is necessary to establish a comprehensive understanding of PA and fitness in adolescents. To date no measure of PA suitable for use with the Vietnamese adolescent population has been developed and no study on the PA levels of Vietnamese adolescents and appropriate correlates has been undertaken. The studies contained in this dissertation developed a method for estimating energy expenditure (EE) in such a population and revealed the determinants of PA for Vietnamese adolescents. These results were compared with results obtained from other countries in order to provide some insights into cultural influences upon PA and fitness. Such information may lead to recommendations with respect to PA prescriptions and other intervention strategies in the context of health promotion among Vietnamese young people. A total of 284 Vietnamese adolescents, including Australian adolescents of Vietnamese background, participated in three separate studies which involved determining their typical PA and estimating their EE.

Study 1 considered the validation of the Computer Science Applications (CSA) activity monitor (model 7164) for predicting activity EE. A group of Vietnamese adolescents and another group of Australian adolescents of Vietnamese backgrounds performed three 5-minute treadmill trials at 4.5, 6.6, and 8.8 $km \cdot h^{-1}$. Mean activity counts and heart rate (HR) were not significantly different between the two groups for the three-speed trials ($p > 0.05$). The inter-instrument correlation coefficients of activity counts of two actigraphs were statistically significant and

ranged from 0.85 (slow walking) to 0.91 (running). An equation to predict EE ($kcal \cdot min^{-1}$) was developed from activity counts and body mass (BM) from 24 random subjects in Vietnam, and was validated on the remaining 10 subjects. This equation explained 72% of the variability in $kcal \cdot min^{-1}$ (adjusted $R^2 = 0.72$, SEE = 0.91 $kcal \cdot min^{-1}$). Consistent with previous studies, the relatively high SEE indicates that the equation is more suited for groups of Vietnamese adolescents rather than individuals. Although the CSA activity monitor is a valid instrument for estimating EE in treadmill exercises, it may not be feasible for field conditions in Vietnam due to high costs and technical reasons such as malfunction and/or interference with the CSA by children.

The second study measured PA levels and EE for 179 Vietnamese adolescents (aged 12 - 14 years) in Hanoi, Vietnam. The energy expenditure of this group was estimated by using the 3-Day Activity Record (Bouchard et al., 1983) modified for Vietnamese adolescents. The intensity of PA was categorised from 1 to 9 and the energy cost of each category was calculated from the values provided by Bouchard et al. (1983). Generally, there was no significant difference ($p < 0.05$) in the estimated daily EE ($kcal \cdot kg \cdot d^{-1}$) between the three-age groups for both genders. The estimated daily EE was higher in males than in females ($p < 0.05$). For males, the estimated daily EE was 41.0 $kcal \cdot kg \cdot d^{-1}$ and 43.6 $kcal \cdot kg \cdot d^{-1}$ for weekdays and weekend days, respectively. For females, the estimated daily EE was 39.9 $kcal \cdot kg \cdot d^{-1}$ and 40.9 $kcal \cdot kg \cdot d^{-1}$, for weekdays and weekend days, respectively. The gender difference in EE was due to males being engaged in more moderate-to-vigorous PA (MVPA, categories 6 to 9) than females for all these monitored days ($p < 0.01$). Percentages of the estimated total daily EE ($kcal \cdot d^{-1}$) derived from MVPA were 9.6% for males and

4.8% for females on weekdays, and these percentages were increased more in males (18.7 %) than in females (9.8%) on weekend days. The estimated total daily EE was higher ($p < 0.05$) on weekend days than on weekdays, as students spent less time studying (3.5 vs 7.32 hrs, and 3.4 vs 7.43 hrs for males and females, respectively), and engaged more in MVPA on weekend days. The estimated EE was strongly and negatively related to studying time for both weekdays and weekend days ($p < 0.01$). Students also spent more time ($p < 0.05$) viewing television (TV) on weekend days than on weekdays. No significant correlation was found between the estimated EE and TV time on any of the monitored days for males. The estimated EE however, was negatively related to TV in females ($r = -0.25$) on weekend days ($p < 0.05$). Overall, the relationship of the estimated EE with physical fitness components and body mass (BM) of this adolescent group was from weak ($r = -0.16$) to high ($r = 0.79$). Based on the result of the regression equation to predict daily EE, age and socio-economic status (SES) accounted for 24% of the variance in total EE ($kcal \cdot d^{-1}$), approximately 2% of that total estimated variance was accounted for by SES which is not an independent predictor by it self.

Study 3 extended the research to evaluate the PA of Vietnamese adolescents in relation to fitness, culture, environment and SES, the PA patterns and EE of 66 Australian-Vietnamese adolescents (AV group) across the same age range were assessed using the modified three-day physical activity record and questionnaires. The results were compared to the Vietnamese adolescents (VN group) of Study 2. The estimated daily EE ($kcal \cdot kg \cdot d^{-1}$) averaged over three days between the two groups was not significantly different (42.3 vs 41.3 and 40.4 vs 41.8 for VN and AV, in males and in females, respectively). The estimated total daily EE ($kcal \cdot d^{-1}$) of AV was significantly greater than VN for both genders ($p < 0.01$), which was due to the greater BM of the AV group compared with the VN group ($p < 0.05$). The estimated daily EE costs of both the AV and VN adolescents were similar to the values reported for Taiwanese adolescents but were lower than those values reported for Canadian adolescents. The AV group spent more time in sleeping and watching TV than the VN group, but the VN group spent more time in studying (approx. 1.5 times) than the AV group. The studious activity was the major stationary activity for the VN adolescents, but this was not the case for the AV adolescents as the contribution of study to the daily EE prediction in the regression equation was not significant ($P > 0.05$). The AV group spent significantly greater time on MVPA ($p < 0.01$) than the VN group, because they had more opportunities (both with respect to time and facility availabilities) to participate in sports than the VN group. However, the comparable estimated daily EE of the VN adolescents with the AV adolescents is most likely due to their longer waking hours in comparison to their peers in Australia. Because the AV adolescents were reared in an affluent country (Australia) where living standards are higher than in Vietnam, their anthropometrical data and physical fitness levels as measured by muscle endurance, power, flexibility and cardiorespiratory were generally greater than the VN adolescents with the exception that the scores for the 20m-shuttle run between the two groups were not significant. The estimated EE was related more to the fitness components of the VN group than of the AV group, although the estimated EE was moderately related to the aerobic fitness in both groups. However, the estimated EE was not related to SES in the AV group.

Based on the results of this study, the following conclusions were obtained: 1) the modified three-day physical activity record in this study was easy to implement and can be used as a valid instrument for measuring PA in Vietnamese adolescents; 2) although Vietnamese adolescents have limited opportunities to participate in high intensity PA and sports, the EE of typical PA undertaken by them was comparable to their peers in Australia. This is because they are have more daily active time than adolescents living in western countries; 3) the PA patterns of Vietnamese adolescents were related to several factors, the main influence was cultural and environmental conditions; 4) the PA level of Vietnamese adolescents (similar to other Asian adolescent groups) is lower than western adolescents; 5) a criterion for the amount of PA that is appropriate for the health of adolescents living in a developing country such as Vietnam needs to be defined. A new physical education intervention program for them should be developed to enhance current levels of PA.

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For the past few years since I commenced my study in Australia, I have gained a lot of experience in research skills, learning styles and management. I also faced a lot of difficulties in my study and my family, including "culture shock" because the circumstances were entirely different from those in my home country, Vietnam. Luckily, I have met a lot of good people and gained a lot of help from them. Some of these people have become my friends.

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Dedication

I would like to dedicate this dissertation to my special and lovely daughter:

Chu Hoai Trang

DECLARATION

This dissertation is the result of original, previously unpublished work conducted at Victoria University of Technology, Footscray, in the Department of Human Movement, Recreation and Performance. The work was performed solely by the author, with the exception of some assistance provided by others, as acknowledged on page vii.

Chu Ba Binh

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List of Abbreviations

AEE = activity energy expenditure ($kcal \cdot kg \cdot d^{-1}$) averaged over three days

AV = Australian-Vietnamese

BM = body mass

BMI = body mass index

CSA = Computer Science Application

EE = energy expenditure

HR = heart rate

MVPA = moderate to vigorous physical activity

PA = physical activity

PAQ-C = Physical Activity Questionnaire for Older Children

PE = physical education

SES = socio-economic status

SUM = sum of skinfold

TEE = total EE ($kcal \cdot d^{-1}$) averaged over three days

VN Vietnamese

VPA = vigorous physical activity

wd = weekday

wk = weekend day

20m-ST = 20 m shuttle run test

CHAPTER 1

INTRODUCTION

1.1 Statement of the Thesis

1.1.1 Physical Activity and Health

Encouraging participation in physical activity (PA) is a goal of many public health policies in nations all over the world. Populations of all ages have been targeted by campaigns to increase PA as a healthy lifestyle choice. High PA levels have been linked to reduced incidences of coronary artery disease, especially myocardial infarction, sudden cardiac mortality (Blair, Kohl, Paffenbarger, Clark, Cooper, and Gibbons, 1989; Powell, Thompson, Carsperson, and Kendrick, 1987), hypertension, and non insulin-dependent diabetes mellitus in adults (Baranowski, Bouchard, Bar-Or, Bricker, Health, Kimm, Malina, Obarzanek, Pate, Strong, Truman, and Washington, 1992). Physical inactivity is now considered a major risk factor for several chronic diseases (Fletcher, Blair, Blumenthal, Caspersen, Chaitman, Epstein, Falls, Froelicher, and Pina, 1992). Powell and Blair (1994) quantitatively estimated that a sedentary lifestyle is responsible for about one-third of deaths, through coronary heart disease, colon cancer, and diabetes. Supporting this report, Blair and Connelly (1996) stated that inactive people have 31% higher risk of cardiovascular mortality than active people. Individuals who have been sedentary and unfit in early life are also more likely to have limited functional development as they age; that is, regular PA appears to improve functional status and contributes to disability prevention during the middle and later years (Sallis, Simons-Morton, Stone, Corbin, Epstein, Fausette, Jannotti, Killen, Klesges, Petray, Rowland, and Taylor, 1992; Sallis and Patrick, 1994; Blair and Connelly, 1996).

In the same way that PA is important for adults, PA plays an important role in health benefits for children and adolescents (Strong, 1990). Although there is a relatively smaller amount of research on children and adolescents compared to adults (Baranowski et al., 1992; Bouchard, Shephard, and Stephens, 1994; Myers, Strikmiller, Webber, and Berenson, 1996), some evidence has suggested that adult health problems, such as obesity, high blood pressure, heart diseases and bone injury, can, in some cases, be traced back to risk factors originating in childhood (Berenson, McMahan, Voors, Webber, 1980; Sallis et al., 1992; Bailey and Martin, 1994). For instance, about 60% of children in the United States were reported to have at least one modifiable risk factor for adult heart disease by the age of 12 years (Berenson et al., 1980; Freedman, Dietz, Srinivasan, and Berenson, 1999). Increasing PA levels is one strategy to prevent or reduce the risk factors for coronary heart disease (Baranowski et al., 1992). Additionally, studies also suggest that the PA patterns adopted in early childhood and during adolescence may persist into adult life (Berenson, Wattigney, Tracy, Newman, Srinivasan, Webber, Dalferes, and Strong, 1986; Powell and Dysinger, 1987; Dennison, Straus, Mellits, and Charney, 1987; Strong, 1990; Sallis et al., 1992; Luepker, 1999; Taylor, Blair, Cummings, Wun, and Malina, 1999). For these reasons, international recommendations encourage adolescents to be active every day to obtain the health benefit from PA (Sallis and Patrick, 1994; Shephard, 1995).

1.1.2 Assessment of Physical Activity

Assessment of PA is always a challenge, especially with children, because children's PA patterns are very different from adults. Their daily activities are not regular and long-lasting but, instead are diverse, and very transient in nature (Freedson, 1989; Janz, 1994; Louie, Eston, Rowlands, Tong, Ingledew and Fu, 1999). There is still no single standard method of measuring PA (Kriska and Caspersen, 1997), although 30 different methods have been tested and applied in assessing PA of both adults and children (Laporte, Montoye, and Caspersen, 1985). Nevertheless, this wide range of physical assessment techniques gives the researcher more choices in deciding what method is going to be used (Freedson, 1989). The chosen methods might depend on a variety of conditions such as the objectives of the study, the validity and reliability of the instrument, the sample size, ethnicity and age of subjects, environmental and financial aspects. Each method has advantages and disadvantages that need to be considered in relation to the context and research question. Self-report measures are the most commonly used for assessing PA in studies of large sample sizes of both adults and children (Baranowski, 1988; Cale, 1994). However, results based on these methods must be treated with some caution (Freedson, 1989; Freedson, 1991; Goran, 1998; Trost, Pate, Ward, Sounders, and Riner, 1999a), as young children may have difficulty in recalling their PA (Sallis, 1993). Recently, advances in technology support instruments such as accelerometers and heart rate monitors, have facilitated measuring PA in children and adolescents. These instruments are assumed to be accurate, objective, qualitative measures which eliminate the limitations of self-report measures (Freedson, 1991; Janz, 1994; Trost et al., 1999a). However, according to a number of validation studies of monitoring devices, either in the field or in the laboratory, there are some disadvantages associated with their use. They provide no information on the kind of activities and do not discriminate between the amounts of time spent on various activities (Freedson, 1991). Those validation studies of electronic monitoring devices for PA assessment have mostly used children living in North America or Europe as subjects (Louie et al., 1999), while children living in other parts of the world (e.g. Asia) may physically differ in terms of their stature. Louie et al. (1999) have also pointed out that current studies are very culturally and environmentally specific: "Habitual PA in children is highly dependent on their culture and living environment...". Therefore, the reliability, validity, and practicability of these activity-measuring instruments may need to be evaluated in a specific ethnicity and culture (Kriska, 2000).

1.1.3 Physical Activity and Influencing Factors

Physical Activity is a broad term that encompasses both organised activity (e.g. sport activity, recreational groups, and structured physical training) and unorganised activity (e.g. spontaneous play). PA thus varies in kind as well as in intensity and physiological outcomes. Participation in PA may be affected by many factors such as genetic influences, physical environmental conditions, health-related fitness, socio-economic status (SES) and personal interest (Malina, 1988; Sallis et al., 1992; Sallis, Zakarian, Hovell, and Hofstetter, 1996; Luepker, 1999). The relative contributions of each factor might further vary with age, sex, culture and ethnicity (Gottlieb and Chen, 1985; Cratty, 1986; Sallis et al., 1992; Sallis et al., 1996). In terms of PA promotion, identifying the factors which influence PA of adolescents is of interest to national health planners. Baseline data about PA and fitness are useful in identifying trends, and providing directions for future public health policies and physical educational (PE) curricula as well as for the planning of community facilities.

1.1.4 Statement of the Problem Specific to Vietnam

Physical activity is addressed as an important part of national development programs for children and adolescents in every country. Unfortunately, PA has not been studied extensively and efficiently in Vietnam, especially in the case of children and adolescents. To date no research on the effects of PA or fitness on the health of Vietnamese youth has been published in the peer-reviewed international literature. This is not surprising, given that a review of the available literature also indicates that there has been no systematic study on fitness profiles of Vietnamese adolescents. This deficit of research into the PA patterns of the younger population in Vietnam has a number of explanations. Firstly, after its internal war, Vietnam was isolated for a long time from the world because of political issues (e.g. The American Embargo). This has led to a lack of information from the international community on research into the PA and health areas in Vietnam. Secondly, on a financial level, there were not sufficient resources for internal and external studies to be conducted. Furthermore, there was a lack of prominent Vietnamese experts who were fluent in the international languages (e.g. English, French) and who could also align themselves with the scientific development of PA from public health and educational standpoints. This has limited the number of international publications coming out of Vietnam. Vietnam is however, currently changing from a centralised-government driven economy to a privatised, market-driven economy, along with an open-door policy, as part of its "reform" process. The PA and fitness levels of Vietnamese children and adolescents have emerged as a concern to physical educators, sport physicians and appropriate government organisations. Finally, to date, the available literature, primarily from studies of PA and fitness conducted in Western countries, does not inevitably apply to the Vietnamese context. Therefore, research into PA and fitness of children and youth in Vietnam is necessary to assist the professionals involved in the development of PA and fitness programs and the promotion of suitable sports.

This study aimed to develop a valid instrument for the evaluation of PA in a group of adolescents of Vietnamese ethnicity and to identify the patterns of PA and physical fitness of this group of Vietnamese adolescents. These techniques can then be used to conduct studies in larger, representative samples of Vietnamese adolescents at a later date. It further aimed to examine some of the factors such as culture, gender, and SES, which influence participation in sports activity by young people in Vietnam. The differences in PA patterns and fitness between native Vietnamese adolescents and Australian adolescents of Vietnamese background were also examined in order to identify further cultural, physical and environmental factors which influence the choice of PA.

1.2 The Objectives of the Study

The general objective of this study was:

To identify PA patterns in a group of Vietnamese adolescents and assess the influence of physical, cultural, environmental and socio-economic factors on their participation in PA.

Specific objectives of this study were:

1. To develop an objective and quantifiable measure of PA, suitable for use on a Vietnamese adolescent population.

2. To assess PA in a group of Vietnamese adolescents using a modified three-day physical activity record and questionnaires.

3. To measure some indicators of health, anthropometrical and fitness components for a group of Vietnamese adolescents using current physical fitness field-tests.

4. To compare patterns of PA and fitness between gender and socio-economic groups of a sample of Vietnamese adolescents.

5. To identify the interrelationships between PA patterns, fitness, and SES in Vietnamese adolescents.

6. To compare the PA patterns and fitness of a group of Vietnamese adolescents with a similar age-matched group of Australian adolescents of Vietnamese background.

7. To gain an understanding of the effect that changes in culture and in environment can have on PA and fitness.

1.3 Significance of the Study

To date there has been no measure of PA suitable for use on a Vietnamese or Southeast Asian population reported in the international literature. This study developed such a tool (especially for adolescents) and also provided valuable and original information on the caloric equivalents of typical PA undertaken by Vietnamese adolescents.

At this time there is limited information on PA and fitness profiles of Vietnamese children and adolescents. This study provides the first set of such data on these functions and on their interrelationships. Such information may lead to the development of recommendations to the Vietnamese government for improving health promotion, with the emphasis on PE and sport training policies for young people.

Although the effect of culture is often suggested as a factor in adolescent PA and fitness profiles, no previous work on this area in relation to Vietnamese adolescents has been reported in the literature. This study provides some insights into the effect of cultural influences on these parameters.

1.4 Limitations and Delimitations

The nature and physical environments of this study imposed several conditions, which were beyond the absolute control of the researcher.

1.4.1. Although the three-day physical activity record was modified and made suitable for Vietnamese adolescents, rather than used in its original form (Bouchard et al., 1983), the precision of the measurement is still reliant on the subject's recall skills. Thus this study and other studies involved were limited by the student's recall ability.

1.4.2. As access to oxygen uptake measuring equipment in Hanoi is extremely restricted, a convenient sample of participants to be tested in the laboratory had to be recruited from schools in Ho Chi Minh City, where the laboratory was used to conduct study 1. Thus, these subjects were not the same as the adolescent students who were subjects for the field-testing conducted in Hanoi city for study 2. This was perceived as an unavoidable limitation of the study.

1.4.3. A further limitation to the study was found in the data provided by the CSA activity monitors. In spite of constant advice from manufacturers and adherence to maintenance schedules, the CSA activity monitors malfunctioned during the field data collection and that became a problem in the analysis of data.

14.4. Studies 1 and 3 were limited by the use of different equipment in Vietnam and in Australia. Although the equipment utilised was the same in make and model, and calibration and experimental techniques were identical in both countries, the use of different equipment does limit the study.

In conducting this study, the following delimitations were imposed by the researcher:

1.4.5. In order to make the study feasible, the participants were delimited as male and female adolescents aged between 12 and 14 years and living in Hanoi City. But the pubescent status of each participant could not be revealed because of the difficulty of the reserved nature of students growing up in the Vietnamese culture.

1.4.6. Due to the nature of the program and the age of the participants, no attempt was made to randomly select adolescents, as participation in the study was undertaken on a voluntary basis. Randomisation of adolescents in Hanoi City would have made the data collection beyond the scope of the single researcher within the time permitted for completion of the study.

1.4.7. The duration and intensity of each exercise during the laboratory test were selected on the basis of previous research designs and were delimited to the activities of walking and running.

1.5 Definition of Terms

It is important to consider the definitions that are used in assessing and classifying

PA. The following terms have been defined in order to clarify their usage throughout this dissertation:

***Physical Activity*:** Many definitions of PA and fitness have been published. Generally, PA is a broad term that describes "any bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen, Powell, and Christenson, 1985). Physical activity can be categorised in different ways. Caspersen et al. (1985) have simply categorised PA into occupational, sleeping and leisure activities, in which the leisure activities were further subdivided into sports, conditioning exercises, household tasks, and other activities.

PA has four basic dimensions:

- *Frequency is the number of sessions per day or week.*

- *Intensity refers to the rate of energy expenditure.*
- *The duration is the time spent in activity and refers to a single or a cumulative amount of time over a day or week.*
- *The type of activity is a qualitative descriptor of the nature of the activity.*

(Sallis and Patrick, 1994)

These four elements, when combined, will contribute to the net effect of producing a health benefit or increased physical fitness.

Physical fitness: "a set of attributes, that people have or achieve that relates to an ability to perform physical activity" (Caspersen et al. 1985).

Another definition of youth fitness has been described which is more appropriate: "Health-related physical fitness is (1) the ability to perform strenuous physical activity with vigor and without excessive fatigue, and (2) demonstration of physical activity traits and capacities that are consistent with minimal risk of developing hypo-kinetic diseases" (Pate, 1983). Measurements of physical fitness generally contain health-related and skill-related elements (Safrit, 1995).

Health-related fitness components are:

- *Cardiorespiratory fitness* (also referred to as aerobic fitness), which relates to the ability of the circulatory and respiratory systems to supply fuel during sustained PA and to eliminate fatigue products after supplying fuel.
- *Body composition*, which relates to the relative amounts of muscle, fatness, bone, and other components of the body.
- *Muscular endurance,* which relates to the ability of muscle groups to exert external force for many repetitions or successive exertions.

- *Muscular strength*, which relates to the amount of external force that a muscle can exert.
- *Flexibility,* which relates to the range of motion available at a specific joint.

(Caspersen et al., 1985).

Health: The World Health Organization Health (WHO) has defined health as a " state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1948). Since 1948, the definition has not been amended (WHO, in www.who.int, 2001).

There are also some other definitions of terms used in relation to the research area, which are as follows:

Adolescents: The International Consensus Conference on PA Guidelines has defined the adolescent age group as ages 11 through 21 years (Sallis and Patrick, 1994).

Body mass index (BMI): A measure of a person's weight in relation to their height, calculated as weight in kilograms divided by height in metres squared. Body mass index is considered to relate directly to body fatness (Rowland, 1996).

Calorie: A unit of energy measurement. A calorie is a measure used to express the heat or energy value of food and PA. It is defined as the amount of heat necessary to raise the temperature of 1 kg (1 litre) of water 1^{o} C, from 14.5 to 15.5 ^{o} C. Thus a calorie is more accurately termed a kilogram calorie or kilocalorie (kcal). The accepted international standard for expressing energy is the joule.

One joule = one kcal x 4.2 (McArdle, Katch and Katch, 1991)

1 kcal = 1,000 calories = 4,184 joules = 4.184 kilojoules

Energy expenditure (EE): Energy relates to the ability to perform work. Any PA can result in the release of energy. Energy expenditure is an estimate of the total energy release. It is expressed in oxygen equivalents either in a rate ($ml \cdot kg^{-1} \cdot min^{-1}$) or as a capacity ($ml \cdot kg^{-1}$). It is usually reported as an estimate of the energy costs of PA derived from reports, observations or indirect objective measurements of activity levels of children and adolescents. The total daily activity EE can be calculated from the following formula:

$$Kcal_{sleep} + kcal_{occupation} + kcal_{conditioning} + kcal_{household} + kcal_{other} = kcal_{total\ daily\ physical\ activity}$$

(Caspersen et al., 1985).

Exercise: A subset of PA (bodily movement) that is planned, structured, and repetitive and is aimed to improve or to maintain one or more components of physical fitness (Caspersen et al., 1985).

Maximal oxygen consumption (uptake) VO_2max: A measure of peak oxygen consumption by the muscle during exhaustive physical work in a specific activity. It is widely described as the aerobic capacity, but this is dimensionally incorrect as it is essentially a unit of power, being expressed as a rate ($ml \cdot kg^{-1} \cdot min^{-1}$).

Metabolic equivalents (METs): A multiple of the resting metabolic rate that can be expressed in terms of oxygen consumption per unit of body weight, 1 MET being about 3.5 $ml \cdot kg^{-1} . min^{-1}$.

CHAPTER 2

LITERATURE REVIEW

This dissertation investigates the levels and types of physical activity (PA) in Vietnamese adolescents. It also considers the extent to which culture, socio-economic status (SES), and physical environment influence participation in PA in Vietnamese adolescents. In doing so it begins with an examination of the validity and reliability of the CSA activity and heart rate monitoring as a quantifiable measure of PA suitable for use with a Vietnamese adolescent population. Furthermore, it compares PA patterns of Vietnamese adolescents with those of other countries to determine the effects of cultural and environmental factors on PA. It contributes to gaps in information on PA, fitness and health in developing countries in the international literature.

This review begins with an overview of research on the measurements of PA and fitness, focusing on the validation of objective measures, and activity questionnaires for assessing PA in children and adolescents. The next section reviews the effects of PA and fitness on health and prevention of risk factors among children and adolescents. The third section addresses the international literature on the PA status of children and adolescents, the interrelationship between PA, fitness and SES factors as well as discussing the influence of cultural and environmental factors on different ethnic children and adolescents. The final section concerns the issues specific to research on health, PA and fitness in Vietnamese native children and adolescents in relation to the nation's history, education and culture.

2.1 Historical Overview of Physical Activity and Fitness

Throughout history there are numerous examples from different cultures emphasising the importance of PA in human life. For instance, hunting and food gathering were the main activities for Greeks, Romans and Indigenous North Americans prior to the arrival of Europeans (Bouchard, McPherson, and Taylor, 1992). Because of the importance of such physical skills, young males were trained in endurance, strength and power to become soldiers or hunters, females and children were trained to grow plants and collect food (Bouchard et al., 1992; Bouchard et al., 1994). During and after the industrial revolution of the 18th and 19th centuries, new physical education (PE) systems were established in many countries in Europe and America (Bouchard et al., 1992). This formalising and institutionalising of PA led to the development of research in this area at the commencement of the 20th century. Early significant continued research in this area was conducted in the Harvard Fatigue Laboratory, which commenced operations in 1927 in the United States (Horvath and Horvath, 1973). During the middle part of the 20th century, studies on PA began to consider its relationship to health issues. In 1958 Morris and Crawford conducted research into the role of physical inactivity on the development of coronary artery disease. At the same time, Karvonen, Kentala and Mustala (1957) studied the effects of exercise training on heart rate at rest and at work in different intensities.

There is also a long history of studies of anthropometry, growth and maturation of children (Malina and Bouchard, 1991). According to Park (1995) who compiled a history of research on PA and health from 1867 to 1950s, Henry Bowditch conducted his first study of growth in children in Boston, America in 1872. One year later

Francis Galton who was one of the first honorary members of the American Association for Advancement of Physical Education (AAAPE) conducted a study on measurements of height, weight, and other data on British school children. In the early 1890s William Porter conducted a project on the measurements of 35,500 St. Louis school children in America to establish percentile tables of rates of growth and to examine the association between physical development and other measurements (Park, 1995).

A number of longitudinal studies of physical performance and fitness tests of children have been conducted since the mid 1950's in North America and Europe (Seefeldt and Vogel, 1989; Malina and Bouchard, 1991). The University of Oregon conducted the Medford Boys' Growth Study in 1956 to measure growth, maturation, physical fitness and motor performance of young males from 7 to 18 years old. Beginning from 1960, the Prague Study considered the measurements of motor performance and aerobic power in a group of boys from 10 to 18 years of age. In the late 1960s, The Leuven Growth Study in Belgium, The Nijmengen Growth Study, and The Amsterdam Growth and Health Study in the Netherlands were conducted. These studies were continued for about 6 years and focused on measures of growth, motor performance, aerobic power and habitual PA of adolescents aged 12 to 20 years (Malina and Bouchard, 1991).

Since 1950, Studies on PA, fitness and health reported in the literature have generally been based on two main aspects (Blair and Connelly, 1996). Firstly, research was based on the role of PA and the effects of a sedentary lifestyle on the development of coronary artery disease, some cancers and other health problems (Bouchard et al., 1994; Powell and Blair, 1994). Secondly, research was concentrated on the relationship of PA to the improvement of physical fitness and its measured components (Blair and Connelly, 1996). Consequently, the relationship of PA to fitness and health has been studied intensively in the past three decades (Blair, 1993).

Whilst the numerous health benefits of PA for adults are widely documented in many countries, there is not a great deal of literature on the relation of PA or fitness to health in children and adolescents (Baranowski et al., 1992; Bouchard et al., 1994). Most of the past statements and recommendations on PA for children and adolescents were based on studies of adults (Sallis and Patrick, 1994). The effect of PA on youth health has emerged as a topic of interest to epidemiologists, physiologists, physical educators, and governmental organisations largely in the last two decades. In the 1992 International Consensus Conference, a group of about 100 international scientists examined the evidence of the beneficial effects of regular PA on health as a scientific basis for developing PA guidelines for adolescents (Shephard, 1995). Therefore, during recent years, more studies have concentrated on the relationship between health and PA lifestyle during childhood and adolescence.

2.2 Assessment of Physical Activity and Physical Fitness

2.2.1 Introduction

According to the definitions of PA and physical fitness (cited in section 1.6), PA is considered as the process, while physical fitness is the outcome (Shephard, 1995). Strong (1990) has briefly emphasized the qualitative and quantitative difference between PA and physical fitness in terms of measurements: "physical activity is usually measured qualitatively by self-report questionnaires, and structured interviews that estimate the degree of physical activity during work, leisure time, and sports participation... Physical fitness, on the other hand, relates to a measurable set of physical variables". This distinction helps health professionals to understand not only the definitions but also measurements of PA and physical fitness in epidemiological studies among children and adolescents.

Reliable measurements or descriptors of PA and fitness for children and adolescents are currently needed to understand better the associations between physical inactivity, low levels of fitness and poor health. The accurate assessment of habitual PA and fitness levels in childhood is of interest for epidemiologists who need to refine these relationships. It is also important for the promotion of PA and fitness, which may assist in the maintenance of PA in later life (Sallis, 1993; Malina, 1996). This section will describe and discuss the use of the most common assessment methods of PA and fitness focusing on issues in relation to the assessment of PA.

2.2.2 Field Methods of Assessing Physical Activity

The assessment of PA is always an important and challenging issue as each component of PA is varied both in individuals and between populations, and several dimensions of PA such as EE, aerobic intensity, weight bearing, durations and styles of activities can be measured in different ways (Kriska and Caspersen, 1997). Not only is there a need to understand PA patterns, but also the relationship between PA and health status requires further elucidation. Thus, commitment to this challenge is a difficult but priority concern for physiologists, epidemiologists, and physicians. Bouchard et al. (1994) have classified various individual measurable techniques that have already been manipulated into six categories of PA assessment (see Table 2.1 below).

Table 2.1. *PA assessment procedures* (adapted from Bouchard et al., 1994).

1. Calorimetry:
   a) Direct heat exchange (in insulated chamber or "space-suit")
   b) Indirect (respirometry)
2. Physiological markers:
   a) Heart rate monitoring
   b) Doubly isotopically labelled water
   c) Cardiorespiratory endurance ($\dot{V}O_2max$)
3. Mechanical and electronic motion detectors:
   a) Pedometer
   b) In-shoe step counters
   c) Electronic motion sensors
   d) Accelerometers
4. Behavioural observations
5. Dietary energy intake (food diary)
6. Occupational and leisure-time survey instruments:
   a) Job classification
   b) Global self-assessment
   c) Activity diaries or records
   d) Recall questionnaires
   e) Quantitative historical

Except methods in category 1 (Calorimetry), which are laboratory methods, all the methods in this table can be utilised as field techniques for assessing PA. Technically, these methods can be used for both children and adults (Baranowski et al., 1992). However, there are many interacting factors that must be considered when selecting these assessment instruments (Bouchard et al., 1994), especially in children (Baranowski et al., 1992; Welk, Corbin, and Dale, 2000). Thus, each method of assessing PA has advantages and disadvantages, and no one method is suitable for all studies (Baranowski et al., 1992; Welk et al., 2000). The assessment of PA is often ethnic and culture specific in nature (Kriska, 2000). Issues that require consideration, particularly in epidemiological studies, are validity and reliability of the instrument, suitability to subjects, the time and cost of study, and the size and demographics of the population under review.

Laporte et al. (1985, p. 131) suggested four important criteria that researchers need to evaluate when selecting an instrument:

" - *To be valid, the instrument must measure what it is intended to measure.*

- *To be reliable, the instrument must consistently give the same results under the same circumstances. If the instrument is reliable and valid, it is also accurate.*
- *To be practical, the instrument must have acceptable cost to both the investigator and the participant.*
- *To be nonreactive, the instrument must not alter the population or the behaviour it seeks to measure*".

Direct Observation

Use of direct observation methods provides a high level of information on PA in children and adolescents (Baranowski, Dworkin, Cieslik, Hooks, Clearman, Ray, Dunn, and Nader, 1984; Bailey, Olson, Pepper, Porszasz, Barstow, and Cooper, 1995;

Welk et al., 2000). There are two kinds of direct observation methods: Simple observations where observers view subjects and record activities in systemised forms, and complex observations where observers use techniques and equipment such as movie cameras and video recorders (Montoye, Kemper, Saris, and Washburn, 1996). Like other measurement methods of PA, observations have some advantages and some disadvantages. On the one hand, observation methods can provide accurate information on durations, intensities and types of activities being observed, thus EE of PA can be estimated (Montoye and Taylor, 1984; Montoye et al., 1996). On the other hand, as large studies use a large number of observers, they are time-consuming and cost is often prohibitive (Montoye et al., 1996). Furthermore, subjects might change their normal activities if they know they are being observed (Montoye et al., 1996) or, in some cultures, subjects may not agree to being observed. Because of these limitations, observation methods have usually been utilised in studies with a small number of subjects, or they are used as a criterion measure to validate other methods (Montoye and Taylor, 1984; Montoye et al., 1996).

Saris and Binkhorst (1977) have used a simple observation to validate the pedometer and actometer for measuring PA in 11 kindergarten children. The observation was categorised into four activities (sitting, standing, walking and running), and two-minute intervals of each type of activity were recorded. Sleap and Warburton (1992) have used 4-minute periods of observation to measure PA in 56 British children (aged 5 to 11).

Klesges, Coates, Klesges, Holzer, Gustavson, and Barnes (1984) have developed an observational coding system for recording PA in kindergarten children named the Fargo Activity Timesampling Survey (FATS). This observational instrument has coding categories of child behaviours with 8 levels of intensities from level 1 (sleeping) to level 8 (running), and an interval time of 10-second observations. The authors reported that the level of agreement between observers about the behaviour and intensity of activities ranged from 91% to 98%. Correlations between the FATS and motion sensor scores were from r = 0.79 to r = 0.90.

Klesges, Klesges, Swenson, and Pheley (1985) and Klesges and Klesges (1987) both used the FATS as a criterion measure to examine the validity of motion sensors for assessing PA in younger children in field settings, and they found the validity of instruments was increased when longer observation was used (see the section on *Objective Instruments,* p. 30). Mukeshi, Gutin, Anderson, Zybert, and Basch (1990) also used FATS to estimate EE and compared it with the method using the Caltrac during 1-hour observations in children by video cameras. In this study, the mean EE values of the two estimated methods did not significantly differ between indoor and outdoor conditions (see also the section of *Objective Instruments*).

Another observation system for assessing PA in children named Children's Activity Rating Scale (CARS) was developed by Puhl, Greaves, Hoyt, and Baranowski, (1990). Activities were categorised into 5 levels of intensities, from stationary activities (lying or sitting) to very fast/strenuous activities. The authors used videotapes and observers recorded activity scales (1 - 5) during each minute of observation. By using the CARS, 84.1% of agreement among observers over a 12-month period was obtained in 192 children (aged 3-4 yrs). Puhl, et al. (1990) also calibrated the activity EE of the levels of the CARS in a laboratory setting. A group of

25 children (aged 5-6 yrs) performed eight activities representing the 5-levels, and $\dot{V}O_2$ and heart rate were determined. The mean values of $\dot{V}O_2$ for the eight activities were from 1 MET (level 1) to 5.42 METs (level 5) and were significantly different ($P < 0.05$) between all 5 levels of the CARS (Puhl, et al., 1990). The authors concluded that the observation system (CARS) was reliable for measuring PA and EE in young children.

It appears that the two observation systems (the FATS and CARS) developed by Klesges, et al. (1984) and Puhl, et al. (1990) were used with young children (ages < 6 yrs). The use of young children in most observation studies indicates that observation methods can be used more easily in young children than in adolescents or in adults, who may not agree to being observed throughout the day (Baranowski, 1988). The reliability of the observation methods in most of the studies (mentioned above) was demonstrated by the high percentages of agreements between observers during observations, but the intervals used in each observation system ranged widely, from 4-minute periods (Sleap and Warburton, 1992) to 10-second periods (Klesges et al., 1984). In summary, observation methods seem to be suitable for assessing PA in small groups, and in younger children. These methods also showed high reliability when the observation systems were carefully categorised (Montoye et al., 1996). The limitations, such as the tediousness, costs, time-consuming aspect, and/or the discontentment of subjects however, may make these methods impractical in assessing PA in large groups and older children or adults.

Questionnaires

The most popular instruments of PA assessment for large populations are questionnaires (Baranowski, 1988; Cale, 1994; Kriska and Caspersen, 1997). This instrument has many advantages: it does not change the behaviour of the subject being assessed, it is both time-and cost-efficient, easily applicable, and convenient for subjects (Kriska and Caspersen, 1997). Furthermore, it has been evaluated as a valid and reliable measurement (Montoye and Taylor, 1984; Laporte et al., 1985).

Kriska and Caspersen (1997) have documented the latest versions of most of the popular PA questionnaires, along with results of reliability and validity studies of these instruments. By summarising several questionnaires for measuring PA, the authors also described different aspects of their use: a) complexity of surveys; b) time frame of surveys; c) types of activity surveys; d) scoring physical activity data; and e) reliability and validity measures. This report described a variety of questionnaire use, from single-item questionnaires (measuring levels of PA or influencing factors) to complex questionnaires (measuring a wide range of popular activities in a selected time frame). The time frame, which covered the assessment time of the activity questionnaire varied from the past week, month, year, or carried out over a lifetime. Types of activities surveyed included assessments of both occupational and leisure-time activities. Generally, scoring physical activity data obtains values from measuring the type, frequency, duration, and the intensity of the activity. It can be measured in metabolic cost (METs) or kilocalories. Other factors, such as the subject's ability to recall information, researcher or participant bias, the time of days of being monitored, and socio-demographic and cultural influences must be considered in developing a questionnaire, as they affect the reliability and validity of questionnaires.

Previously, Laporte et al. (1985) had described the different characteristics that questionnaires need to have to obtain complete information from respondent's activities. Firstly, the time frame of PA that respondents need to report could be from a short time (eg. less than 24 hours) to more than a year. Secondly, questionnaires may detail the volume of activities (frequency, duration, intensity) and types of activities, provided by respondents' answers. Thirdly, there are different methods of data collection such as interviews, self-administration, mail survey, or a combination of these methods. Another characteristic is that questionnaires may need to predict activity EE in kilocalories or levels of PA. According to these characteristics, Laporte et al. (1985) generally classified questionnaires into four categories: diary, recall, quantitative history, and general surveys.

Recently, Baranowski (1988) and Cale (1994) reviewed several validation studies of activity questionnaires conducted in both children and adults, and have generally classified these questionnaires into three types of self-report measures: concurrent or end-of-the day diaries; retrospective reports on self-completed forms; and retrospective interviewer-conducted forms. These three types of self-report measures provide several advantages that researchers can use to quantify a variety of variables in assessing PA (Baranowski, 1988). Selection of these different measures depends on the ability of researchers to use instruments skilfully to fit the study design, problems being examined, and aims of studies. Although Baranowski (1988) highlighted many attractive advantages of self-report measures, he also has indicated two major sources of error in terms of the accuracy of this technique: the definition of the desired variables, and human cognitive processes. Regarding the first source of error, although PA has beneficial influences on health (Shephard, 1995), the kind of

PA, and exact duration and intensity of PA that are clearly identified as achieving health related outcomes are not known (Haskell, 1985). Consequently, various measures used in the self-report process have been chosen to quantify physiological processes (e.g. EE, or frequency and intensities of PA), but it is difficult to approximate the behaviours that produce this physiological stimulus and to compare values from different instruments applied to the same subjects (Baranowski, 1988). In order to identify the effective physiological stimulus, Baranowski (1988) suggested that a combination of controlled laboratory and field setting studies would be an answer.

Issues from the second source of errors (relative cognition processes) are more problematic when using questionnaires in assessing PA in children, since they have memory limitations and less cognitive ability to recall PA than adults (Baranowski, 1988; Cale, 1994). Children quickly forget details of activity information and mix together imagination and awareness in remembering (Cale, 1994), thus they may exclude the characteristics of activities that are important for the investigator (Baranowski, 1988). Because of this failure of recalling activity in children, salient information on activities provided by children recalling may not be accurate (Baranowski, 1988).

Other sources of error with self-report measures are related to accurate judgements of time of activities by respondents (Cale, 1994). For example, children may not report correctly the time of an activity because they do not have watches, and their daily tasks are normally organised by parents (Baranowski et al., 1984). The appropriate length of assessment and seasonal variation also need to be addressed, to improve the accuracy of recall measurement (Baranowski, 1988; Cale, 1994). "How many days of assessed activity are necessary to obtain a reliable estimate of habitual physical activity, which is the variable of interest in most cardiovascular epidemiology? How does activity differ by weekday versus weekend, and by season of the year? And how do these sources of variability affect the estimates of habitual activity?..." (Baranowski, 1988, p. 324).

In spite of limitations, several self-report measures available in the literature have been developed and used with children and adolescents (Cale, 1994; Goran, 1998). Cale (1994) has reviewed eight self-report measures which have been validated by a number of studies, with reports of reliability and validity. These self-report measures are summarised as follows:

1) Self-report aerobic activity forms (Baranowski et al., 1984).
2) Leisure-time exercise questionnaire (Godin and Shephard, 1985, Sallis, Buono, Roby, Mical, and Nelson, 1993).
3) 7-day recall physical activity questionnaires (Wallace, Mckenzie and Nada, 1985; Sallis, Patterson, Buono, and Nader, 1988; Sallis et al., 1993).
4) One-item activity rating (Sallis et al., 1988; Sallis et al., 1993).
5) One-item aerobic activity questionnaire (Tell and Vellar, 1988).
6) Activity poster (Murphy et al. 1990).
7) Moderate to vigorous physical activity recall (Simons-Morton, Parcel, Huang, Baranowski, and Wilson, 1990).
8) The yesterday activity checklist, the weekly activity sum, the weekly activity checklist and the 7-day activity tally (Sallis et al., 1993).

The reliability values of self-report measures reported among these studies were from moderate to high, while the validity values were reported lower than the reliability. Like all other instruments, self-report measures have some disadvantages (Cale, 1994), but in fact, a variety of self-report questionnaires described in the literature provide a wide range of choices for studies involving in PA (Cale, 1994).

In order to examine age effects on the reliability and validity of three styles of self-reports (7-day recall, the Godin-Shephard physical activity survey, and the activity rating scale), Sallis et al. (1993) conducted a study in three different age groups of children (36 fifth, 36 eighth, and 30 eleventh grade students). Overall, for the test-retest reliabilities, correlation coefficients were high and significant for all three instruments ($r = 0.77$; 0.81; and 0.93 for the 7-day recall, the Godin-Shephard survey, and the activity rating, respectively). The reliability was also improved with age for all measures except for the activity rating. The effect of age was clearly found when the authors compared the reliability of the kilocalorie expenditure index estimated by the 7-day recall between the three age groups. For instance, the correlation coefficient was $r = 0.47$ for fifth grade, but r was = 0.59 for eighth grade and $r = 0.81$ for eleventh grade. These findings indicate that elementary school children (fifth grade) had more difficulty in recalling activities than did adolescents at middle school (eighth grade) or high school (eleventh grade). To test the validity of the 7-day recall Sallis et al. (1993) used heart rate monitoring on the same day as recall as a criterion measure. They defined the intensity of "activity intervals" based on heart rate data. To eliminate the psychological effect on low and mid elevations in heart rate, activity intervals with heart rate ≥ 140 or ≥ 160 bpm lasting for at least 10 min were classified as very hard activities. The validity coefficients were also improved with age, a significant correlation of 0.53 – between the time reported by recall and heart rate monitoring of very hard activities - was found for the total group. Interestingly, Sallis et al. (1993) found that the reliability of 7-day recall was affected by gender. For example, the reliability correlation of the EE index for males was much higher (r = 0.80) than for females (r = 0.49). Because the 7-day recall used in this study was an interviewer-administered recall of PA over the last seven days, Sallis et al. (1993) examined the effect of the length of intervals between day recalls on reliability in order to find out how many days between interviews should be appropriate for an interval. They reported that the reliability coefficient was decreased from r = 0.79 after 2-3 day interval to r = 0.45 after 4-6 day interval. The shorter the time between activity and recall, the more reliable children's memory of activities obtained. Thus activity recalls over the last 24 hours may be the most reliable reports (Sallis et al., 1993). Based on the above findings, Sallis et al. (1993) emphasised that the 7-d physical activity recall can be used reasonably for assessing children as young as 10-11 yrs, but because both the reliability and validity of this method were improved with age, the application of self-reports should be used with caution in younger children (Sallis et al., 1993).

To test further validation of self-reports, Kowalski, Crocker, and Faulkner (1997) examined the validity of a self-administered 7-d recall named the Physical Activity Questionnaire for Older Children (PAQ-C) by assessing the relationship between the 7-d recall and other PA measured instruments. In their first study (n = 89 students grades 4 – 8), there were significant correlations between the PAQ-C and an activity rating (r = 0.63), a teacher's rating of PA (r = 0.45), and a total of 24-hr MVPA (r = 0.53). The PAQ-C also significantly correlated with perceptions of athletic competence (r = 0.48) indicating the construct validity of the 7-d recall (Kowalski et al., 1997). In the second study conducted in another 97 school students (aged 9 – 14 yrs), Kowalski et al. (1997) have found that the PAQ-C was moderately correlated with all other measures including a 7-day physical activity recall interview (r = 0.46), the Godin and Shephard leisure questionnaires (r = 0.41), and the Caltrac (r = 0.39). There was only a weak correlation between PAQ-C and a step test of fitness (r = 0.28). The results of the Kowalski et al. study (1997) apparently showed that the 7-d recall was not only significantly associated with other PA self-reports, but also with objective measures (Caltrac), perceptions of athletic competence, and the teacher's rating. Thus the study provided strong evidence of validity of PAQ-C.

Objective Instruments

The development of electronic and microcomputer technology has facilitated the introduction of new devices, including motion sensors, accelerometers and heart rate monitors, which can somewhat overcome the limitation of questionnaires and meet the criteria of providing objective measures of PA with minimal discomfort (Goran, 1998; Westerterp, 1999). Although several studies used these instruments to assess PA, issues such as malfunctioning and tampering need to be considered in the use of these instruments for assessing PA in children and youth (Freedson, 1991; Welk et al., 2000). The following pages review the literature that has reported on the evaluation of validity and reliability of these mechanical and electronic motion detectors, as well as recommendations for using these devices when assessing PA among children and adolescents. In table 2.2, a summary of selected studies of validated motion sensors, accelerometers, and heart rate monitors is derived from the literature. Most of the validation studies of these PA monitoring devices utilised western children and adolescents as subjects.

Table 2.2. *Validity and reliability of accelerometers and heart rate monitors for assessing physical activity in children and adolescents.*

Author (Year)	Subject (Age)	Objective Measure	Criterion Measure	Condition	Reliability	Validity
Saris & Binkhorst 1977, Part2	11 (4-6 yr) Netherlands	Pedometer Actometer	Direct observation, Questionnaire	Field	NR	$r = 0.93^*$ $r = 0.97^*$
Laporte et al. 1982	22 (12-14 yr) USA	LSI	3-d Food Intake Taylor Leisure Time Activity Survey	Field	NR	$r = 0.30$ $r = 0.16$
Klesges et al. 1985	30 (1.6-5.6 yr) USA	LSI & Caltrac	Direct observation	Field	NR	$r = 0.40^*$ *(LSI)* $r = 0.35^*$ *(Caltrac)*
Klesges & Klesges, 1987	30 (2-4 yr) USA	Caltrac	Direct observation	Field	r = 0.90 (inter-observation)	$r = 0.54^*$
Fenster et al. 1989	18 (6-8 yr) USA	LSI	$\dot{V}O_{2peak}$	Laboratory	NR	$r = 0.59$
Mukeshi et al. 1990	20 (2.5-3.4 yr) USA	Caltrac	Direct observation	Field	NR	$r = 0.62^*$

* = Significant correlation; NR = no report; LSI = Large Scale Integrated Sensor.

Table 2.2. *Continued*

Author (Year)	Subject (Age)	Objective Measure	Criterion Measure	Condition	Reliability	Validity
Sallis et al. 1990	36 (8-13 yr) USA	Caltrac HR monitor	Study1: 7-d PA Recall	Field	r = 0.96* (inter-Caltrac)	*r = 0.39* - 0.39* (Caltrac)* *r = 0.42*- 0.54** *(heart rate)*
		Caltrac	Study2: $\dot{V}O_2$	Laboratory	r = 0.89* (inter-Caltrac)	*r = 0.82**
Danner et al. 1991	51 (2.6-5.5 yr) USA	Caltrac	Direct observation	Field	NR	*r=0.86* (year1)* *r=0.83* (year2)*
Freedson & Evenson, 1991	30 (5-9 yr) USA	Caltrac	NR	Field	r = 0.38* (D1 vs. D2) r = 0.79* (D1 vs D2) r = 0.42* (D1 vs D3)	*NR*
Bray et al. 1994	40 (13 ±1.8 yr) USA	Caltrac	Calorimetry	Laboratory	NR	*r = 0.80**
Janz, 1994	31 (7-15 yr) USA	CSA (Model 5032)	HR	Field	r = 0.23 - 0.25 (between-D Caltrac)	*r = 0.58**

* = Significant correlation; NR = no report; D = day; HR = heart rate.

Table 2.2. *Continued*

Author (Year)	Subject (Age)	Objective Measure	Criterion Measure	Condition	Reliability	Validity
Janz et al. 1995	30 (7-15 yr) USA	CSA (5032)	Self-report	Field	r = 0.81 to 0.84* (between-D Caltrac)	$r = -0.03 - 0.51^*$
Melanson & Freedson, 1995	28 (21.0 ± 1.0 yr) USA	CSA (5032) Caltrac	EE HR Prediction equation	Laboratory	NR	$r = 0.66^* - 0.82^*$ *(EE)* $r = 0.77^* - 0.89^*$ *(VO_2)* $r = 0.66^* - 0.80^*$ *(HR)* $R^2 = 0.92$ *(SEE = 0.85)*
Trost et al. 1998	50 (10-14 yr) USA	CSA (Model 7164)	EE Prediction equation	Laboratory	r = 0.87* (intra-instrument)	$r = 0.87^*$ $R^2 = 0.83$ *(SEE = .97)*
Eston et al. 1998	30 (8.2-10.8 yr) UK	Pedometer CSA (7164) Tritrac-R3D HR monitor	$\dot{V}O_2$ Prediction equation	Laboratory	NR	$r = 0.90^*$ *(Tritrac)* $r = 0.78^*$ *(CSA)* $r = 0.80^*$ *(pedometer)* $r = 0.80^*$ *(HR)*
Trost et al. 1999	198 (11.4 ± 0.6 yr) USA	CSA (7164)	Questionnaires: Self-efficacy	Field	NR	$r = 0.18$ & 0.27^* *(boys)* $r = 0.24^*$ & 0.33^* *(girls)*

* = Significant correlation; NR = no report; D = day; HR = heart rate; EE = energy expenditure.

Table 2.2. *Continued*

Author (Year)	Subject (Age)	Objective Measure	Criterion Measure	Condition	Reliability	Validity
Louie et al. 1999	21 (8-10 yr) Hong Kong China	Pedometer CSA (7164) Tritrac-R3D HR monitor	$\dot{V}O_2$ Prediction equation	Laboratory	NR	$r = 0.94^*$ *(Tritrac)* $r = 0.86^*$ *(CSA)* $r = 0.86^*$ *(pedometer)* $r = 0.89^*$ *(HR)*
Ott et al. 2000	28 (9-11 yr) USA	CSA (7164) Tritrac-R3D	HR monitor Predicted MET level	Laboratory	r = 0.59 - 0.95 (CSA) r = 0.6 - 0.96 (TriTrac) (in 8 activities)	$r = 0.43^* - 0.58^*$ *(CSA)* $r = 0.66^* - 0.73^*$ *(TriTrac)*
Ekelund et al. 2001	26, (9.1 ± 0.3 yr) Sweden	CSA (7164)	Doubly labeled water EE	Field	NR	$r = 0.39^*$ *(CSA & TEE)* $r = 0.58^*$ *(CSA & PAL)* $R^2 = 0.54 - 0.60$
Sirard et al. 2000	20 young adults (25 ± 3.6 yr) USA	CSA (7164)	Self-reported diary (three days)	Field	D3 ≠ D2 only	$r = 0.65^*$ *(D1)* $r = 0.49^*$ *(D2)* $r = 0.55^*$ *(D3)*

* = Significant correlation; NR = no report; D = day; HR = heart rate; EE = energy expenditure; TEE = total EE; PAL = physical activity level.

Actometer and Pedometer

Schulman and Reisman (1959) used the actometer as a device that measures the acceleration and deceleration of movements to quantify the amount of PA. Since the first use of motion sensors, other authors have examined the reliability of both the pedometer and actometer instruments during different activities in children and adults. Saris and Binkhorst (1977) conducted a laboratory study on subjects (including 9 children aged 5-6, and 6 young adult males aged 21-31 yrs) who were wearing both an actometer and a pedometer on the hip whilst they were walking and running (6-9 $km \cdot h^{-1}$) on a treadmill. These authors found that the pedometer did not reflect the intensity level at different speeds, as did the actometer. Thus, the EE could not be estimated accurately with the pedometer (Saris and Binkhorst, 1977). Although Saris and Binkhorst suggested that the actometer could be valuable for estimating EE of daily PA, the r-value of the reliability was not reported and the subject sample in this study was quite small. For inter-instrumental unit comparisons, high variation was observed because of variations in the spring tension (Saris and Binkhorst, 1977).

In the second part of the study by Saris and Binkhorst (1977) the validity of the pedometer and actometer for measuring PA were evaluated by an observation of a kindergarten group (aged 4-6 yrs). They found that the observation data were more significantly correlated with the ankle actometer (r = 0.97) than with the wrist actometer (r = 0.71). The mean of the observation index for PA was 148 and 108, and the mean of the pedometer output was 2530 and 1346, for the most active and the least active groups, respectively. There appear to have been few extensive studies validating pedometers in field settings. The lack of field studies utilising pedometers may be due to the introduction of the new generation of electronic motion detectors such as the Caltrac and Computer Science Application (CSA) which have replaced the pedometer and actometer in PA research (Freedson, 1991).

Large Scale Integrated Sensor

Another type of motion sensor, used previously for measuring PA in adults, was the Large Scale Integrated Sensor (LSI), which is 51-gram, and 3.8 x 4.5 x 2.2 centimetre in size (Freedson, 1989). Foster, McPartland, and Kupfer (1978) validated the LSI to measure PA in adult subjects (n = 7) at different speeds of walking and running on a treadmill, and reported that the correlation between LSI counts and the speeds was high (r = 0.96). In contrast, in a later study, Wasburn and Laporte (1988) found that correlation of LSI data with the walking speed in a field setting study in adults was r = 0.53, and test-retest correlations were r = 0.22 and 0.42, for slow and fast walking speeds respectively. Klesges et al. (1985) examined the validity of LSI in a study of 30 children aged 1.6 to 5.6 years, using 1-hour observation of activities as the criterion measure. Pearson correlations between observed variables of activity behaviours (distinguished by rating scales) and LSI readings ranged from r = - 0.31 to r = 0.38, and the correlations of LSI with activity intensity levels ranged from r = - 0.27 to r = 0.44, for the minimal and maximal intensities, respectively. Fenster, Freedson, Washburn, and Ellison (1989) measured one day's PA by LSI in a group of 18 children aged 6-8 years, and reported that the correlation of LSI counts per hour with the $\dot{V}O_{2peak}$ data measured on a treadmill was r = 0.59. It was argued that the low correlations in the field study by Klesges et al. (1985) may be due to the short period of observation, and to the fact that the LSI device could not mechanically discriminate between the characteristics of the diverse short bursts of activities in these children (Freedson, 1989). It should be noted that most of the studies validating the motion sensors were carried out in small samples of subjects and over short periods. There also appears to be a shortage of information on the data of validity and reliability of these devices in studies for adolescents.

Caltrac Accelerometer

The Caltrac was defined as an accelerometer that measures movement in a single plane only (Goran, 1998). While the old models were somewhat large (14 x 8 x 4 cm, and weighing 400 g) (Freedson, 1991), the new model is more compact (9.7 x 7.0 x 1.3 cm, and weighing 78 g) (Westerterp, 1999). This device is able to determine PA (vertical acceleration) by scoring in counts or by estimating EE of activities. Predetermined values for each individual (i.e. Age, height, weight and gender) are entered in order to estimate EE; output measures are obtained through a display on a small liquid crystal screen or interfacing with a printer.

Several studies have examined the validity of a Caltrac accelerometer in measuring the daily PA of adults and children in laboratory settings (Montoye, Washburn, Servais, Ertl, and Webster, and Nagle, 1983; Sallis et al., 1990; Maliszewski, Freedson, Ebbeling, Crussmeyer, and Kastango, 1991), and in the field (Klesges et al., 1985; Klesges and Klesges, 1987; Mukeshi et al., 1990; Danner, Noland, McFadden, Dewait, and Kotchen, 1991; Freedson and Evenson, 1991; Bray, Wong, Morrow, Butte, Pivarnik, 1994).

Sallis et al. (1990) examined the validity of Caltrac for assessing PA in children (aged 8 - 13 yrs) both under laboratory conditions and in field settings. In the laboratory study, Sallis et al. (1990) reported that a Pearson correlation between the caloric cost and the Caltrac counts was r = 0.82 across the three treadmill speeds (at 3, 4, and 5 mph), although the standard error was 23%. Similarly, in a previous study, Montoy et al. (1983) found a high correlation of r = 0.74 between the Caltrac counts and oxygen consumption during 14 activities in adults (aged 20-60). Sallis et al. (1990) also calculated a caloric cost per Caltrac count (one Caltrac count being equal to 0.101 $kcal \cdot kg^{-1}$) by measuring the mean $kcal \cdot kg^{-1}$ versus the mean Caltrac count scores for each treadmill trial. Sallis et al. (1990) then used this caloric cost constant to convert the daily EE from Caltrac counts for children who wore the Caltrac for two days. The daily Caltrac kilocalories for the mean weight of this group (n = 35) were 405 kilocalories on day one and 403 kilocalories on day two, whereas, the daily EE estimated from physical activity recall at the end of those days were 450.4 and 318.8 $kcal \cdot d^{-1}$ for day one and day two, respectively. From these results, Sallis et al. (1990) suggested that the one Caltrac count of approximately 0.101 $kcal \cdot kg^{-1}$ was a reasonable estimate and this conversion constant could be used to approximate EE for measuring PA by Caltrac accelerometer.

The correlations between Caltrac counts and direct observation of PA were significant in the previous studies conducted in pre-school children (Klesges et al., 1985; Klesges and Klesges, 1987; Mukeshi et al. 1990; Danner et al., 1991). However, the range of correlations between hours was quite different in these studies. Klesges et al. (1985) found a low correlation of r = 0.35 between the criterion measure of one hour of direct observation and Caltrac score. Klesges and Klesges (1987) in their subsequent study, used a longer observation (8.9 h) as the criterion measure to validate the Caltrac for assessing PA in 30 preschool children. The correlation between observation and hourly Caltrac counts ranged from moderate (r = 0.62) to high (r = 0.95), and the correlation of the Catrac readings with observed activity was high (r = 0.80) for the older group (2.7- 4 yrs), but low, (r = 0.39), for the younger group (2-2.6 yrs). The correlation values however, were not significantly different between the activity intensity levels.

In another study, Danner et al. (1991) measured PA in 51 children (aged 2.6 - 5.5 yrs) by a Caltrac motion sensor and a video for one hour in the first year and in the second year. The correlations between Caltrac readings and observational scores (which used the Children's Activity Rating Scale, CARS) were high and consistent in both year one (r= 0.86) and year two (r= 0.83). These results were, however, inconsistent with the findings by Mukeshi et al. (1990) who used a similar method to examine the validation of Caltrac using direct observation (video) in pre-school children (aged 2.5-3.4) for one hour, indoor and outdoor, of unorganised playground activity. The correlations between the Caltrac scores and observational values were moderate both in indoor (r = 0.56) or outdoor activities (r = 0.48). But when they statistically determined the personal data (body weight, height, age, and sex) from both the direct observation and Caltrac values, the correlations turned out to be lower (r = 0.47) and non-significant (r = 0.16) for indoor and outdoor activity, respectively.

Bray et al. (1994) examined the validity of the Caltrac in a respiration chamber and by observation. Forty females aged 10 to 16 were observed over 24 hours in normal activities and were then required, on a separate occasion, to exercise for two 20-min periods on a cycle ergometer. The subjects wore a Caltrac unit on each hip; one programmed for estimating EE and the other for assessing activity counts. There was a significant correlation between the EE calculated in the respiration chamber and a combination of Caltrac counts and body weight (r = 0.86).

The inconsistent results reported from the above studies could possibly be explained by the fact that, while all studies used Caltrac and direct observation, each utilised Caltrac programs and observational score systems differently (Danner et al., 1991). It was also pointed out that the observational periods used in those studies were quite short, except in the Klesges and Klesges' study (1987). In addition, the Caltrac can only measure vertical movements, while there are many activities where the whole body movements are not just vertical, such as cycling, playing in the sitting position, pushing or pulling, and these movements and/or any others can be accounted for by observation (Freedson, 1991).

Uni-axial Accelerometers: Computer Science Application (CSA)

The other electronic motion detector, produced by Computer Science Application, Inc. (CSA, Shalimar, FL), is the CSA activity monitor. It is designed to detect a single normal human movement without impeding activity, in a non-controlled setting, to quantify PA. There are two models of this activity monitor available. The original activity monitor (Model 5032 measures 6.6 x 4.3 x 2.5 cm, and weight 70 g) has been previously validated (Janz, 1994; Melanson and Freedson, 1995; Janz, Witt and Mahoney, 1995). The new activity monitor (Model 7164) is small (5.1 x 4.1 x 1.5 cm) and very lightweight (43 g). The CSA activity monitor can assess acceleration ranging from 0.05-2.0 G with frequency response from 0.25 to 2.50 Hz. The filtered acceleration signal is digitised and the magnitude of the motion is summed over a user-specified epoch interval. At the end of each epoch, the summed value of movements is stored as counts and the integrator is reset. The CSA activity monitor, especially the new model of CSA can easily be worn at the subject's hip or waist. Some studies (most of which have been conducted in laboratory controlled-settings) have examined the validity and reliability of the new model of CSA in children and adults (Freedson, Sirard and Debold, 1997; Eston, Rolands, and Ingledew, 1998; Trost, Ward, Moorehead, Watson, Riner, and Burke, 1998; Freedson, Melanson and Sirard, 1998; Louie et al., 1999).

Janz (1994) used heart rate telemetry as a criterion measure to examine the validity and utility of the CSA activity monitor in 31 children aged 7-15, and reported that the correlation coefficients between the heart rate monitor and accelerometer were moderate to high across three monitored days (r = 0.05-0.74). There were no significant differences between day activity variables in either heart rate telemetry or CSA monitor data. However, the correlations between each activity variable over the three days were very low to moderate (r = 0.23 – 0.53) indicating a large intra-individual variation of PA (Janz, 1994). In support for these findings Janz et al. (1995) reported the accelerometry stability of activities increased by increasing the number of monitored days (30 children aged 7-15 yrs wore the CSA for 12 $h \cdot d^{-1}$ for six days). That is, the stability of the accelerometer used for one day was r = 0.42-0.47, but increased to r = 0.81-0.84 when it was used for six days, and the intraclass correlations were r = 0.75-0.78 for four days of monitoring. It was suggested that heart rate and activity monitors need to be worn for more than three days to assess the stability of the activity levels (Janz, 1994; Janz et al. 1995). With regard to the utility of these devices, children reported that the activity monitor did not impede their activities, while the electrodes of the heart rate telemetry were not convenient to wear during hot days (Janz, 1994).

Melanson and Freedson (1995) conducted a further examination of CSA monitor validity and used EE as a criterion measure. Participants (aged 20-22) were required to walk and run on three different treadmill grades, while they wore the CSA monitor and the Caltrac at the same time. Both CSA and Caltrac counts were significantly correlated with EE (r = 0.66 – 0.82), heart rate (0.66 – 0.80), $\dot{V}O_2$ (r = 0.77 – 0.89) and treadmill speed (r = 0.82 – 0.92). However, the monitors did not appear to discriminate between treadmill grades. As both Caltrac and CSA accelerometers measure vertical acceleration, Melanson and Freedson (1995) have compared the CSA monitor with the Caltrac and found that they had a similar parameter output and were also able to be used for estimating EE. In a multiple regression equation utilising CSA counts and body mass as predictors, data from all three located CSA units (at the ankle, hip and wrist) achieved the highest multiple correlation coefficient (R = 0.95) with a variance of 92% and a standard error of the estimate (SEE) of 0.85 $kcal \cdot min^{-1}$ (Melanson and Freedson (1995). The correlation coefficient between actual and predicted EE was high (r = 0.89), but the range of individual differences was still large (from -2.86 to + 2.04 $kcal \cdot min^{-1}$). These values are very similar to those found in other studies in children (Trost et al. 1998) and in adults (Freedson et al. 1998).

The placement and the number of the CSA monitors worn by subjects also need to be considered. As Melanson and Freedson (1995) demonstrated, the EE prediction equation obtained from two units was of higher value than from a single unit, regardless of their location, and the best EE prediction equation was obtained from three units placed on the wrist, hip and ankle. These findings indicate that the more units worn by subjects, the more accurate the output of activity measurements as the multiple units can measure all body part movements. For example, if a single unit was placed on the ankle or hip, it cannot reflect single arm actions. The use of multiple monitors however, requires an extra cost and is burdensome on the subjects, especially in children and adolescents (Trost et al., 1998). For these reasons, single site attachments (waist or hip) of accelerometers have been recommended for most current studies in children and adolescents (Janz et al. 1995; Trost et al., 1998; Trost et al., 1999a).

Since the CSA monitor measures PA as movement counts, it is important to define the count range that denotes different intensities of activity levels. Janz et al. (1995) established the activity monitor count ranges (model 5032) corresponding to sedentary, moderate, and vigorous activity of 25-250, 251-499, and ≥ 500 counts·min^{-1}, respectively. These results were based on heart rate and movement counts recorded simultaneously in children. For the new CSA model 7165, Freedson et al. (1998) developed the activity monitor count categories by using MET classifications based on the data from the adult participants working at three treadmill speeds. These count ranges were ≤ 1951, 1952 – 5724, 5725 – 9498, and ≥ 9499 counts·min^{-1}, corresponding to light, moderate, hard, and very hard activity intensity levels, respectively. The count ranges of the new CSA model however, were developed from data of adult subjects only.

The correlation coefficients between activity movement counts and self-reports have been demonstrated to be from very low to moderate (r = -0.03 – 0.51, Janz et al., 1995). Trost et al. (1999) reported similar correlation coefficients (ranging from r = 0.01 to 0.33) between psychosocial and environmental variables and the activity counts of the CSA worn by children for seven consecutive days. The low and discrepant correlations between self-reports and accelerometers might be caused by the limitations of both these instruments. On the one hand, the different self-reports used in these studies may not accurately record the inconsistent and spontaneous PA in children (Janz, 1994; Janz et al. 1995; Trost et al. 1999) or perhaps because "children tend to overestimate their PA" (Sallis et al. 1993, p106). On the other hand, the limited measuring ability of the CSA accelerometers, which cannot detect non-vertical movements, may cause the inaccuracy of PA readings of individuals (Janz, 1994; Janz et al. 1995; Trost et al. 1999).

Since the SEE values were quite large in some studies (Melanson and Freedson, 1995; Freedson et al., 1998; Trost et al., 1998), the EE equation developed from the CSA was appropriate for predicting the mean of activity EE of a group, but may not be accurate for individuals in the field. These large SEE values were noticed even though all those studies were conducted in laboratory-controlled settings. In a recent study, Sirard, Melanson, Li, and Freedson (2000) evaluated the ability of the CSA activity monitor to measure PA in free-living conditions using a self-report diary as a criterion measure of the daily EE. This study involved 19 participants (mean age 25.0 ± 3.6 yr) and reported that there was a significant correlation between the CSA counts and total activity EE calculated by the activity diary (r = 0.51). The CSA overestimated light activity and underestimated vigorous activity, compared with the self-report diary. Therefore, the limited number of studies using the new model of CSA activity monitors in the field shows the need for further investigation of the validity and reliability of this measure in predicting EE and distinguishing PA intensity, especially among children and adolescents.

Tri-axial Accelerometers: Tritrac-R3 D

The TriTrac-R3 D (Model t303, Madison, WI) is a Tri-axial accelerometer; it can detect three dimensions of movement. Its size is larger than the CSA accelerometer, 11 x 6,7 x 3,2 cm, weight 170 g, thus it is usually worn on the hip, waist or low back (Westerterp, 1999). As with the Caltrac, EE can be estimated by entering height, weight, age and gender. In laboratory conditions, Louie et al. (1999) examined the validity of activity monitors including the tri-axial accelerometer for estimating $\dot{V}O_2$ in a group of Hong Kong Chinese boys (aged 8-10) during regulated activities (walking and running) and unregulated activities (playing catch, hopscotch and crayoning). This was the first study that validated accelerometry instruments on Asian children. Overall, the TriTrac-R3 D was the best predictor of $\dot{V}O_2$ ($R^2 = 0.89$) compared with CSA monitor ($R^2 = 0.74$), heart rate ($R^2 = 0.79$), and the wrist pedometer ($R^2 = 0.08$). This outcome is very consistent with a previous study by Eston et al. (1998) who used a very similar methodology on UK children (mean age 9.2 ± 0.8 yr), and also reported that the best of the single estimates of $\dot{V}O_2$ was the TriTrac-R3 D accelerometer ($R^2 = 0.83$). Mathews and Freedson (1995) further used the Tritrac-R3D to estimate daily EE in 25 young adults (aged 25 - 28) in free-living conditions and compared the results with records of a 3-d activity diary and 7-d recall.

While the Tritrac counts were strongly correlated with the diary (r = 0.82) and 7-d recall (r = 0.77), the daily EE estimated from the Tritrac underestimated the EE values calculated from the other two measures.

Some other tri-axial accelerometers have been validated and introduced in the literature; for example the Tracmor tri-axial accelerometers, Tracmor O (4 x 6 x 8 cm, 350 g), Tracmor 1 (11 x 7 x 3,5 cm, 250 g), and Tracmor 2 (7 x 2 x 0.8 cm, 30 g). These accelerometers were developed in the laboratory at Maastricht University in the Netherlands, and have been validated as a tool for estimating EE and measuring activity intensity levels (Westerterp, 1999). It would appear that the tri-axial accelerometer might be the best device to provide an accurate assessment of EE and intensity levels in children's PA (Eston et al. 1998; Louie et al. 1999; Westerterp, 1999). Nevertheless, the cost is high and the size of this instrument may not be comfortable for subjects to wear.

Heart Rate Monitor

Heart rate monitoring is one of the field techniques commonly used to measure PA (Livingstone, Robson, and Totton, 2000). Because the correlation between HR and $\dot{V}O_2$ is linear during exercise, EE can be estimated from a HR recording (Montoye and Taylor, 1984; Karvonen and Vuorimaa, 1988; Freedson, 1991; Goran, 1998; Eston et al. 1998; Louie et al. 1999). Additionally, this technique is simple and not invasive as well as being an objective measure (Janz, 1994; Livingstone et al., 2000). Heart rate monitoring (HR telemetry system, HR monitor) is the most general method for determining HR during physical exercises. However, there are some disadvantages that need to be considered when using HR monitoring, particularly in natural conditions. Heart rate can vary from day to day as it is affected by a number of factors other than PA, such as gender, age, training status, and psychological and environmental conditions. Furthermore, different kinds of muscle groups or different exercises make the HR respond differently, although the total amount of EE during these exercises may not be different (Londeree and Moeschberger, 1982; Montoye and Taylor, 1984; Sallis et al. 1990; Freedson, 1991). For example, leg exercise elicits a higher HR response than arm exercise but both exercises may require the same EE. Because of these limitations, HR may have a poor relationship with EE, especially with low intensity activities (Montoy and Taylor, 1984). Therefore, most investigators did not calculate EE by HR monitoring, but determined the intensity levels of activities by discriminating the minutes of low, moderate and strenuous intensities based on HR during these exercises (Freedson, 1991; Janz, 1994).

Several studies have examined the validity of HR as a criterion measure to determine PA in children and adolescents, in both laboratory and field conditions (Gilliam, Freedson, Geenen, Shahraray, 1981; Sallis et al. 1990; Livingstone, Coward, Prentice, Davies, Strain, McKenna, Mahoney, White, Stewart, Kerr, 1992; Durant, Baranowski, Davis, Rhodes, Thompson, Greaves, Puhl, 1993; Janz, 1994; Maffeis, Pinelli, Zaffanello, Schena, Iacumin, Schutz, 1995; Gilbey and Gilbey, 1995; Eston et al. 1998; Louie et al. 1999). Sallis et al. (1990) determined children's daily PA by using three instruments: a HR monitor, the Caltrac and 7-d PA recall, and found the mean activity HR (calculated by subtracting the mean of the five lowest HRs of the day) was significantly correlated with the Caltrac ($r = 0.42$) and the activity recall ($r = 0.54$). The correlations between days of HR monitoring however, were low and non-significant (r = 0.10). These findings were supported by Janz, in 1994, who found the between day stability of individual PA measured by HR was r = 0.02 – 0.32. These results indicate that like the Caltrac, a HR monitor needs to be worn at least for a few days to determine PA patterns (Sallis et al. 1990; Freedson, 1991; Janz, 1994).

Although the types of exercises cannot be directly determined by HR monitoring, the levels of PA can be determined by HR monitoring over a long period of the day and over a few days (Freedson, 1991; Janz, 1994; Gilbey and Gilbey, 1995). For example, if exercises raise the HR ≥ 150 $b \cdot min^{-1}$ (about 70% of maximal HR), these exercises reflect vigorous activities (Janz, 1994). If children spend a number of minutes in activities where the HR is low or close to the resting level, they are considered as being less active, or sedentary (Freedson, 1991; Gilbey and Gilbey, 1995). Based on this methodology, Gilbey and Gilbey, (1995) determined the PA patterns of Singapore primary school children (aged 9 - 10 yrs) by HR monitoring. This was the first study that used HR monitoring to assess daily PA patterns in an Asian child population. The subjects wore a HR monitor (Polar Vantage XL) for three normal school days and one weekend day. The authors reported that the HR of 20% of boys and more than 50% of girls never once reached a single 10 min ≥ 140 $b \cdot min^{-1}$ during a day; boys were more active than girls and lean girls were more active than obese girls. The PA levels of these children did not differ between weekdays and weekend days. The above findings indicated that HR monitoring could determine the levels of activities (Freedson, 1991; Janz, 1994; Janz et al., 1995; Gilbey and Gilbey, 1995), and that the correlations between HR and the activity self-report were significant (Sallis et al., 1990).

2.2.3 Measurement of Physical Fitness

The measurement of physical fitness, or physical fitness testing, has been consistent throughout the world over the past 40 years (Kemper and Van Mechelen, 1996). In order to assess the physical fitness of populations, it is important to establish the differences between *performance-related norms* (PRN) and *health-related criterion standards* (HRCS) (Bouchard et al., 1994). While PRN should have levels such as: below average, average, and above average to be used for comparison among peers, HRCS should have levels such as: undesirable, minimal, acceptable, and desirable, to be used as viewing and guidelines for adjustment of fitness levels of populations (Bouchard et al., 1994).

There is no doubt that physical fitness testing is very important for the development of fitness education programs and for sports talent selection in children and youth. It can be a vital part of the fitness curriculum, and give students incentives for improving fitness and developing (their) healthy lifestyles (Safrit, 1995). Physical fitness testing has been used for different purposes (Pate, 1989), based on physical education, including program evaluation, student motivation and recognition, selection of sports talents, screening for fitness deficiencies, and promotion of cognitive and affective learning. Unlike the assessment of PA, the measurement of fitness in children and adolescents has obvious criterion measures for different types of fitness (Baranowski et al., 1992). Several fitness tests have been developed for children and adolescents, most of which distinguish between performance-related and health-related physical fitness components, and each component has both criterion measures and field measures. Determination of the components to be measured with mainly health-related or mainly performance-related tests depends on how we define physical fitness (Safrit, 1995). However, this section will focus more on health-related physical fitness measurement, which generally covers four main components of fitness: Cardiorespiratory fitness, body composition, muscle strength and endurance, and flexibility. Definitions of these components have been mentioned previously (see section 1.6). Baranowski et al. (1992) have listed the pertinent laboratory and field tests for each component of health-related physical fitness (Table 2.3).

Table 2.3. *Health related physical fitness component procedures (adapted from Baranowski et al. 1992).*

Cardiorespiratory	Lab: maximal aerobic power ($\dot{V}O_2max$); submaximal cycle ergometer tests (PWC_{170})
	Field: distance runs (mile, 1,5-mile, 9-min, 12-min); step tests; graded shuttle run
Body composition	Lab: hydrostatic weight; deuterium oxide dilution; potassium counting
	Field: skinfold thickness; body mass indices; girth measures
Flexibility	Lab: goniometric measures; Leighton flexometer
	Field: sit-and-reach; stand-and-reach
Muscular strength	Lab: isometric dynamometer; isokinetic dynamometer; isotonic one repetition maximum; cable tensiometer
	Field: pull-ups; modified-pull-ups; sit-ups
Muscular endurance	Lab: repetitions or time to fatigue at set percentage of maximum force

Cardiorespiratory endurance (aerobic fitness) is "a key element of health-related fitness" (Skinner and Oja, p 172 in Bouchard et al., 1994) and is directly measured by maximal aerobic power ($\dot{V}O_2max$) as a criterion measure. Because direct measures of $\dot{V}O_2max$ in children face many difficulties, sub-maximal tests such as the physical work capacity (PWC) are commonly used instead. Field tests of aerobic fitness are usually distance runs and shuttle runs (Table 2.3). Distance runs are traditional tests for aerobic power, and have been widely conducted in children and adolescents. But the validity of these tests has not been well documented in children (Baranowski et al., 1992), as the conducting of the tests in children still has some difficulties, such as the distance or time requirement, motivation and contribution of anaerobic power in children (Massicotte, Guathier, and Markon, 1985).

In previous studies, Massicotte et al. (1985) validated two distance tests for predicting $\dot{V}O_2max$ in children aged 10-12 yrs (1600 m) and adolescents aged 13-17 yrs (2400 m). The authors used direct measurement on the bicycle ergometer as a criterion measure, and reported that $\dot{V}O_2max$ was significantly correlated with the running time in both tests (r = from 0.62 to 0.84 for age and sex). The average error of the best prediction equation of $\dot{V}O_2max$ was 10% for boys and 13% for girls. Although other distance runs such as the 12-min run or the 1-mile run have been commonly used, the multistage 20m-shuttle run developed by Leger and Lambert (1982) has recently been used in children (Baranowski et al., 1992). The validation of the 20m-shuttle run in children will be discussed in chapter 5 (see 5.2.2).

Percentage of body fat has been utilised intensively in assessing body composition (Bouchard et al., 1994). Methods of assessment of body composition will be described in the section below (see 2.3.4). Measures of body mass index (BMI) and skinfold thicknesses are mostly used in field measurement to estimate the percentage of body fat. Several equations for predicting percentage of body fat from skinfold have been developed in children (Docherty, 1996). The equations developed by Slaughter and her co-workers (1988) are commonly used by epidemiogists to estimate the percentage of body fat from skinfold thickness measurements in children, as these equations take into account the variations of biochemical maturation. The Slaughter equation group has been cross-validated as reliable to use for children aged 7 to young adults with a standard error of 3% - 4% (Janz, Nielsen, Cassady, Cook, Wu, Hansen, 1993). This equation has been divided into groups such as gender (males and females), biochemical maturation (prepubescent, pubescent, and postpubescent), and ethnicity (black and white). However, no equation which is suitable for estimating percentage of body fat in Asian children has been reported in the literature.

A combination of muscle strength, muscle endurance, and flexibility is sometimes classified as "musculoskeletal fitness" (Bouchard et al., 1994) or "neuromuscular fitness" (Baranowski et al., 1992). These fitness variables are considered health-related fitness components, as the weakness of trunk muscles is associated with increased risk of low back pain (Baranowski et al., 1992). The association between these fitness components and health however, is not well known (Bouchard et al., 1994). Tests such as sit-ups, pull-ups, modified pull-ups, push-ups, and sit and reach are most popularly used in field measurement in children and adolescents, as these tests are simple, low-cost and can be used in large samples of populations. These tests however, need to be used with some caution as a lack of validity of the tests has been reported (Baranowski et al., 1992; Pate, Burgess, Woods, Ross, Baumgartner, 1993).

Pate et al. (1993) examined the validity of five field tests (pull-ups, flexed arm hang, push-ups, Vermont modified pull-ups, and New York modified pull-ups) for upper muscular strength and endurance in 94 American children aged 9-10 yrs. The authors found that there was no significant correlation between the field test scores and the criterion measures ($p < 0.05$). Correlation coefficients between the field-test scores and criterion measures however, were significant, when the data was expressed relative to body weight ($r = 0.50 - 0.70$). Pate et al. (1993) contended that these field tests were not valid for measuring absolute strength and muscle endurance of the upper body, but they were valid measures of weight-relative muscle strength.

In order to establish criterion-referenced standards for youth fitness, numerous batteries of fitness tests have been conducted by many fitness organizations in many countries in past years. For example, the Youth Fitness Test was published by the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) in 1958 (Seefeldt, and Vogel, 1989). Since then, several fitness tests were revised, and four national fitness surveys were conducted in American children (Corbin and Pangrazi, 1992). In Canada, the CAHPER Fitness Performance Test Manual was first published in 1966, and the Physical Working Capacity Test (PWC_{170}) was published by CAHPER in 1968 (Docherty, 1996). After several tests in the first Test Manual were revised, the new CAHPER Fitness Performance II Test

Manual was published in 1980 (Docherty, 1996). In Europe, the development of fitness tests has followed the USA since the 1960s, and the EUROPFIT handbook was published in French and English in 1988 (Kemper and Mechelen, 1996). In Australia, the Australian Youth Fitness Survey was firstly conducted in the late 1960s, and after it was revised by ACHPER, a National Fitness Award Scheme was published in 1983 (ACHPER, 1987). Subsequently, the Australian health and Fitness Survey (1985) and the National Nutrition Survey (1995) were conducted on Australian school students (Magarey, Daniels, and Boulton, 2001).

Although the measurement of fitness has a longer history and more criterion measures than that of PA, the components, interpretation, validity and reliability of fitness tests, and the development of criterion referenced standards for children are still subject to debate (Rowland, 1989; Safrit, 1990). Another issue related to the measurement of fitness is that there have also been misclassifications of the current fitness standards for youth (Cureton and Warren, 1990; Pangrazi, 2000). Consequently, a proportion of youth populations may be classified as unfit or their fitness level as undesirably low, thus these individuals are identified as having low PA and increased risk of disease (Cureton and Warren, 1990; Pangrazi, 2000)

2.2.4 Summary

Although there are a variety of field methods that have been used in assessing PA in children and adolescents such as observations, questionnaires, and objective measures, no standard method has been recognised internationally. Each method has some disadvantages and advantages, but no one measure is satisfactory in all circumstances. Among the field methods of measuring PA, questionnaires are still the typically chosen measures for population studies. However, when using this technique for measuring PA in children, especially under 10 year olds, it can be problematic, as children have less ability to estimate their daily PA than adults. In contrast, objective measures can obtain more accurate estimates of activity EE but they are not practical for large studies. Initially therefore, objective measures have usually been used to validate the PA questionnaire measure. Observation can provide a high level of information about PA in children. The implementation of this method however, may not be realistic as it is high-cost and time-consuming, and subjects may not allow observation or they may alter their PA style during observation.

In contrast to PA, the measurement of fitness, or fitness testing, has more criterion measures. Several fitness test batteries creating health related criterion-referenced standards or performance related norms for youth have been developed in many countries. However, research is still needed to discriminate more clearly between performance-related fitness and health-related fitness. Many issues, including the validity and reliability of the criterion standards and the tests for children also need to be classified.

Implementation of PA measures and/or fitness tests depend on the purposes of the studies. Many issues need to be considered, such as finance, the duration of the study, gender and age of subjects. For example, observation methods may be suitable for assessing PA in younger children, while questionnaire methods may be suitable for assessing PA in older children.

2.3 Health Benefits of Physical Activity and Fitness for Children and Adolescents

2.3.1 Introduction

Many large population-based studies (Kohl, Laporte, and Blair, 1988; Baranowski et al., 1992; Haskell, 1994; Luepker, 1999; Blair, and Brodney, 1999) have reported a connection between PA and fitness and many health areas. Research in this area was well summarised by Blair (1993) who represented evidence of health benefits from PA (Table 2.4). But it must be emphasised that the available information was based on adult subjects only. Studies of PA, fitness and health of adolescents has generally concluded that adult diseases such as obesity and coronary heart disease might have antecedents during childhood and adolescence (Sallis et al., 1992; Bouchard et al., 1994; Twisk, Kemper, Mellenbergh, van Mechelen, 1997).

Although a number of studies (cross-sectional and longitudinal) have generally reported that habitual PA has many physiological influences on the health of youth (Shephard, 1984; Rowland, 1990; Sallis, 1993; Sallis et al., 1996; Luepker, 1999; Twisk, Kemper, and Mechelen, 2000), the relationships between the PA levels of adolescents and health outcomes, as well as the influencing elements, are not well understood (Twisk, Snel, Vente, Kemper, Mechelen, 2000; Twisk, 2001). Individual variations in growth during adolescence and in childhood morbidity factors prevent easy establishment of clear relationships. It should also be acknowledged that most of the available data on PA and health for both adolescents and adults have been gathered in the industrialised developed countries (Bouchard et al., 1994).

Table 2.4. *Summary of results of studies investigating the relationship of PA or physical fitness to selected chronic diseases or conditions, 1963-1993 (reproduced from Blair, 1993).*

Disease or condition	Number of studies[a]	Trends across activity or fitness categories and strength of evidence[b]
All cause mortality	***	↓↓↓
Coronary artery disease	***	↓↓↓
Hypertension	**	↓↓
Obesity	***	↓↓
Stroke	**	↓
Peripheral vascular disease	*	→
Cancer:		
colon	***	↓↓
rectum	***	→
stomach	*	→
breast	*	↓
prostate	**	↓
lung	*	↓
pancreas	*	→
Non-insulin-dependent diabetes	*	↓↓
Osteoarthritis	*	→
Osteoporosis	**	↓↓
Functional capability	**	↓↓

Note: * = Few studies, probably less than 5; ** = several studies, approximately 5-10;
*** = many studies, more than 10.
→ = no apparent difference in disease rates across activity or fitness categories, good methods;
↓ = some evidence; ↓↓ = good evidence; ↓↓↓ = excellent evidence of reduced disease rates across activity or fitness categories, good control of potential confounders, excellent methods, extensive evidence of biological mechanisms, relationship is considered causal.

Nevertheless, the consensus guidelines about the type, amount, and frequency of PA for adolescents are based on reviews of studies that demonstrate a relationship between PA and health indicators (Sallis and Patrick, 1994). Increased PA during adolescence has been related to other health outcomes including bone mineral density status (Bailey and Martin, 1994), adiposity and obesity (Bar-Or and Baranowski, 1994), blood lipids (Armstrong and Morton, 1994), reduced hypertension (Alpert and Wilmore, 1994), and psychological parameters (Calfas and Taylor, 1994). In the consensus process that established the connection between PA and fitness and many health outcomes as well as influences of the complicated factors on PA, a concept of linkages between PA, fitness and health was developed by the 1992 consensus conference (figure 2.1, Bouchard et al., 1994).

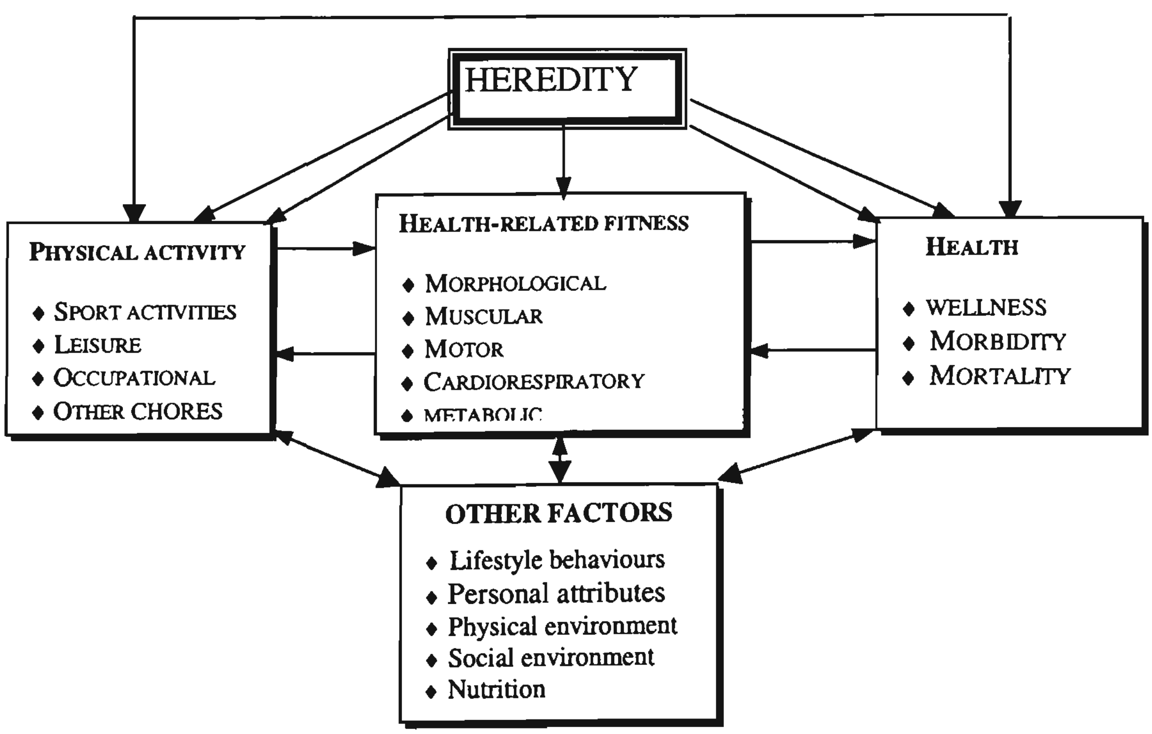


Figure 2.1. *Model describing the relationships among habitual physical activity, health related fitness, and health status (modified from Bouchard et al., 1994).*

2.3.2 Cardiovascular Risk Factors

Cardiovascular (CV) disease was a leading cause of mortality in the 20th century (Sytkowski, Kannel, D'Agostino, 1990; Kimm, and Kwiterovich, 1995) accounting for one third of all deaths in United States in 1989 (Kimm, and Kwiterovich, 1995), and for a similar ratio (about 40% of deaths) in Australia (Department of Human services, 1999). Regular PA has a beneficial effect on health, and is inversely associated with several CV risk factors in adults (Blair et al., 1989; Powell, Caspersen, Koplan, Ford, 1989; Slattery, Schumacher, Hunt, and Williams, 1993; Guillaume, Lapidus, Björntorp, Lambert, 1997; Luepker, 1999). Physical inactivity and low aerobic fitness have been recognized as important risk factors causing overweight and obesity contributing to mortality (Blair and Brodney, 1999).

Compared with research on adults, studies of the relationship of PA to CV risk factors in children and adolescents are more suggestive than unequivocal about the benefit of PA for the lessening of CV risk factors (Guillaume et al., 1997). Some evidence associated with this relationship in youth has however, been established. In the Guillaume et al. study (1997), the high BMI of 1028 Belgian children (aged 6 - 12 years) was positively related to physical inactivity measured by the amount of television viewing (TV) and negatively related to PA in boys, but not in girls. The gender difference was linked with the finding that the boys were more active than the girls. However, TV is unlikely to be the only cause for physical inactivity, as the sedentariness may come from various activities (e.g. lying on bed, reading books or studying). Sallis et al. (1988) also demonstrated gender differences in PA-CV risk factors associations. Surprisingly, the PA variable (measured by seven-day recall) was significantly associated with a ratio of high and low density lipoproteins (HDL/LDL) in only female children (n = 142) and adults (n = 180).

Recent studies have raised more concerns about CV risk factors, sedentariness, and their interrelationship in children and adolescents. An article from the Bogalusa Heart Study reviewed the data from 9167 participants aged 5-17 years in seven cross-sectional studies, and revealed that among those 813 who were overweight, 58% had at least one CV risk factor and 50% were found to have two or more CV risk factors (Freedman et al., 1999). Thus, the successful prevention and treatment of obesity during childhood could reduce the incidence of cardiovascular disease in adults (Freedman et al. 1999). Supporting evidence of this suggestion, Spyckerelle, Fournier, Steinmetz, and Collignon (1995) had previously examined the prevalence of the CV risk factors in relation to PA in 6,974 French adolescents between 14 and 18 years of age in 1980, 1984, 1988, and 1990. An increase in PA (from 46.9% to 57.5%) was accompanied by a decrease in CV risk indicators such as smoking (from 21% to 13.5% of smokers), and serum cholesterol (an average decrease of 5,7%). These results further agreed with another longitudinal study by Åkerblom, Viikari, Raitakari, and Uhari, (1999) which examined the effects of PA on CV factors in 3596 Finnish children (aged 3-18 years). This study began in 1980 and was followed up in 1983, 1986, 1989, and 1992. High levels of PA are associated with lower total cholesterol ratio and decreased incidence of smoking and obesity of both males and females (Åkerblom et al., 1999). Contrary to these results, Twisk, Boreham, Cran, Savage, and Mechelen (1999) reported no significant association between PA (measured by questionnaire) and the clustering of data of biological CV disease risk factors (measured by total cholesterol, diastolic BP, skinfold and cardiopulmonary fitness) during a 3-year observation of 229 boys and 230 girls between 12 and 15 years of age.

There was evidence of a high percentage of CV risk factors in Australian adolescents and children (Milligan, Thompson, Vandongen, Beilin, and Burke, 1995; Beilin, Burke, and Milligan, 1996). For example, about 21% of 555 school adolescents (15 year old) in Western Australia were identified with significantly high CV risk factors (Milligan et al., 1995). In another study conducted in this western region of Australia, 30% of a group of 1147 children aged 10-12 years had high CV risk factors in terms of blood pressure, cholesterol levels, fitness and body fat (Beilin et al., 1996).

The inconsistent results of the studies of CV risk factors and the association with PA might be due to the difficulty of both the PA measurement in adolescence and the different definitions of clustering of CV risk factors (Twisk et al., 1999). Therefore, the comparison of results representing the association between PA and CV risk factors in different studies in children and adolescents is difficult (Twisk et al., 1999). Several studies demonstrated the positive relationship between PA or fitness in children and adolescents and the lowering of the impact of CV risk factors implied by this (Milligan et al., 1995; Spyckerelle et al., 1995; Beilin et al., 1996; Francis, 1996; Guillaume et al., 1997; Åkerblom et al., 1999; Freedman et al., 1999). Identifying children with CV risk factors internationally is the urgent first step in modification, and an intervention program is the effective way of modifying these factors (Reginald, 1999). An increase in PA levels has probable beneficial effects on lowering CV risk factors in children. However, different approaches to prevention and reduction of these risk factors by increasing PA are needed in both higher and lower CV risk children and adolescents.

2.3.3 Blood Pressure

A number of studies have underlined that blood pressure (BP) was associated with PA and fitness, but that BP was probably influenced by age (Siconolfi, Lasater, McKinlay, Boggia, Carleton, 1985; Dahl et al., 1985; Hofman, Walter, Connelly, Vaughan, 1987; McAuley, McCrum, Stott, Evans, McRoberts, Boreham, Sweeney, Trinick, 1996). A cross-sectional study conducted in 1980 in Finnish children and adolescents aged 3-18 years showed that children's systolic and diastolic BP increases with age and physical maturation (Dahl et al., 1985). Similarly, between 9 and 24 years of age, the mean resting systolic BP increased from 102 mmHg to 116 mmHg, and from 102 mmHg to 128 mmHg in girls and boys, respectively (Åkerblom et al., 1999). It seems that more studies have reported the association of BP with fitness than with PA. Blood pressure was inversely associated with fitness level as measured by $\dot{V}O_2max$ in Siconolfi et al. (1985) and in Andersen (1994). The strength of the associations, however, was decreased sharply for both males and females after correction for the effects of age (Siconolfi et al., 1985). These findings were supported by similar results of a later study by McAusley et al. (1996) which reported a significant inverse correlation between both measures of BP and physical fitness using $\dot{V}O_2max$ as the criterion measure. Again the correlation was not sustained after adjustment for the effect of age. These authors also reported that the systolic BP of the subjects who had a lifetime of activity participation was 6 mmHg lower compared to those who had a lifetime of inactivity.

The relationship between PA or fitness and BP however, was not found to be as strong as between BP and weight or BMI in a study by Jenner, Vandongen, and Beilin (1992). Blood pressure in 1311 Australian school children (aged 12.0 ± 0.4) was inversely related to PA (measured by questionnaires) only in girls. There was no significant relationship between BP and physical fitness as measured by a shuttle run (Jenner et al., 1992).

Morrison, Barton, Biro, Daniels, and Sprecher (1999) reported that overweight (defined by BMI) boys aged 10 to 15 had higher systolic and diastolic BP than non-overweight boys in both black and white groups. The authors also found that among Belgian boys, the CV risk factor levels were high and increased in those who were overweight and that physical inactivity was significantly related to increase in BMI, triceps skinfold, and BP. However, there was no significant correlation between these variables in girls. Based on a national survey of Australian school children, Gliksman, Dwyer, and Wlodarczyk, (1990) previously reported that children from Mediterranean/Middle-East countries or children from lower SES backgrounds, who were more liable to be overweight, had significantly higher BP and higher levels of CV risk factors than children from Asian countries or from higher SES backgrounds, who were liable to be overweight. Thus, overweight was probably a significant factor for higher BP in different socio-demographic groups of children and adolescents. This conclusion has yet to be confirmed.

2.3.4 Body composition

Body composition is an integral product of growth and maturation of children and adolescents (Lohman, Boileau, and Slaughter, 1984) and significantly influences physiological changes and responses to exercise (Rowland, 1996). Changes of body composition during maturation can affect physical fitness, PA and health in later life. However, Bar-Or and Baranowski (1994) additionally acknowledged that it is difficult to assess body composition changes and PA in children and adolescents as they are influenced by factors such as growth, gender, and nutrition.

Most research on body composition and its influence on physiological responses to exercise and various environmental factors in growing children is based on indirect methods of measurement rather than the direct assessment of lean and fat tissue (Lohman et al., 1984; Rowland, 1996). The techniques of these measurements have used the terms of fat mass (FM) and fat free or lean, body mass (FFM). When the young child becomes chemically mature it is assumed that the composition of FFM does not significantly change and it is close to that of adults (Lohman et al., 1984). The common techniques for body composition assessment are divided into two types: laboratory based methods such as underwater weighing, total body water, dual energy x-ray absorptiometry (DXA) and body potassium concentration; field setting methods, which are commonly applied for children, such as, skinfold thickness and circumference measurement, BMI, and bioelectric impedance. These techniques were initially developed by research on adult subjects, and subsequently were adjusted so that they could be used to estimate the body composition of children and adolescents (Rowland, 1996).

Because of changes in body composition during childhood, several issues need to be considered when field tests are applied to the measurement of body composition among children and adolescents (Rowland, 1996). Firstly, the values from these tests can be affected due to changes in biological immaturity in growing children (eg. prepubescent, pubescent, and postpubescent). Secondly, body composition can be affected by factors such as racial background, the levels of PA and fitness, and these testing methods have not been sufficiently cross validated in children adjusting for these factors. Thirdly, the individual variations in distribution of body fat and significant inter-and intra-tester variability in measurements are likely to occur. Rowland, (1996) recommended that at the present time, skinfold measure is thought to be more reliable than other field measures.

2.3.5 Overweight and Obesity

Based on a review of several cross-sectional and longitudinal studies, Bar-Or and Baranowski (1994) formulated definitions of adiposity, obesity, overweight and body mass: "Adiposity is the amount of body fat, presented either as mass (sometimes referred to as "weight") or as a percentage of total body mass. Obesity is a state above normal adiposity at which health problems are likely to occur..." (Bar-Or and Baranowski, 1994). Other authors have defined criteria for overweight which are more specific such as: children and adolescents with BMI between 85^{th} and 95^{th} percentiles should be considered at risk of becoming overweight (Himes and Dietz, 1994; Troiano and Flegal, 1998). In the endeavour to establish a definition of overweight and obesity for international clinical research, Cole, Bellizzi, Flegal, and Dietz (2000) presented data samples drawn from six countries (in America, Europe and Asia) and used age- and sex-specific cut-off points corresponding to adult BMI values of 25 kg/m^2 and 30 kg/m^2 as calculations for overweight and obesity in children aged 2 - 18 years. Although this definition was suggested as an acceptable international reference, since the incidence of overweight/obesity remains constant throughout childhood (Cole et al., 2000), the use of the criterion still remains controversial. As excessive body mass usually occurs at late adolescence or in early adulthood, the evaluation of body weight needs to be considered in maturating and growing children (Rowland, 1996). Kinra, Nelder, and Lewendon (2000) also argued that, in some children, obesity is manifest at the pubertal period, but variation in timing of puberty between populations is not known. Because it is difficult to define obesity or overweight for children and adolescents, various criteria have been used to identify prevalence and trends of obesity among children and adolescents. Therefore, any criteria used to evaluate the level corresponding to obesity or overweight should specify which measure(s) is going to be used (Bar-Or and Baranowski, 1994; Troiano and Flegal, 1998).

Physical inactivity and obesity in adults have been assumed to be cause and effect, as Luepker (1999) has interestingly pointed out that the most obese people (frequently with the lowest calorie ingestion) are sedentary, and the leanest people (who frequently consume the highest levels of food) are labourers. Obviously, in adults, sedentariness is a major factor in obesity, or, in other words, obesity is not only associated with nutrition but also related to PA (Luepker, 1999).

Overweight and obesity in children and adolescents are associated with increased CV risk factors (Berenson, Srinivansan, Wattigney, and Harsha, 1993; Raitakari, Porkka, Rönnemaa, and Åkerblom, 1994; McGill, McMahan, and Malcom, 1995; Mahoney, Burns, and Stanford, 1996; Morrison et al., 1999; Freedman et al., 1999). Obesity is often a burden on children and adolescents, as the associated psychosocial and emotional problems may affect their self-esteem, and childhood obesity often presages adulthood obesity (Roudier and Tomblin, 1994). According to national surveys in the United States from the mid-1960s to the early 1990s, there was a significant increase in overweight children from pre-school age through adolescence (Hill, 1998). This incidence was confirmed by a recent study, which reported an increase of about 20% from 1980 to 1990s (Bar-Or, Foreyt, Bouchard, Brownell, Dietz, Ravussin, Salbe, Schwenger, Jeor, and Torun, 1998). This phenomenon had also been observed in previous studies (Zack, Harlan, Leaverton, and Cornoni-Huntley, 1979; Ross and Pate, 1987; Gortmaker, Dietz, Sobol, and Wehler, 1987; Kuntzleman and Reiff, 1992). There were similar trends reported in publications from European countries and affluent countries outside Europe (Sneidell, 1995). Hill (1998) suggested that the trends of increased overweight in children were due to elemental shifts in dietary and PA behaviours, but Sneidell (1995) pointed out that the factors that caused the increasing trends of obesity prevalence in Europe are not clear. The childhood trends however, could lead to a subsequent rise in obesity among adults (Hill, 1998).

As the trends of obesity increased in America and Europe, there has been a similar trend towards an increase in body mass among Australian adolescents in the last few decades (Wilcken, Lynch, Marshall, Scott, and Wang, 1996; Hill, Nowson, Tavener, Huggins, and Loesch, 1997; Booth, Macaskill, Lazarus, and Baur, 1999; Lazarus. Wake, Hesketh, and Waters, 2000). Recently, Lazarus et al. (2000) compared the 1985 survey (in 1421 children) and the 1997 survey (in 2277 children) in Victoria, Australia, and reported that the overall increase in BMI from 1985 to 1997 was significant ($p < 0.01$) for both genders. In another study, Booth et al. (1999) measured body fatness in 5518 school students graded in years 2, 4, 6, 8 in New South Wales.

Although the main aim of this study was to determine variations in socio-demographic distribution in Australia, body fatness levels of Australian school students were high, and the rates of adiposity increased from year 2 to 10. For example, the numbers of children who had BMI $\geq 95^{th}$ increased from 22.1 in year 2 to 27.9 in year 10 for boys, and from 21 in year 2 to 28.3 in year 10 for girls (Booth et al., 1999). Booth et al. (1999) also found there were no significant differences in BMI between school students living in urban and rural areas.

The contribution of an 'over-nutrition factor' and low PA in lifestyle could be a possible explanation for these trends of increase in obesity (Eveleth and Tanner, 1990). Hill et al. (1997) examined the responses from 1804 Australian school students in Melbourne city aged five to 18 years and compared PA participation and nutrition with BMI. In this Australian population sample, they found that weight systematically increased with age in relation to nutrition and a reduction in physical participation.

Studies by Ward and Evans, 1995; Guillaume et al., 1997; Rowlands, Eston, and Ingledew, 1999 reported that PA is inversely associated with body fatness, while studies by Bar-Or and Baranowski, 1994; Owens, Gutin, Allison, Riggs, Ferguson, Litaker, and Thompson, 1999; Epstein and Goldfield, 1999; Epstein and Paluch, 2000) reported that one effect of PA was a contribution to the reduction of obesity in adolescents. Reporting in a review of research into the relationship between PA and adiposity, Bar-Or and Baranowski (1994) found that, overall, there was little effect from PA interventions on reduction in adiposity (about 1 - 3 % body fat reduced). The authors also noted that the difficulty in highlighting the relationship between PA and adiposity or obesity in several studies could be due to the lack of standardised methodology in assessing PA and EE along with adiposity and obesity. The contribution of PA to reduction of obesity also differs between genders, SES and geographic cohorts (Guillaume et al. (1997). The combination of diet and PA is likely to be more effective in reducing obesity for the long term (Bar-Or and Baranowski, 1994; Epstein, 1995; Epstein and Goldfield, 1999; Tremblay and Doucet, 1999). Rowlands, Ingledew, and Eston (2000) recently used meta-analytic procedures to review 50 studies of the relationship between body fat and PA. These authors found that the strength of this relationship was influenced by the type of activity measure. That is, direct measures of PA such as observation or accelerometry methods elicited a significantly stronger relationship of PA with body fat than did questionnaire. These direct methods were recommended to be used to assess the relationship between PA and health (Rowlands et al., 2000).

Several studies have reported that obese and overweight adolescents were less fit and had low levels of exercise (Huttunen, Knip, and Paavilainen, 1986; Gliksman et al., 1990; Rowland, 1996; Guillaume et al. 1997; Hill et al., 1997; Ward, Trost, Felton, Saunders, Parsons, Dowda, and Pate, 1997), and that fitness was inversely related to fatness (Rowland et al., 1999; Ward et al., 1997). Obese children and adolescents often have lower levels of PA and fitness compared with non-obese, and this may be a cause for their obesity (Bar-Or et al., 1998). Supporting this hypothesis, Ward et al. (1997) compared PA and fitness levels between obese and non-obese African-American female adolescents. In some fitness tests (isometric strength and PWC 170), the scores from the obese group were similar to or higher than those from the non-obese group, but when the scores were expressed relative to body weight, the obese group showed significantly lower values. Participation in moderate to vigorous physical activity (MVPA) among obese adolescents was also lower than that of their counterparts without obesity in the Ward et al. study (1997).

There is however, not enough evidence that total EE is low in juvenile obesity (Bar-Or et al., 1998; Treuth, Hunter, Pichon, Figueroa-Colon, and Goran, 1998). There was no evidence of significant differences in daily physical activities between normal weight and obese children. For example, Huttunen et al. (1986) demonstrated that the daily activities of obese children aged 5 to 16 years were not significantly different from their normal weight counterparts, but participation in the training teams of sports clubs in the obese group was lower than in the non-obese group. It was not clear why the results of these studies were equivocal nor is the actual reason clear for increased trends of obesity in youth (Sneidell, 1995; Bar-Or et al; 1998; Hill, 1998).

Some evidence suggests that overweight and obese children are more likely than non-obese children to become obese adults (Must, Jacques, Dallal, Bajema, and Dietz, 1992; Must, 1996; Srinivasan, Bao, Wattigney, and Berenson, 1996; Vanhala, Vanhala, Kumpusalo, Halonen, and Takala, 1998). For instance, Vanhala et al. (1998) reported that about 50% of obese children had become obese adults and found that the obese adults who had been obese as children had higher CV risk factors than those obese adults who had not been obese as children. From these findings, Power, Lake, and Cole (1997) suggested that people who were continuously obese from childhood to adulthood acquired more CV risk factors than those who had obesity which appeared in adulthood or, whose obesity even decreased in adulthood. Therefore, success in identification and treatment of obesity during childhood could lead to early prevention of obesity in adulthood, and could reduce various cardiovascular risk factors (Vanhala et al., 1998; Freedman et al., 1999). For these reasons, health promotion programs, physical intervention, and healthy diet were highly recommended for weight management in childhood (Bar-Or and Baranowski, 1994; Epstein, 1995; Hill et al., 1997; Booth et al., 1999; Epstein and Paluch, 2000).

2.3.6 Summary

Although there is a long history of research on fitness, more intensive studies on the association of PA or fitness with health in children and adolescents have been undertaken in the last two decades. This section has reviewed studies that argued a justification for habitual PA in health promotion in children and adolescents. The studies indicate an important relationship between PA and its health-related outcomes of CV disease prevention, and well-being. The available data demonstrated that normal daily activities, sports participation, active recreation are important behaviours for the prevention of poor health and CV disease. Current trends indicate that CV disease was a leading cause of mortality in the 20th century in many developed countries, and additional trends reported in the limited available literature show that PA is inversely related to CV risk factors, particularly with obesity in children and adolescents. Improvements in PA therefore, may prevent the increase of these risk factors among children and adolescents. Some studies have also reported that PA intervention and PE programs can effectively contribute to prevention of CV risk diseases, especially for children at high risk of developing CV diseases. These observations, however, are based on relatively few studies and are dependent on PA measurements that might not be sensitive and sufficient for children and adolescents with high CV risk factors.

2.4 Status of Physical Activity and Fitness in Children and Adolescents

This section will describe the Characteristics of PA and fitness as well as discuss the relationship between PA and fitness in relation to maturation of children and adolescents.

2.4.1 Patterns of Physical Activity and Fitness in Children and Adolescents

With regard to the evaluation of PA and fitness in children and adolescents for maintaining health, research is primarily interested in explicating levels of PA and fitness in children and adolescents. In doing so, there are questions that need to be answered. How are they active/inactive or how fit/unfit are they? (Malina, 1995), and "how much physical activity should we do" (Blair and Connelly, 1996). Nowadays, pediatric scientists have attempted to determine the criteria of PA which children and adolescents need to meet to obtain health outcomes. Consequently, in the International Consensus Conference (Sallis and Patrick, 1994), two main PA guidelines for adolescents (based on a large number of studies of PA and health) were developed to provide recommendations on the levels, amount and duration of PA in which all participants should be encouraged to engage.

" Guideline 1: All adolescents should be physically active daily or nearly every day, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and community activities.

Guideline 2: Adolescents should engage in three or more sessions per week of activities that last 20 min or more at a time and that require moderate to vigorous levels of exertion..."

(Sallis and Patrick, 1994, P. 307-308)

According to these conference guidelines, regular participation in a variety of physical activities including work, leisure activities, and sports participation in their daily lifestyles during adolescence, is an important part of maturation that may have many health benefits and positive physiological effects (Sallis and Patrick, 1994). Twisk (2001) argued that the evidence of health benefits from PA in adolescents, that the international conference guidelines were based on, was not strong enough, and that it is difficult to suggest a certain dose of PA to obtain a threshold value of health benefits. Nevertheless, there is no doubt that these PA guidelines are important for public health strategy (Twisk, 2001) as: they encourage young people to be active every day, and thus, health benefits can be obtained through their active lifespan.

Besides these guidelines introduced by the International Consensus Conference, several other recommendations were also developed by independent associations and in the formation of national objectives for healthy people in some developed countries, that can be applicable to children and adolescents. For example, *Healthy People 2000* in America recommended similar guidelines as in the 1994 International Consensus Conference which suggested that children and adolescents should engage in MVPA three or more days per week, with 20 or more minutes per occasion (U.S. Public Health Service, 1990). According to other recent guidelines from the United Kingdom and the United States, accumulations of 60 minutes (Health

Education Authority, 1998) and of at least a 30 to 60 min period of age-appropriate PA (Pangrazi, 2000) per day for children and adolescents to obtain optimal health outcomes were recommended.

Some studies (Strong, 1990; Kuntzleman and Reiff, 1992; Malina, 1995) have expressed concern that children and adolescents in Western society nowadays tend to be less active or less fit than they should be, and are at risk of developing chronic diseases in later life. Malina, (1995) has reviewed a number of newspaper articles (published from 1983 to 1994 in the United States), which developed the perception that young people have undergone a decrease in their fitness level. Kuntzleman and Reiff (1992) noted that the aerobic fitness level of American children aged 6 - 17 (measured by distance running) declined about 10% in the 10 years from 1980 to 1990. Other studies, Corbin and Pangrazi (1992) and Pangrazi (2000) however, suggested that the current fitness level of American children is the same as in the past. Pangrazi (2000) also pointed out that the different beliefs of people about children's fitness levels could be due to the different fitness test batteries and changes of fitness definitions from time to time. It is also mistaken to believe that children are inactive if their fitness scores are lower than the expectation, because in children, the fitness level may be more related to heredity than to PA patterns (Pangrazi, 2000). Nevertheless, many authors (Strong, 1990; Malina, 1995; Kuntzleman and Reiff, 1992; Pangrazi, 2000) agreed that Western children nowadays are fatter than in the last few decades.

One possible reason for decreased PA in children was supposed to be the increase in the fragmentation of the family unit, causing children to have less opportunities for being active than in the past (Strong, 1990). Because more parents work outside the home, children therefore, stay in day-care settings or in relatives' and neighbour's homes where they may be kept as inactive as possible for safety concerns (Strong, 1990). The other reason due to societal changes is the proliferation of televisions, videos, computer games and play stations, which encourage non-active play at home. In addition, the consequences of environmental changes, such as urbanisation, and high-rise development, tend to create a lack of playgrounds, safe parks, and open fields, which contribute to eliminating opportunities for children to be active (Strong, 1990; Johns and Ha, 1999).

A number of studies have reported that PA levels of children and adolescents have been decreasing with age. For example, the levels of vigorous PA (VPA) decreased progressively between grades 9 (72.7%) and 12 (57.5%) in the Praff, Macera, and Blanton study (1999). This evidence was also strongly supported by Sallis (1993) who has reviewed several previous studies and reported a strong trend of decreased PA levels from 6 to 17 years in males and females. The observed age-related PA decreases were further supported by Myers et al. (1996) who found a similar decline in MPA with increasing ages from 9 to 15 years and an increase in sedentary behaviour over the same time span.

In order to assess PA levels of children and adolescents, research is generally based on the PA guidelines. The National Children and Youth Fitness Survey (NCYFS I) conducted in 1984 in the USA used a self-report in 8800 school students and established that the median proportion of American children and adolescents who participated in VPA three times per week for at least 20 minutes increased from 53%

in grades 5-6 to 62% in grades 10-12 (Malina, 1995). In this survey, children also reported that they spent more daily time (84.4% of the weekly time) in participation in physical activities outside the school than in PE (Simons-Morton, Parcel, O'Hara, Blair, and Pate, 1988). Similarly, in a later survey, the 1990 Youth Behaviour Survey of adolescents in grades 9-12, 50% of boys and 24% of girls engaged in VPA three times per week for at least 20 minutes (Malina, 1995). In another article (Pratt, Macera, and Blanton, 1999), which was based on the 1997 national survey, 63.8% of American high school students (n = 16, 262) recently reported participating in VPA three or more times per week for at least 20 minutes. A seven-month survey, which measured PA by self-reports and 7 different components of fitness in 3540 Swiss school students, reported that 75% of boys and 56% of girls engaged in at least one hour a day of MVPA that induced sweating (Michaud, Narring, Cauderay, and Cavadini, 1999). There were similar percentages of students participating in MVPA in Switzerland and in the United States. However, the survey in Switzerland used a different measurement of PA from the survey in the US as Swiss students reported on at least one hour per day instead of the 20 min sessions reported by US students. It seems that levels of PA in adolescents in Switzerland were higher than their counterparts in the USA. This is evidence that a comparison of PA levels in children between different nations or between studies using different measurements is difficult. In the most recent study, Sleap and Tolfrey (2001) used heart monitoring to examine the PA level in a group of British children (n = 79 aged 9-12 years) and reported that most of these children engaged in a total of more than 60 minutes of accumulated MVPA per day. Therefore, these authors acknowledged that the PA level of the related age British children met the current PA guidelines in the UK and in the USA.

Nevertheless, the different results of PA levels of children and adolescents in some of the countries mentioned above may be due to many issues. Basically, the intensities defined by the different guidelines for adolescents are uncertain and can be interpreted in different ways (Sleap and Tolfrey, 2001). Studies in different countries also used different methods of PA measurements, therefore, the authors set up a different threshold of PA intensity. Furthermore, differences in sample sizes of subjects were used, from more than ten thousand (Pratt et al., 1999) to a group of less than a hundred subjects (Sleap and Tolfrey, 2001) making for a doubtful comparison.

2.4.2 Physical Activity and Television Viewing

Because an increase in sedentary behaviour parallels the decline in PA in children and adolescents, understanding the causes of the sedentary lifestyle is important for developing strategies to prevent obesity and CV risk factors in later life. It has been stated that TV may be one of the main causes for increasing inactivity among youth and it is considered as contributing to a sedentary lifestyle (Strong, 1990). A few studies have found TV was significantly related to PA and/or to body fat (Guillaume et al., 1997; Andersen, Crespo, Bartlett, Cheskin, and Pratt; 1998); other studies reported weak correlations and equivocal results (Rissel, 1991; DuRant, Baranowski, Johnson, and Thompson, 1994; Myers et al., 1996; Katzmarzyk, Malina, Song, and Bouchard, 1998; Gordon-Larsen, McMurray, and Popkin, 2000) or even found no significant correlation (Taras, Sallis, Patterson, Nader, and Nelson, 1989). Most of these authors have assessed sedentariness by examining the time that children spent on viewing television. For example, Guillaume et al. (1997) found that a high percentage of Belgian children (84% to 93%) watched TV 6 to 7 days per week, and this inactivity was significantly related to bodyweight adjusted for age. In boys, the number of TV hours per week was also significantly related to BMI, triceps skinfold, and blood pressure (Guillaume et al., 1997).

Similarly, The National Health and Nutrition Examination Survey III (between 1988 and 1994) in the USA investigated the relationship between TV and body fat in 4063 children aged 8 – 16 years (Andersen et al., 1998). It was reported that 26% of US children watched 4 or more hours of TV per day and 67% watched at least 2 hours per day. Children who watched 4 and more hours per day had greater body fat than those who watched less than 2 hours each day (Andersen et al., 1998). This study also compared PA and TV in different ethnic groups and reported that non-Hispanic black children who had the highest rate of TV (4 or more hours per day) had a lower level of PA compared to other ethnic American children. These results were not in agreement with the study by Durant et al. (1994) who examined the associations between TV, PA and BMI in 191 younger children aged 3 - 4 yrs. Although this study reported lower PA levels during TV time rather than non-TV time, TV was not associated with BMI and negatively associated with PA levels. There were also no differences in TV and PA in terms of gender or ethnicity. Furthermore, in a review, Taylor and Sallis (1997) surprisingly reported that only one study described that TV related to PA, but another five studies found it was almost unrelated to PA in children. Consistent with these findings, Taras et al. (1989) found no significant correlation between TV and PA in a group of 3-8 year old children. However, Taras et al. (1989) did report that this group of children had a high number of TV hours per week (mean = 21.4 hrs), and that this was significantly correlated with caloric intake. Interestingly, these authors reported that TV-hours were significantly and positively correlated with the number of food items requested by children and subsequently bought by the parents.

Recently, Gordon-Larsen, McMurray, and Popkin (2000) reported data from a national survey that weekly participation hours of TV and video/computer games, considered as inactivity, of 17766 American adolescents, were most related to sociodemographic variables, while PA was most related to environmental variables. Armstrong, Sallis, Alcaraz, Kolody, McKenzie, and Hovell (1998) also reported weak and conflicting results of the relationship between TV and different fitness components in children.

The above apparent equivocal results in the literature on the relationship of TV to PA seem to be due to the limitation of the method of measurements (Robinson, 2001), and due to the fact that TV is not the only indicator of inactivity. However, the stronger associations between TV and PA or BMI seem to be found in older children and adolescents than in younger children. Gender and ethnic differences in TV time were possibly to be found more in adolescents rather than in younger children (Taras et al., 1989). Nevertheless, the result of one experimental study by Faith, Berman, Heo, Pietrobelli, Gallagher, Epstein, Eiden, and Allison (2001) recently demonstrated that an intervention program to improve PA and reduce TV time in the home environment might be successful in the reduction of childhood obesity, even if the small sample size in this study (n = 10 obese children) did not confirm the conclusion.

2.4.3 Relationship between Physical Activity and Physical Fitness

The relationship between PA and physical fitness in children and adolescents is not yet clearly understood. Some studies have suggested that PA has a low to moderate but significant association with physical fitness in children and adolescents (Weymans and Reybrouck, 1989; Pate, Dowda, and Ross, 1990; Kemper, 1995;

Shephard and Bouchard, 1995; Katzmarzyk et al., 1998), but other studies have reported a weak association or no relationship with this outcome (Armstrong, Williams, Balding, Gentle, and Kirby, 1991; Sallis et al., 1993; Andersen, 1994; McAuley, McCrum, Evans, Stott, Boreham, and Trinick, 1999). Research has recently focused on understanding this relationship, as there is some evidence that an active life and fitness levels during childhood persist in adulthood (Morrow and Freedson, 1994; Katzmarzyk et al., 1998).

Weymans and Reybrouck, (1989) demonstrated that the habitual level of PA was significantly associated with cardiorespiratory endurance capacity in a cross-sectional study of 257 children in Belgium (aged 5.7 – 18.5). The significant association however, was only found in males, who had the higher level of PA, but not in females, who had the lower level of PA. In males, the highest value for cardiorespiratory endurance capacity was found in the most active subjects and the lowest value was found in the less active ones, but this relationship was not evident in females. The authors concluded that more active children showed a higher fitness level than less active ones, except during puberty where biological changes might have more influence over other activity related stimuli.

Taylor and Baranowski (1991) examined the relationships between cardiovascular fitness (as the dependent variable) and PA, BMI, age, and gender in a sample of 93 high-adiposity and 93 low-adiposity children aged 8 to 13 yrs in the USA. Low and high adiposity samples were classified by a median split on the sum of three skinfold measures (triceps, suprailiac, subscapula), PA was assessed by a 2-day observation period and the fitness level was measured with a physical working capacity (PWC170) cycle ergometer test. The authors reported that in a model of predicting cardiovascular fitness, four independent variables (PA, BMI, age, and gender) accounted for 38% of variance in PWC170 which was significant in the high-adiposity group, but not in the low-adiposity group.

The relationships between PA and fitness might vary with different components of heath-related fitness and with age, gender and maturation. Katzmarzyk et al. (1998) investigated these relationships using four different components of fitness encompassing skinfolds, sit-ups, PWC150 and leg strength tests in 356 boys and 284 girls divided into three age groups by gender (9-12, 13-15, and 16-18 yr). By using the partial canonical correlation analyses, Katzmarzyk et al. (1998) found a weak to moderate significant association between PA and fitness in the three different groups of adolescents (R^2 was from 0.11 to 0.21). These findings were similar to other results in a previous study by Pate et al. (1990) who examined the associations between physical fitness (measured 1.6-km run and skinfolds) and PA in a nationally representative sample of 1150 boys and 1202 girls in third and fourth grades in the USA. Multiple regressions were performed in this study and the results indicated that the associations between PA and physical fitness were moderate but significant (R^2 were = 0.21 and 0.18 for the 1.6 km run and the sum of skinfold, respectively). Rowlands et al. (1999) recently also reported a positive relationship between fitness (measured by the endurance time and skinfolds) and PA (measured by Tritrac, r = 0.66; and pedometer, r = 0.59 worn for an average of 4.93 days) in 17 males and 17 females aged 8 to 10 yrs.

Other studies have reported an absence of significant relationships between PA and aerobic capacity and other components of physical fitness among adolescents in both a longitudinal study (Andersen, 1994) and a cross-sectional study (Armstrong et al., 1991). In the longitudinal study, Andersen (1994) investigated the changes over 2 years in four different fitness components (maximal aerobic work capacity, functional strength, muscle endurance, agility and flexibility) and their relationship to the changes in PA in 259 adolescents (aged 16.5 yrs at baseline). Most of these measures of fitness increased significantly over two years in both sexes, but no change was found in PA or sports participation except for a significant decline in leisure-time sports in girls. The relationships between levels of PA and sports participation and physical fitness at baseline and in two years later were weak or non-significant (r^2 = 0.04 – 0.19). Andersen (1994) also indicated that the changes in physical fitness measures between two years seem to be very similar in different countries (Belgium, Sweden and Ireland), despite differences in measures of PA and performance. From these findings, Andersen (1994) postulated three reasons that might elucidate the weak relationship between PA and fitness: the variability in fitness was partly due to genetics; changes of growth and hormonal factors, especially in boys, mask the stimulus of training; and in adolescents, because of a high level of physical fitness, only PA at high relative intensity may have an effect on the fitness level. The non-significant relationship between PA and fitness found in the Andersen study (1994) was supported by the study of Armstrong et al. (1991) who studied British children aged 11 – 16 yrs and failed to reveal any significant correlation between $\dot{V}O_{2peak}$ and PA.

The complex relationship between PA and fitness was well reported in the review by Morrow and Freedson (1994) who presented the findings of 20 studies that reported on the association between PA and aerobic fitness in children and adolescents in ages ranging from 7 to 18 yrs in different countries in the USA, Europe and Asia. In this review, the authors obtained a total of 53 correlation coefficients and 37 conclusions, of which 20 reported no relationship, and 17 reported a positive relationship. The correlation coefficients however, were from small to moderate, and the median was r = 0.16 – 0.17. It should be emphasised that among these 20 studies, all those that used a large sample size (≥ 186 subjects) reported a positive relationship between PA and fitness. Morrow and Freedson (1994) suggested that the weak association between daily PA and aerobic fitness ($\dot{V}O_{2max}$) could be associated with: poor measurement of PA; the high level of aerobic fitness in adolescents; and/or the lack of a true relationship between PA and aerobic fitness in children and adolescents.

Other factors could possibly influence the equivocal findings of this relationship in children and adolescents such as the contrasts and the different perceptions of evaluation between PA and fitness (Pangrazi, 2000). Physical fitness is commonly assessed by fitness performance tests, but hereditary factors can have greater influence on fitness performance than on PA patterns (Pangrazi, 2000). Growth velocity, personal lifestyle, social and physical environments, and methodological factors among different individuals can influence both PA and physical fitness (Shephard, 1995). Furthermore, the difficulty of measuring and classifying physical fitness (Shephard, 1995), and the limited time over which PA has been measured in each study may limit the relationship (Armstrong and Welsman, 1997; Baranowski et al., 1992). It is apparent that the relationship between habitual PA and physical fitness in children and adolescents requires further investigation.

2.5 Factors Influencing Physical Activity

Several issues such as gender, physical environment, and social trends appear to contribute to physical inactivity in children and adolescents (Strong, 1990; Malina, 1995). Based on the importance of PA for health benefit, research has led to a concept of developing PE strategies for increasing PA and fitness levels in children and youth. Many countries have educational and sporting policies to improve PA levels in children and adolescents. In order to develop successful programs to maintain and improve PA levels in children and adolescents, a number of factors require consideration. While the explicitness of status of PA and fitness, and the relationships between PA, fitness and health remains essential, an understanding of the many other factors that influence PA participation needs to be taken into account in order to improve PA levels and health benefits in children and adolescents. There are a variety of factors, and varying degrees of influence of these factors on PA and fitness depending on the group under investigation (Sallis et al., 1992; Sallis, Prochaska, and Taylor, 2000). Most studies and reviews commonly described PA and fitness status in which, as a whole, males reached higher values for PA and fitness than females, rather than giving evidence of factors influencing these differences. Although several factors such as social, biological, physical, psychological and environmental factors are believed to contribute to gender differences, how these variables, if any, relate to gender trends is not well understood (Trost, Pate, Dowda, Saunders, Ward, Felton, 1996). The following sections of this chapter will focus on demographic factors such as gender, SES, ethnicity and culture that can be expected to influence PA.

2.5.1 Gender

Although various descriptive studies of PA in children and adolescents have used a variety of PA measurements, gender differences in PA and fitness have been consistently reported in several studies (Pate, Long, and Heath, 1994; Taylor and Sallis, 1997, Sallis et al., 2000). Sallis (1993) has reviewed a number of studies that examined gender differences during change in PA with ages from childhood to adolescence. These studies have been classified according to the use of methods in measuring PA such as self-report or objective measures and the change in relative fitness.

Overall, all these studies reported males were 15 to 25% more physically active than females, and between the ages of 6 and 17 the decline in PA per year in females was greater than in males (1.8% vs 2.6%, and 2.7% vs 7.4% in self-report and objective measure studies, respectively). Based on these findings Sallis (1993) stated that the gender difference in PA seems to broaden with age, and thus, the increase in female sedentary lifestyles may put them at higher risk of poor health or obesity. This finding by Sallis was supported by Spyckerelle et al. (1995) and Anding, Kubena, McIntosh, and O'Brien, (1996) who found that among adolescents, the CV risk factors were higher in girls than in boys, as girls were less active and had a lower level of cardiovascular fitness than boys. Recently, in another review by Sallis et al. (2000), 25 of 31 children studies and 27 of 28 adolescent studies of gender comparisons reported that boys were more active than girls.

Lower levels of PA in females than in males in children and adolescents appear to be due to a lower number of females participating in MVPA. For example, school students who reported participating in sport activities were more frequently boys (64-69%) than girls (33-46%) in Switzerland (Michaud et al., 1999) or 72.3% in boys versus 53.5% in girls who reported participating in VPA in the USA (Pratt et al., 1999). The literature supports trends of females being less active than males and PA levels decreasing in late adolescence in both sexes (Weymans and Reybrouck, 1989; Pate et al., 1994; Malina, 1995; Myers et al., 1996; Guillaume et al., 1997). Hill et al. (1997) reported that in Melbourne, Australia, the percentage of school students participating in VPA decreased between primary and secondary schools. Girls especially decreased from 13.3 to 6% compared with boys from 17.1 to 14.8% over the same years of schooling.

To examine contributions of some selected fitness, psychological, and environmental determinants to gender differences in PA, Trost et al. (1996) conducted a study using a self-report method in 334 fifth grade children, mainly African-American students. Once again, boys reported a higher average daily number of 30 min blocks in which they engaged in MVPA than girls (2.8 ± 0.1 vs. 1.6 ± 0.1). Among the selected psychological determinants of PA behaviour the authors reported that self-efficacy in overcoming barriers to PA and participation in community sports contributed significantly to gender differences in participation in MVPA. This study however, relied on self-reports of psychological determinants, and other factors such as genetic, motor skills and culture were not examined. To better understand the gender differences in PA, researchers need to conduct explicit studies that examine factors that influence gender differences in PA in children and adolescents. The results from Trost et al. (1996) however, indicated that psychological and environmental factors have implications for the low levels of PA most specifically among female children. This finding is important for physical educators in assisting girls to become more confident in PA and sport participation to prevent sedentary lifestyles.

2.5.2 Socio-Economic Status and Ethnicity

There is some evidence that SES is associated with PA among adults as people from high SES groups are more active than people from lower SES background (Ford, Merritt, Heath, Powell, Washburn, Kriska, and Haile, 1991). Results from studies in children have also indicated that children from lower SES less frequently participated in PA than higher SES children (Sallis et al., 1996; Taylor and Sallis, 1997), and that the higher levels of PA were associated with high levels of education and income, and with Caucasian ethnicity. The lower levels of PA were associated with low levels of education and income, and with black populations (Praff et al. 1999). Sallis et al. (1996) examined PA levels (using three separate self-reports) in children from different ethnic and SES groups in a sample of 1871 high school students aged from 11 to 19 yrs. Results showed that adolescents from high SES families participated more frequently in PA than students from low SES families. The high-SES Anglo students who came from wealthy districts were most likely to take part in PE lessons and vigorous exercise, while Asian/Pacific Islanders who came from low-SES areas were least likely to participate in sport teams, and PE lessons. Sallis et al. (1996) referred to the costs of lessons as possibly one reason for the low participation rates of low-income students. There were however, no broad conclusions that could be derived about ethnicity and SES differences in participation in sport activities. Sallis et al. (1996) have emphasised that SES may have more influence on access to activity in PE classes than the selection of specific sport activities.

In a study of an Australian population, Blanksby, Anderson, and Douglas (1996) evaluated the influence of SES on PA patterns in 4672 secondary school students with ages ranging from 12 to 18 yrs. The author evaluated SES by two elements: education (measured by the ranking of the school attended) and the occupation of parents (based on the Australian standard classification of occupation). Although there were significant gender differences in activity participation at each SES level, a lower proportion of adolescents from the low-SES ranking school participated in organized sports, health and fitness, and recreational activities. In addition, the female high-SES group had the lowest proportion of adolescents who had BMI greater than 85^{th} percentile and reported the highest levels of participation in these activities. Blanksby et al. (1996) postulated that in aspects of fitness and fatness, adolescents from high-SES families could obtain more benefits for their physical health as they had taken part in a variety of recreational and sport activities. Subsequently, students from schools with a higher SES ranking had appropriate body weight for their height.

The phenomenon of higher body fat found in children and adolescents who came from low-SES areas compared to their high-SES counterparts was also reported in a study in Belgium by Guillaume et al. (1997). However, the relationship between body fat and SES should be treated with some caution, especially with BMI scores, because of standard error and limitations in this measure (Blanksby et al., 1996; Richard and Katherine, 1998). It has been stated that the relationship between PA and

SES is due to the fact that low-SES children seem to have fewer opportunities to attend a variety of recreational and sport activities due to time and cost of activities and/or their parent's occupational demands, prestige, and family expectations (Sallis et al., 1996; Blanksby et al., 1996).

Ethnicity is claimed to interact frequently with SES and PA as this evidence was reported in the aforementioned (Sallis et al., 1992; Praff et al., 1999). Consistent with these results, Andersen et al. (1998) analysed data from two national surveys between 1988 and 1994 in the USA, and found that non-Hispanic black and Mexican American girls had the lowest VPA levels, and the highest rates of TV watching compared to white American children. Similarly, Myers et al. (1996) examined gender and ethnic differences in PA in 995 subjects aged 9-15 yrs and reported that black adolescents spent significantly higher time on sedentary activities than white adolescents. Wong, Butte, Ellis, Hergenroeder, Hill, Stuff, and Smith, (1999) recently demonstrated that pubertal African-American girls (n = 41) expended lower energy both at rest and during PA than Caucasian girls (n = 40). This difference remained even after being adjusted for gender and fitness. These authors suggested that lower EE in the pubertal African-American girls put them at a higher risk of becoming overweight than their Caucasian counterparts.

2.6 Cross Cultural Comparisons of Physical Activity Patterns in Children and Adolescents

2.6.1 International

Most information about PA, fitness and health in the international literature reviews comes from industrial, developed countries. North America is the most reported region for the conduct of research on PA and health both in adults and children, with other research coming from European countries and to a less extent from Australia. Little information in this area has been reported from other countries, especially, less developed countries in Asia, South Africa and South America, even though populations of children and adolescents in these nations are high. Although population surveys conducted in PA and fitness in children and adolescents in different countries have been varied in sample size, measurement technique, and culture, it is useful to make a worldwide comparison of PA and fitness levels. Levels and associated determinants of PA and fitness among children and youth were discussed in detail in the previous section, while this section will draw a comparison between countries that have reported on PA in adolescents.

US researchers have conducted the highest number of studies on PA and fitness in children and adolescents including national, cross-sectional and longitudinal studies. Table 2.5 contains a summary of selected studies that reported the proportion of adolescents who have participated in MVPA in some developed countries in North America and Europe. According to the literature review, approximately 50 - 60% of adolescents in these countries participate in MVPA for three or more 20-min sessions per week. It is however, difficult to reach consensus on the PA levels of international adolescents.

The figures (in Table 2.5) indicate that in overall, approximately 40% of adolescents in those countries do not meet the international conference guidelines, and this proportion of adolescents can be classified as inactive adolescents. However, it must be noted that the percentage of adolescents in developing countries who are active or inactive is not well reported as few studies have been undertaken in such nations. Therefore, it is difficult to draw a broad conclusion for the worldwide comparison between developed and less developed countries.

Table 2.5. *Comparison of proportions of adolescents who participated in moderate to vigorous physical activity in countries in North America and Europe.*

Nation	Style of Studies	Participation in MVPA	Reference
The USA	National survey n = 16,262 aged 9-12	72.3% boys 53.5% girls	Fraff et al. 1999
Canada	n = 452 aged 9-15	56.8 % boys 47.7 % girls	Katzmarzyk et al. 1998
North Ireland	n = 1600 aged 16+	52% boys 46% girls	MacAuley et al. 1999
Switzerland	National survey n = 16,262 aged 9-12	75% boys 56% girls	Michaud et al. 1999
Denmark	n = 259 (aged 16.5 ± 0.6)	59% boys 49% girls	Andersen, 1994

2.6.2 Australia

Similar to all other western nations, the prevalence of overweight and obesity of Australian people is of concern to the Australian government. A National Health and Medical Research Council (NHMRC) report of 1997 indicated that a national survey in 1989 in Australia reported that 48% of males and 34% of women were classified as overweight and obese. Another report by the Department of Human Services in Victoria (1999) also expressed concern about the increased trends of overweight in both adults and youth in Australian people. Magarey and his co-workers (2001) reported that percentages of overweight and obesity (defined by BMI cut-off points) in Australian adolescents increased from 1985 (the Health and Fitness Survey, 9.3% and 1.4% of boys and 10.6% and 1.2% of girls were overweight and obese, respectively) to 1995 (the National nutrition Survey: 15.0% and 4.5% of boys and 15.8% and 5.3% of girls were overweight and obese, respectively). The trend was assumed to be caused by decreases in PA and changes in nutrition among a majority of people (NHMRC, 1997). In order to address this situation, NHMRC has released *Acting on Australia's Weight: a Strategic Plan for the prevention of overweight and obesity*. Since this report, efforts have been made to encourage all Australian people to increase PA and sport participation. This initiative is co-ordinated through *Active Australia* launched by the Australian Sports Commission and the federal Ministers for Health and Sport (Department of Health Services, 1999).

Although a number of reports and surveys have described the PA levels of adults in Australia, there is a lack of available information on levels of PA in children and adolescents (Department of Human Services, 1999). One reason for this could be that the assessment of PA in children and adolescents has different requirements from adults and requires different sampling to measurements in the general population (Department of Human Services, 1999).

Blanksby (1996) assessed levels of PA in 4672 secondary school students, according to three categories: organized sport, health and fitness, and recreational activities. Results were reported in relation to SES and gender, and showed a marked difference between these groups. For example, the participation rate of organized sports in females in the high SES group was 58% but was 45% in the low SES group, and for males was 50% in the high SES group and was 37% in the low SES group, respectively. The highest rate of PA participation was found in the high SES adolescent group participating in recreational activities.

Similarly, Hill et al. (1997) evaluated dietary restraint, PA patterns, and BMI in a random sample of 1804 Melbourne school students of European descent. Participation in sport activities decreased in the time span of primary school students through to high school students, although on average, physical participation was low to moderate for the majority of school students. A greater decrease in PA participation rates was found in the older student group (aged 15 and older) in secondary school. For example, 17% of boys and 13% of girls participated in vigorous activities during the primary school time span, but respective vigorous activity rates decreased to 13% of boys and only 6% of girls during the secondary school time span.

To date no longitudinal studies evaluating trends of PA patterns from childhood to young adulthood have been reported in Australia (Department of Human

Services, 1999) and no national surveys have estimated current levels of PA and inactivity in children and adolescents across the country. There was, however, a recent population survey in the state of New South Wales (NSW) that investigated a range of data in children and adolescents living in this state (Booth, Macaskill, Mclellan, Phongsavan, Okely, Patterson, Wright, Bauman, and Baur, 1997). The NSW School Fitness and Physical Activity Survey measured anthropometry, health-related, fundamental motor skills, self-reports of PA, PE classes, sedentary activities, and individual influences on PA participation in 5518 school students aged 7-15 yrs. The survey classified PA levels of this population according to the international consensus conference guidelines. In summer, on average, 65% and 73% of boys, and 63% and 78% of girls participated in VPA for grades 8 and 10, respectively. In winter, a similar proportion of boys adequately participated in VPA, but among girls in this season, only 48% of year 8 girls and 43% of year 10 participated in VPA. Findings also revealed those girls from Middle Eastern and Asian backgrounds were the least active and boys from European backgrounds tended to be most active. Rural girls were more active than urban girls. Positive association between PA and SES was found in girls, but in boys, the association between PA and SES and the difference in geographic regions were not significant. Although the NSW survey used a large sample of subjects and was conducted in the most populated state in Australia, whether it is representative of all Australian adolescents remains uncertain. Nevertheless, the NSW survey should reflect PA patterns of young people living along the eastern coast of Australia.

2.6.3 Studies on Physical Activity Patterns in Children and Adolescents in Asian Countries

Unlike developed countries in North America, Europe and Australia, information on PA, fitness and obesity in Asian children and adolescents is presently limited; some studies have described the PA patterns of children and youth in some fast growing industrial countries in South Pacific Asia. Huang and Malina (1996) studied 282 adolescents aged 12-14 years in Taiwan by assessing body size, daily total EE, PA patterns and socio-demographic variables. Energy expenditure in MVPA was estimated using the Bouchard three-day record that was validated in 1983. The percentages of total EE estimated from MVPA on weekdays were small in both boys (6.5-7.6%) and girls (2.4-6.6%), but these values of EE rose on weekend days to 18.7-30% in boys and to a lesser extent in girls, 6.0-10%.

Another recent study examined PA levels in 40 Hong Kong Chinese children (aged 6 to 8 yrs) in both recess and home environments using an observational system in which the children were observed for four 1-hr and six 20-min observation times (Johns and Ha, 1999). The activities were coded into 5 levels to include lying, sitting, standing, active, and very active, and the percentages of time that participants were involved in these activities were observed. During the home observation, they found that 13.8% of the observation time was active and only 2.8% was very active. During the school recess, the active time was increased to 28.2%, and only 3.3% was very active. Although this study observed only a small sample of Hong Kong children, it did reveal low levels of PA. Johns and Ha (1999) suggested that the limited school activities and the densely populated urban environment in Hong Kong could influence children's PA patterns. While the covered playground variable accounted for 67% of the observations, the open school playground variable accounted for only 29%. Johns and Ha, (1999) reasoned that living spaces in Hong Kong are quite narrow, family units are very small and located in extremely high buildings, and there is a lack of playground surrounding homes as well as a lack of public parks. In addition, the culture and safety concerns by parents may create an environment in which children are not allowed to play outside their homes without an accompanying adult (Johns and Ha, 1999). All of these factors would reduce the capacity for PA for children in Hong Kong.

It seems that Asian children and adolescents are less active than western children and adolescents, although the evidence to support this assertion has not been confirmed. This assertion is however, supported by studies conducted not only in Asian populations in some growing industrial countries such as in Hong Kong, Taiwan (Huang and Malina, 1996; Johns and Ha, 1999), and in Singapore (Gilbey and Gilbey, 1995), but also in adolescents of Asian background living in Australia (Booth et al., 1997) and living in the USA (Sallis et al., 1996). It should be noted that the studies cited above, however, were conducted in some Asian industrial developed countries only, and did not report the proportions of children and youth, which meet the guidelines for PA, by the International Consensus Conference. Unfortunately, there are no studies that are available in the literature to document a criterion for the amount of PA that is appropriate for health of children and adolescents living in Asian developing countries.

2.7 Research on Physical Activity, Fitness and Health Status of Children and Adolescents in Vietnam

2.7.1 History, Education and Culture of Vietnam

Vietnam is 329,560 sq km, placed in Southeast Asia, and with a population of 76,324,753 people (Centre Census Steering Committee, 1999). The history of Vietnam is a history "against foreign aggressions" (Whitfield, 1976), since during its 4000 years of establishment, many foreign countries, mainly from the north, have invaded Vietnam. For nearly 1000 years Chinese rulers attempted to unite Vietnam politically and culturally into the Han Empire. The Chinese occupation had fateful consequences for the future course of Vietnamese history and Confucianism (Chinese philosopher: K'ung, Confucius, 551-479 B.C, Judith, 1982) became the official ideology. The practice of Confucian values was that people respect for parents, loyalty to government and the man could be perfected only through education and practice. This philosophy influences the country's policies of education and the population such as values for academic performance and family honour. During the modern era, Vietnam became a French colony and was under French rule for nearly 100 years (from 1858 to 1954). French occupation brought improvements in industries and technology, and contributed to the western influence on Vietnamese culture. After the August 1945 Revolution when Vietnam became an independent state, a national democratic educational system was introduced and replaced the feudal colonial educational system. Consequently, a school system of ten years with a new curriculum was established in 1956. When the north and the south were reunited after the war against the USA, the school system was reformed to become a 12-year school system in 1980. This system consisted of three levels: primary school from grades 1 to 5; lower secondary school from grades 6 to 9; and higher secondary school from grades 10 to 12 (MOET, 2000).

This history and education consequently influenced the lifestyle of Vietnamese young people. On the one hand, martial arts were among the favourite activities of youth as they were usually trained to join the army. On the other hand, the tradition of learning and Confucianism continually influenced the country's policies and the population as the educational policy made completion of primary school compulsory. Subsequently, all students from grades 1 to 12 are required to pass examinations in all subjects in order to proceed to the next grade. As a result, the burden of studying might take up a lot of young people's time and thus they have fewer opportunities to participate in sport activities.

2.7.2 Health, Physical Activity and Fitness of Children and Adolescents in Vietnam

As Vietnam is a poor and densely populated country recovering from the ravages of war, the death rate was 7.76 deaths/1,000 population, and the infant mortality rate was 45.5 deaths/1,000 live births in 1994 (Vern Weitzel and Coombs Computing Unit, 1998). The common diseases among Vietnamese infants and children are rickets, pulmonary diseases, malnutrition, gastrointestinal disorders, and cardiovascular diseases (Nhan, 1988; Dien, Huong, Ngoc, Phuoc, and Dien, 1991; Son and Dien, 1997). Although the health of children and adolescents is of great concern in Vietnam, there is still a lack of data on children's health. Most studies have been conducted in hospitals where children have had diseases or were under treatment. Therefore, studies on health and disease in children focused more on medical rehabilitation, on the outcome of disease prevention and treatments rather than on PA and/or fitness levels.

No study to date, has investigated the association between PA, fitness and health in children and adolescents in Vietnam. There have been, however, some studies that have reported on blood pressure, BMI, and fitness levels among children and youth. Thinh, Van Tien, and Khac Son (1991) conducted a longitudinal study (1982-1987) that tracked blood pressure in 400 school students from age 6 to age 11. Similarly to children in developed countries, the authors observed an increase of systolic blood pressure with age from 93 mmHg and 92 mmHg (aged 6 yrs) to 108 mmHg and 112 mmHg (aged 11 yrs) for boys and girls, respectively.

Hop, Gross, Giay, Schultink, Thuan Sastroamidjojo (1997) observed the growth of Vietnamese children from birth to 10 years of age by recording height, BM and SES in 212 Hanoi children between 1981 and 1995. At the age of 10, this cohort of children reached a height of 130.9 cm and weight of 25.1 kg for boys, and 128.8 cm and 24.1 kg for girls, respectively. These data of children in Hop et al. study (1997) were higher values than those children living in Vietnam in 1942 (Hop, 1943) and in 1975 (MOH, 1976). The increase in anthropometrical data of children could possibly be associated with improvements in living conditions in Vietnam, especially in cities, since 1986 as a result of the introduction of a privatised, market-driven economy. Hop et al. (1997) have found a dramatic improvement in living conditions (assessed by the household property of the children's families) during the 10-year period of the study. The authors suggested that SES was associated with growth of children, and thus nutrition and environmental conditions might be more important than ethnicity.

Hop et al. (1997) also found these anthropometric data of children were inferior to the data of children of Vietnamese ethnicity living in Paris at the same time. Although during the first three months, there were no differences in height and weight between the two cohorts, the differences became visible as the native Vietnamese children were shorter and smaller (4.7 cm and 2.6 kg for girls, and 2.4 cm and 1.2 kg for boys, respectively) than French Vietnamese children after the age of 3 months.

Despite some positive trends, the anthropometrical profiles of Vietnamese children living in Vietnam in recent years were still lower than Vietnamese immigrant children (Hop et al., 1997) and western children (Aurelius, Khanh, Truc, Ha, and Lindgren, 1997) living in other developed countries. Like most developing countries, growth retardation is commonly prevalent in Vietnam (Khoi and Giay, 1994). This could be due to the insufficient nutritional status of both children and their mothers, and environmental conditions, causing inadequate food intake, poor health care of children, and, in general, poor living conditions (Hop et al., 1997). For example, studies reported that 40% of Vietnamese women of child bearing age had a BMI < 18.5 $kg{\cdot}m^2$ (Khoi, 1996), while 59.4% of boys and 58.3% of girls were at risk of being under-nutrition at the age of 21 months in the Hop et al. study (1997).

Few researchers have measured fitness in Vietnamese children and adolescents; indeed, there is an absence of reports of Vietnamese children's fitness in the available international literature. Although PA and fitness of children and youth are of great concern to the Vietnamese government, information in this area is lacking. According to the Ministry of Education and Training (MOET, 1996), from 1962, several government documents proposed strategic plans to improve fitness levels among children and youth, these proposals however, lacked the scientific research to support them. In 1972 (during the war), the General Department of Physical Education and Sports (GDPES) launched the Body Fitness Criteria named *Tieu Chuan Ren Luyen Than The* (MOET, 1996). The guiding principle required all people from 13 to 45 years of age to undertake training and fitness tests covering five areas: endurance running, long jumping, swimming, shooting, and martial arts. Levels of fitness were classified based on the available achievement scores. People were subsequently ranked in one of four levels: excellent, good, pass and not pass (*gioi, kha, dat, khong dat*). Because of the war's demand, this government strategy appeared to target health and fitness training in people as a preparation for joining the army and for protecting their motherland. However, the tests were too complicated, impractical and difficult to implement, as they required expensive facilities and instruments for the shooting and swimming components (MOET, 1996). Children aged less than 13 years were not mentioned in these documents.

After the war, GDPES and MOET refined these documents and published other strategic plans establishing a battery of fitness tests suitable for Vietnamese school students. However, no national survey has been carried out to provide a scientific basic for these documents with the exception of one survey measuring the biological data of 4820 children aged from birth to 15 yrs in 1975 by Ministry of Health, Hanoi (MOH, 1976). It should be mentioned that during the period from 1975 to 1986, Vietnam was in a difficult situation, because of the American embargo, the consequences of the war, and the border conflicts with neighbouring countries. Suppressed social and economic conditions led to a lack of financial and human resources and a dearth of prominent Vietnamese experts in epidemiological and sport science that could give priority to surveys of PA and fitness.

In 1996, the Department of PE of MOET conducted a national survey of fitness in 28,000 school students from grades 1 to 12 in twelve provinces. The fitness test battery encompassed standing long jump, sprint (30 m and 60 m for primary and secondary students, respective), distance running (500 m and 1000 m for primary and secondary students, respective) shot put, throwing the ball at a target, and stand and reach. Similar to the Hop et al. study (1997), the MOET survey reported that height and BM in children at this time, adjusted for age and sex, were significantly higher than data of children in the 1975 survey. Although the MOET survey was the most recent national study of fitness, like the previous studies in children and adolescents in Vietnam, there are some shortcomings in terms of methodology and research design. Fitness in children and youth was described quantitatively only, and there is inadequate detailed information or understanding of the process. For instance, the measurements chosen were based on previous surveys according to the ideas of officials in the Department of PE – MOET rather than based on pilot or validated methodologies. There were very few internal references, no international studies were referenced or compared for these measurements. Thus, no evidence of sound scientific practices to improve the quality of data or evidence of the validity of the standards was reported. This survey was used as the foundation for developing a new Physical Fitness Criteria (*Tieu Chuan Ren Luyen Than The*) that is compulsory for all school students.

There is also a lack of studies reporting the relationship between fitness and PA, or between PA and other factors in Vietnamese children and adolescents. Despite improvements of living conditions in Vietnam, the accessibility of the Internet for research purposes has been limited. The library system also has not been well refined with dated facilities and there is a lack of network connections. These conditions contribute to limitations of research by physicians, epidemiologists, pediatricians and researchers who are interested in PA, fitness and health. Therefore, most available publications are internal to Vietnam, and somewhat lacking information in discussion compared with other international literature reviews. Only a few studies (e.g. Hop et al., 1997) have been published in the international literature and have reported good references and research methodology. It should also be noted that the international publications from Vietnam (Hop et al., 1997) were supported by some international organisations or foreign institutes and scientists.

2.8 Summary

There is a long history of research conducted in fitness, but studies of PA have been intensively conducted only in the last few decades and more in adults than in children. Recently, research into the association between PA, fitness and health in children and adolescents has been more concentrated. A number of studies in this area have arrived at the conclusion that PA during adolescence contributes significantly to the maintenance of health and may persist into adult life. Literature also increasingly demonstrates the prevalence of CV disease in the last decade in many developed countries and a high proportion of children having primary risk factors for CV disease including sedentariness and overweight and obesity. The literature also endeavours to generally describe the number of adolescents that are physically active or physically inactive, and that the levels of PA in children generally decrease with age and differ by gender. These conclusions of PA and health status among children and adolescents however were derived from studies that were mostly conducted in developed countries (mainly in North America and Europe). Information on this area from developing countries is very limited. Because of the importance of PA for health, assessment of current levels of PA in children and adolescents is critical for preventing disease and developing guidelines for PE and public health efforts for any nation. Therefore, more research on PA in children and adolescents in developing countries is urgently required to reveal not only a fairer worldwide standard consensus on PA patterns but also the impact of physical inactivity on children's health in such nations.

Although a variety of methods of assessing PA have been described in the literature, there is still no accepted gold-standard measurement tool. The lack of an ideal criterion makes it difficult for researchers to conduct studies on this area, even in large developed nations such as the USA. While some statements have been made in these nations, it remains difficult to interpret prevalence rates of PA among children and adolescents, and it is even more difficult to identify the volume of inactivity that compromises health and well being in the present and in the near future. The assessment of PA becomes more difficult for researchers in a poor developing country like Vietnam, where there is less experience of research, a poor library system and facilities, and very limited financial resources. This has led to the situation that the concept of PA and its measurement methods have been taught in Vietnam, but more in theory than in practice. Assessments of PA are not well referenced, and co-operation with the international community has been limited. There is little knowledge of measurable techniques for assessing PA such as mechanical and electronic instrumentation, PA and heart rate monitoring or double-labelled water methods. The questionnaire methods used have not been well developed or validated. Therefore, while PA, fitness and health, as well as the associations between them have been widely studied around the world in both adults and children, there is very little available information about these issues among Vietnamese children and youth. A number of studies have been conducted on disease in children and a few surveys have been undertaken in fitness, but to this time there has been no study of PA and its relationship to health or to other factors such as SES and ethnicity. Although PA, fitness and health of children and adolescents have become an important issue for Vietnamese researchers over the last decade, it seems the majority of government documents in this area have targeted the training or measuring of fitness, but ignored the assessing of PA and its influencing factors.

It appears that the uniqueness of Vietnam's history, geography, politics, and economics has produced PA patterns specific to this nation. However, due to the small amount of research on PA and fitness and the less cognitive measurements of PA, information about this matter is lacking. Thus, an understanding of PA patterns as well as the cultural, environmental, and SES factors among Vietnamese children and adolescents will not only assist in improving their health status and facilitating PE programs in Vietnam but also assist in a better exploration of the effect of cultural environment on PA in children and adolescents.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This dissertation consisted of three separate studies to address the issues relating to the PA assessment, PA patterns, fitness and the influences of culture, environment and SES on activity in Vietnamese adolescents. The initial focus of this dissertation (Study 1) was to validate the Computer Science Application (CSA) activity accelerometer and heart rate monitor as objective measures of PA on Vietnamese adolescents. Since there is no previous review or study of evaluation of mechanical and electronic motion detectors nor of physiological markers in Vietnamese children and adolescents, this study adapted the methodology previously used in studies of children from western countries. It was conducted among native Vietnamese adolescents living in both Vietnam and Australia.

The second phase of the dissertation (Study 2) was to describe the patterns of PA, to estimate activity EE among Vietnamese adolescents and to show the interrelation of these parameters with fitness and socio-economic status (SES). A secondary objective of this study was to consider some effects of the culture and lifestyle of Vietnamese adolescents on their PA patterns.

The final task of this dissertation (Study 3) was undertaken in Australia and used a similar methodology to Study 2 to attempt a cross cultural comparison of PA between the Vietnamese adolescent group and an Australian-Vietnamese group in order to explore any environmental/cultural effects on PA in these groups.

3.2 Subjects

The subjects referred to in this dissertation were in grades 6 to 9 of their school years. A total of 284 students voluntarily participated in the three studies with 48 participating in Study 1, 179 in Study 2, and 66 in Study 3 (each of these groups will be detailed in the methodology of the specified study). Of those, 80 were Australian adolescents with a Vietnamese ethnic background living in Australia. The rest were native Vietnamese adolescents living in Vietnam.

The names of schools and permission for students to participate were obtained from the Department of Education (DOE) in Hanoi, Vietnam as well as in Victoria, Australia. After consultation with the DOE (Vietnam) students were selected from the district schools across a range of socio-economic backgrounds. In Australia, the Australian schools were selected in the western metropolitan of Melbourne where a high percentage of the population is of Vietnamese ethnicity. The classes were randomly selected in the schools. Students were given the opportunity to volunteer, if they were Vietnamese in normal health and aged between 12 – 14 years, and both their parents were Vietnamese. Prior to the conduct of the studies, agreement to conduct the study was obtained from the relevant principals and school councils. Written, informed consents were obtained from both students and their parents (see Appendix A & B). All the procedures of this dissertation were approved by the University

Human Research Ethics Committee, Victoria University of Technology, Melbourne, Australia.

3.3 Overview of Research Design

This dissertation had a sequential research design and its objectives were realised by employing a four-step strategy. In the initial stage an instrument for the measuring of PA patterns in Vietnamese adolescents was developed. Three discrete studies were then conducted to investigate PA and fitness in adolescents in Vietnam and Australia. The three studies and their relation to the aims of the dissertation were as follows:

Study 1:

The CSA activity monitor (Model 7164, European Version) and heart rate monitor (Polar, NV) were used for the development and validation of an objective instrument suitable for the measurement of EE of Vietnamese adolescents. Oxygen consumption ($\dot{V}O_2$) during known treadmill speeds was used as the major criterion measure.

Study 2:

Physical activity patterns of Vietnamese adolescents and the EE record were determined by using the modified three-day physical activity record (validated by a sub-sample) and the PA questionnaire. These instruments also revealed the cultural influence and the lifestyle of this cohort including the time spent in sleeping, studying, viewing TV, and participating in activities popular among Vietnamese adolescents. An analysis of the interrelation of PA (described in Figure 3.1: A, B, C, D) with the physical fitness, anthropometry, and SES of adolescents in Vietnam was undertaken.

Study 3:

A comparison of PA patterns and fitness parameters between adolescents living in Vietnam and Australian adolescents of Vietnamese ethnicity was undertaken. This study, using the instrument already described in Study 2 to measure PA, focused on the cultural, environmental and SES influences on PA and lifestyle in these groups.

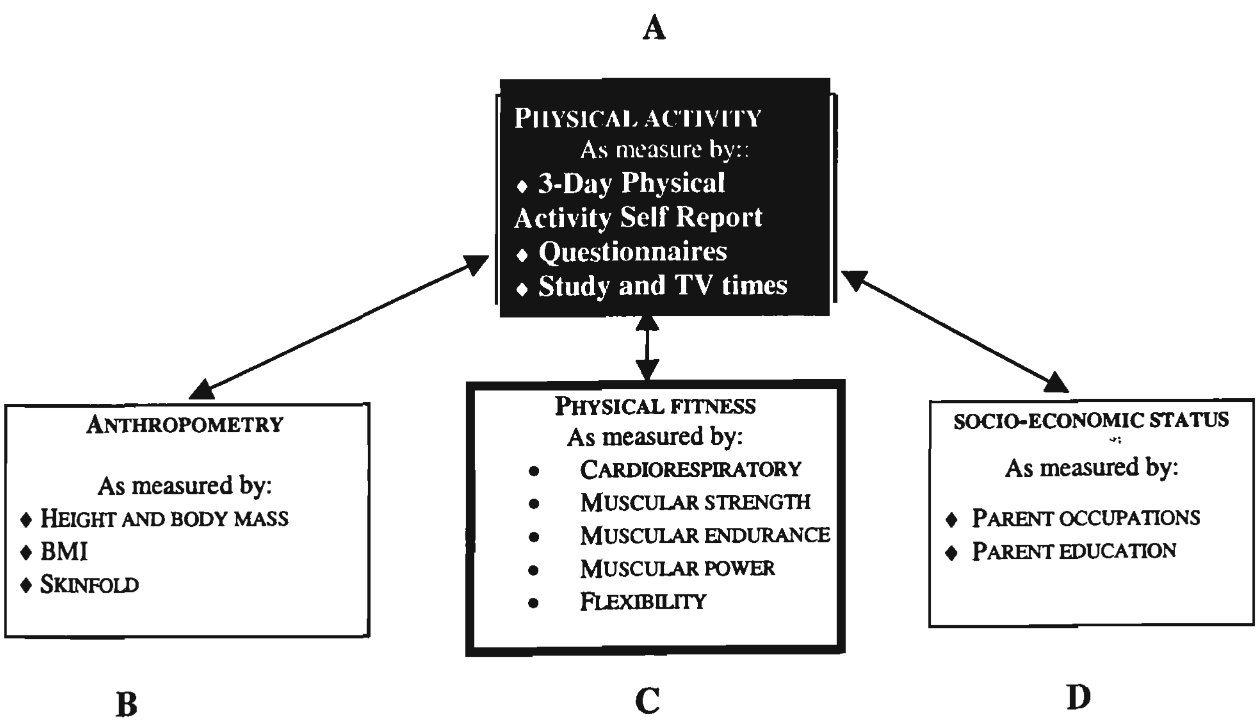


Figure 3.1 *Grouping of assessment variables.*

3.4 Methodology

More details of study-specific methodologies used throughout the dissertation are described in the chapters of this dissertation devoted to each discrete study (see chapters below).

The three studies of this dissertation are titled as follows:

Study 1:

Validation of the computer science applications (CSA) as an objective measure of energy expenditure in Vietnamese adolescents

This study was conducted in laboratory settings in Australia and in Vietnam. The same CSA and HR monitors and similar equipment for determination of oxygen consumption were used in both locations and an equation for estimating EE during PA of Vietnamese adolescents was developed.

Study 2:

Physical activity patterns of Vietnamese adolescents in relation to fitness, culture, and socio-economic status.

This study examined the PA patterns of a group of Vietnamese adolescents and investigated the relationships between PA and other factors, encompassing fitness, culture and SES in this population. In order to achieve this, self-reports and fitness tests were adapted and validated to make them suitable for Vietnamese adolescents.

Study 3: *Physical activity patterns of Vietnamese adolescents in Vietnam and in Australia.*

This study compared PA patterns and influences of cultural, physical and environmental factors on the choice of PA of Vietnamese adolescents in different living conditions between Vietnam and Australia. This study also compared daily EE of Vietnamese adolescents with daily EE of adolescents from other nations to further confirm any factors which influence the level of PA of Vietnamese adolescents. The methods used in this study represent a refinement of those previously employed in Study 2.

3.5 Statistical Analysis

Statistical analysis of the data was undertaken using the Statistical Package for Social Science (SPSS) software (version 10.0). In Study 1, intraclass correlation coefficients were calculated to determine inter-instrument reliability of the CSA monitor. Differences between measured variables were analysed using paired-sample *t* tests, with alpha adjustment to prevent inflation of Type I Errors. The equation development for predicting EE ($kcal \cdot min^{-1}$) was obtained by using linear regression, with CSA activity counts, and BM of the subjects entered as predictors. In Studies 2 and 3, correlation matrices between the dependent variable, EE, and all of the independent measures, Factors B-D, were determined for the Australian and Vietnamese data, separately. Summary descriptors (means, standard deviations, frequencies, percentiles) for PA patterns and EE, were also calculated for the data from both countries, separately. Multiple regression was used to describe the relationship between the dependent measure (EE) and the independent measures, for both the Vietnamese and Australian data, and for specific subgroups within those countries (i.e. gender, age and SES levels). Resulting Beta weights for the corresponding multiple regression equations were compared to yield information about cultural determinants of PA and physical inactivity and group differences. Z tests (one Sample T-Test) and Cohen's *d* effect sizes (Cohen, 1988) were used to compare the generated data (EE, anthropometrics) with existing data in the literature review. In the case of variances of the scores between two groups being statistically unequal (e.g. between age groups, male vs female, Vietnamese vs Australian-Vietnamese groups), the Mann-Whitney test was used to control type I error. Unless otherwise stated, reference to statistical significance refers to $p < 0.05$.

CHAPTER 4

VALIDATION OF THE COMPUTER SCIENCE APPLICATIONS (CSA) AS AN OBJECTIVE MEASURE OF ENERGY EXPENDITURE IN VIETNAMESE ADOLESCENTS

4.1 Introduction

The most difficult issue in validating field measurements of PA in children and adolescent is finding a practical and standard criterion (Saris 1986; Freedson, 1989, Louie et al. 1999, Westerterp, 1999). Hence, development of a valid and reliable instrument for objectively measuring PA is currently required in order to investigate any relationship between PA and health of children and adolescents (Roland et al., 1997). The development of electronic and microcomputer technology has facilitated the introduction of new devices, including motion sensors, accelerometers and HR monitors, which can in some ways meet the criteria of providing objective measures of PA with minimal discomfort. For example, these devices can measure the intensity of body movement to estimate EE without depending on subjective ability to recall activities (Freedson, 1991; Goran, 1998; Westerterp, 1999).

Several studies (Freedson, 1989; Freedson, 1991; Rowlands et al., 1997; Louie et al., 1999; Ott, Pate, Trost, Ward, and Saunders, 2000) have recently attempted to evaluate the validity and reliability of accelerometers and HR as the most common objective techniques for assessing PA in children and adolescents. Among the mechanical and electronic motion detectors, accelerometers (activity monitors) seem to have more advantages of objective measurements of PA, as these electronic accelerometers can replace pedometers, and have storage capacity for data (Freedson et al., 1991; Westerterp 1999).

Although the accelerometers are considered an objective instrument, these devices are still experimental. Studies that examined the validity and reliability of these instruments were summarized in Table 2.2 (section 2.2.2). Trost and his co-workers (1998) previously evaluated the validity of the CSA monitor (model 7164) for measuring PA in North American children (aged 10 to 14 yrs) using EE ($kcal \cdot min^{-1}$) during treadmill exercise as a criterion measure. Similarly, Melanson and Freedson (1995) developed models to predict EE using body mass and CSA counts from monitors attached to three different body positions in American young adults during three-speed treadmill trials. The two sets of authors also suggested that the resulting energy prediction equation using activity monitor counts may be suitable for predicting the mean EE of a group, but may not be considered as accurate for predicting EE in individuals (Melanson and Freedson, 1995; Trost et al. 1998).

The use of these devices has also tended to be country/culture specific. Research on accelerometers, with the exception of the Louie et al. (1999) study, has only been conducted with Western children and adolescents as the subjects. Measurement techniques of habitual PA might also depend on the living environment and culture of the population, thus, for example, Vietnamese adolescents may respond differently toward the PA measurement devices and/or have different levels of activity EE from Western adolescents. Vietnamese children or those children who are living in Southeast Asian countries normally have smaller body sizes than Western children (Aurelius et al., 1997; Hop et al., 1997). Therefore, the aim of this study was to examine the validity of the CSA activity monitor as an objective measure of EE in Vietnamese adolescents. The CSA activity monitor, version WAM-7164 was used as the tool to be validated for assessing PA of Vietnamese adolescent groups. A comparison of this device's validity between two groups of adolescents of Vietnamese ethnicity but living in different environmental and cultural conditions was also obtained.

4.2 Methodology

4.2.1 Subjects

In this study, one group of 34 Vietnamese adolescents (aged 11-15 yrs) living in Vietnam were recruited from Thu Duc district, Ho Chi Minh city, Vietnam. Another group of 14 Australian adolescents (in the same age groupings) of Vietnamese ethnicity (the country of birth of their parents was Vietnam and their first language spoken at home was Vietnamese) were recruited from Maribyrnong city, in the west of Melbourne, Australia. The subject characteristics are as depicted in Table 4.1 below:

Table 4.1. *Subject characteristics of two groups (mean & SD)*

Group	Gender	N	BM (kg)	Height (cm)	Age (year)
Native Vietnamese	Male	20	41.7 (9.5)	153.5 (11.6)	13.6 (0.9)
	Female	14	46.4 (5.7)	156.1 (5.7)	13.9 (0.6)
Australian-Vietnamese	Male	7	40.4 (4.7)	148.2 (9.5)	12.7 (1.6)
	Female	7	43.6 (7.8)	150.6 (4.8)	12.3 (0.8)

4.2.2 Exercise Protocols

This study was undertaken in both Australia (Victoria University, Melbourne Australia) and Vietnam (the University of Physical Education and Sports, No. II, Thu Duc, Ho Chi Minh city, Vietnam). In both locations, subjects followed the same exercise protocols and utilized the same CSA monitor. The CSA monitor was evaluated for metabolic rates at rest, light, moderate, and high caloric output states. Subjects reported to the Exercise Physiology Laboratory in a rest status and each subject refrained from exercise and caffeine for a 4h-period prior to each trial, but apart from these restrictions, they continued their normal daily activities. Following a measurement of the subject's height (NOVEL products Inc. Addison IL. U.S.A) and BM (D-7470 Albstadt 1- Ebingen, West Germany), each subject was given a familiarization period of 5 - 7 minutes with the instrumentation (breath through the mouthpiece, wearing the HR and CSA monitors, walking and running familiarly with the three treadmill speeds). Then the subject's $\dot{V}O_2$ and HR were evaluated at rest. Each subject was then required to perform randomly three bouts of exercise consisting of 3 x 5minutes at different speeds on a motorised treadmill: slow walking at 4.5 $km \cdot h^{-1}$, fast walking 6.6 $km \cdot h^{-1}$ and running at 8.8 $km \cdot h^{-1}$ with each bout of exercise separated by a 5 min passive rest period (Figure 4.1 below). Treadmill speeds were verified at the same time as the calibration together with the MedGraphics with the subject on the treadmill, as they were set up as an automatic program by the lab technician prior to the trials. As a previous study reported that uni-axial accelerometers were generally non-sensitive to changes in treadmill grade (Melanson and Freedson, 1995), all trials were performed at 0% grade level on a treadmill.

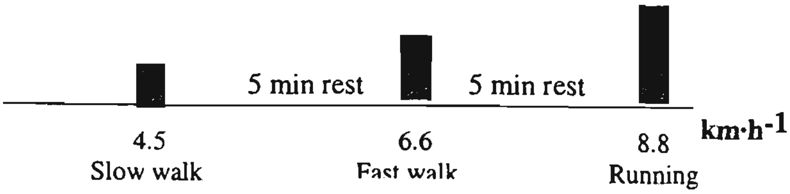


Figure 4.1. *Three 5-min treadmill speed trials*

The order of the 5-min treadmill speed trials was randomized across subjects. During these trials, subjects were wearing a CSA activity monitor on each hip and a heart rate monitor. Oxygen consumption was determined at each treadmill speed and used as the criterion measure. Oxygen consumption, CSA readings, and HR evaluation were recorded and averaged over the 5 min at each level. Values of $\dot{V}O_2$, caloric output equivalent, HR and CSA readings were calculated over minutes 3 to 5. This methodology was adapted from the protocols of Trost et al. (1998). Leg activity was chosen because a pilot study had indicated that the majority of physical activities undertaken by Vietnamese adolescents emphasised lower body large muscle groups.

The Computer Science and Applications (CSA) Activity Monitor

The CSA activity monitor, Model 7164, version 1.1 was used for this study. To evaluate the inter-instrument reliability of the CSA, two actigraphs were housed in small nylon pouches provided by the manufacturer and were firmly secured to the subject's right and left hip by an adjustable elastic belt. The CSA activity monitors were initialised prior to each exercise session according to the manufacturer's specifications and were synchronised with an external timepiece. After finishing the exercise section, data was downloaded on to a personal computer (PC) using the program: RIUK.64.exe, Software Version 2.13c Supports Model 7164 (CSA, Inc. Shalimar, FL, USA).

Heart Rate

Heart rate was monitored throughout the trials and averaged over 60 second intervals using the *Polar Vantage NV* (Polar Electro Oy, KEMPELE, Finland). The transmitter was strapped to the chest of the subject and ECG signals transmitted to a wristwatch attached to the wrist of the subject. A sweatband was placed over the wristwatch to prevent damage or activation of buttons on the watch. Heart rate monitoring was synchronized with $\dot{V}O_2$ and the activity monitor, to enable HR responses to be matched with the subject's three-5 min speed trials. From this point, activity and HR monitoring continued throughout the entire trials, including all exercises and rest intervals. Heart rate data from the wristwatch was subsequently downloaded onto the PC using the *Polar HR Analysis Software* version 5.04 (Polar Electro Oy, KEMPELE, Finland).

Oxygen Consumption

Oxygen consumption was monitored directly by the Cardiopulmonary Diagnostic System (MedGraphics Corporation, Model 762030-202, StPaul, MN. USA). Expired ventilation was determined by an on-line spirometer and analyzed for oxygen and carbon dioxide concentrations by Module VO_2/CO_2 Analyzer (Cardiorespiratory Diagnostic Systems, MedGraphics, Model 762014-202, MN. USA). The gas analyzer was calibrated before the test of each subject using standard gases of known concentration. Carbon dioxide output (VCO_2), $\dot{V}O_2$, respiratory exchange ratio (RER) and ventilatory equivalents for both $\dot{V}O_2$ and $\dot{V}CO_2$ were determined every 30 seconds, using standard algorithms, by an IBM compatible computer (Cardiorespiratory Diagnostic software, 1991-1996 Medical Graphics Corp. MN. USA).

The test-procedure was repeated in both locations using the same make and model instruments with the exception of the use of different treadmills (QUINTON, Q65, USA in Australia, and Trackmaster, ANS/UL 1647, ELT, USA in Vietnam). The tests in both locations were undertaken in a controlled environment physiology laboratory in which the ambient temperature was maintained at 22°c. The inter-instrument reliability for the CSA was only evaluated for the Vietnamese group.

4.3 Results

4.3.1 Inter-instrument Reliability

The correlations between the left actigraphs and the right actigraphs for all the three speed trials were significant ($p < 0.01$). The intraclass correlation coefficients of activity counts of the two actigraphs were $r = 0.85$, $r = 0.90$, and $r = 0.91$ for slow walking, fast walking, and running, respectively. In support of previous studies, there were no significant differences between mean activity counts of the left and right actigraphs for the three speed trials ($P > 0.5$). However, the actigraph worn on the hip over the dominant leg (ascertained by interview) was used for collecting data of the subsequent analysis to avoid the variability (if any) caused by the effects of different functional use between dominant and non-dominant limbs on the body movement.

4.3.2 Measurement Variables

Since no significant difference ($p > 0.05$) between males and females in any measurement variable was obtained for either group, both genders of each group were pooled for statistical analysis. Figure 4.2 shows the magnitude of HR, $\dot{V}O_2$ and CSA counts for the two groups increased significantly with three-treadmill velocities ($p < 0.05$). Although the mean of activity counts of the Vietnamese groups was higher than the Australian-Vietnamese group, there was no significant difference ($p > 0.05$) between the two groups in HR and the CSA counts. But the $\dot{V}O_2$ value of the Australian-Vietnamese group was significantly higher than the Vietnamese group ($p < 0.01$). However, the CSA counts were also highly correlated with HR and $\dot{V}O_2$ ($p < 0.01$), and the magnitudes of increase of these variables with three-treadmill velocities were almost identical for both groups.

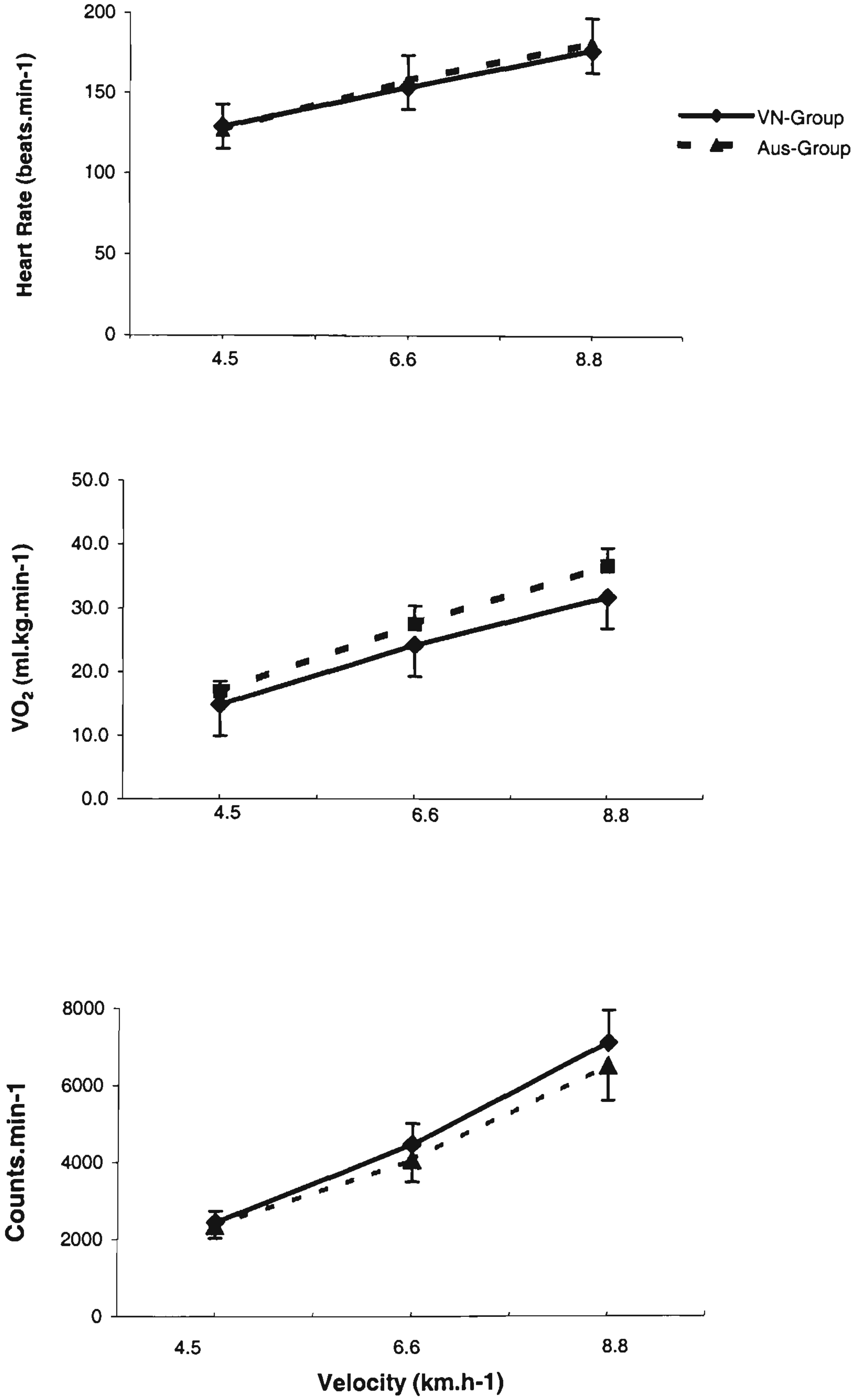


Figure 4.2: *Heart rate, $\dot{V}O_2$ and activity counts (mean ± SD) of the Vietnamese (VN) group compared with the Australian-Vietnamese (Aus) group at three-speed trials.*

4.3.3 Equation Development

The Australian-Vietnamese sample group was statistically not large enough (n = 14) to be used to develop an equation to predict EE. Because there was a significant difference in the $\dot{V}O_2$ value between the Vietnamese and Australian-Vietnamese groups, the two group samples could not be pooled. Therefore, an equation for predicting EE was developed using the data from only 24 random subjects of the Vietnamese group and the remaining 10 subjects were used as the validation group. Figure 1 shows the relationship between the CSA counts and $\dot{V}O_2$ in this group during three-speed trials.

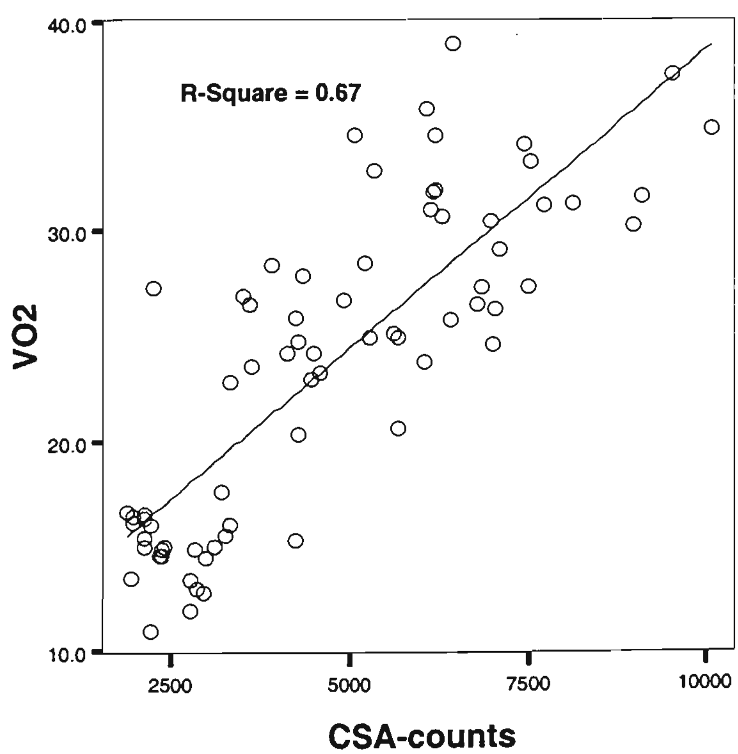


Figure 4.3: *The linear relationship between* $\dot{V}O_2$ *and CSA counts during three-speed trials.*

The dependent variable ($kcal \cdot min^{-1}$) was strongly correlated with activity counts ($r = 0.78$) and HR ($r = 0.74$) in this group. The equation for prediction of activity EE developed from the CSA counts per minute and BM explained 72% of the variability in kcal $ml \cdot kg \cdot min^{-1}$ (adjusted $R^2 = 0.72$). The standard error of the estimate was SEE = 0.91 kcal $ml \cdot kg \cdot min^{-1}$ for this equation. The prediction equation developed from the Vietnamese adolescents was as follows:

$$Kcal \cdot min^{-1} = -1.398\ (constant) + 0.00062\ (counts \cdot min^{-1}) - 0.0803\ (BM\ in\ kg)$$

Based on this equation, the EE of the validation group ($n = 10$) was calculated. The correlation between mean actual and mean predicted EE was significant ($r = 0.90$). The results of cross-validation of this equation are shown in Table 4.2 below. Correlation coefficients between actual and predicted EE at three-speed trials (4.5, 6.6, and 8.8 $km \cdot h^{-1}$) were 0.91, 0.66, and 0.95, respectively. The mean differences between actual and predicted EE at these three-speed trials were 0.4, 0.6, and 0.6, respectively.

Table 4.2. *Results of cross-validation of the equation to predict activity EE.*

Velocity ($km \cdot h^{-1}$)	Measured mean ($kcal \cdot min^{-1}$)	Predicted mean ($kcal \cdot min^{-1}$)	Difference	r	SEE
4.5	3.3 (0.74)	3.7 (1.04)	0.4	0.91^{**}	0.32
6.6	5.4 (1.13)	4.8 (1.36)	0.6	0.66^{*}	0.90
8.8	7.3 (1.84)	6.7 (1.19)	0.6	0.95^{**}	0.58

* = $p < 0.05$; ** = $p < 0.01$

4.4 DISCUSSION

This study examined the validation of the Computer Science Application (CSA) as an objective measure of PA in Vietnamese adolescents. An equation for prediction of activity EE was developed. Results of this study showed that the CSA activity monitor is a reliable instrument, and that activity counts and HR on their own were salient predictors of EE during treadmill activities for Vietnamese adolescents. These results confirm earlier reports on the validation of the CSA activity monitor for measuring PA in laboratory settings in North American (Melanson and Freedson, 1995; Trost et al., 1998), British (Eston et al., 1998) and Hong Kong Chinese children (Louie et al., 1999). This was the first study to be conducted with Vietnamese adolescents living in both Vietnam and in Australia.

4.4.1 CSA Monitor and Intensity of Body Movements

Although this study adapted the exercise protocol from previous studies by Trost et al. (1998) to further validate CSA activity monitors using Vietnamese adolescents, the speed at the running bout was reduced to 8.8 $km \cdot h^{-1}$ to make it appropriate for Vietnamese children's body size. The CSA counts, HR and $\dot{V}O_2$ were significantly changed with the treadmill speeds (Figures 4.2). This finding confirmed that the CSA activity monitor is sensitive to changes of exercise intensities during treadmill walking and running for children (Trost et al., 1998; Louie et al., 1999). However, to date no study has used the CSA new model (Model 7164) to define the appropriate count cut off-points that correspond to activity intensities for children and adolescents. Previously, Janz (1994), based on HR scores of 75, 130, 150 $beats \cdot min^{-1}$ during daily activities of children, established CSA equivalent count ranges of 25 -

250, 251 - 499, and ≥ 500 counts·min^{-1} that represented low, moderate, and vigorous activities. The CSA monitor used in the 1994 Janz study however, was the original model (Model 5032).

When the two groups were compared, the average of the CSA counts in the Vietnamese group was higher than the Australian-Vietnamese group (though, not significantly so), but the $\dot{V}O_2$ value in the Vietnamese group was significantly lower than in the Australian-Vietnamese group ($P < 0.01$) for the three-speed trials. It is possibly that the two subject groups differed in their mechanical efficiency as the Vietnamese group was significantly older than the Australian-Vietnamese group ($P < 0.01$), and slightly taller and heavier (but not significantly, $p > 0.05$) than the Australian group (Table 4.1). A minor variability of the $\dot{V}O_2$ value could possibly be affected by a measurement error. That is, the error was due to the fact that the two groups were tested on different ergometers in different laboratories, although the subjects of both groups underwent the same exercise trials using the same make and model instruments in both locations.

This study also demonstrated a significant correlation for inter-instrument reliability of the CSA activity monitor. The correlation coefficients of the three-speed trials were from $r = 0.85$ to $r = 0.91$ ($p < 0.01$). This significant inter-instrument reliability was consistent with a previous study by Trost et al. (27) who found the average of this reliability over the three treadmill speeds was $r = 0.87$. The small variability of the inter-instrument reliability could be due to the difference of the vertical movement between the dominant leg and the non-dominant leg of the subjects as well as to difference in the instrument. Therefore, in the present study, the data from the hip over the dominant leg was chosen for the analysis.

4.4.2 Equation of Energy Expenditure Prediction

Equations to predict activity EE from CSA monitor counts have been developed in laboratory settings for Western adolescents (Trost et al., 1998), and adults (Freedson et al., 1998). Similar to the Trost et al. study (1998), an equation to predict activity EE in Vietnamese adolescents was developed utilizing CSA counts and BM as the independent variables in the present study. However, in the present study a multiple linear regression was used to develop the equation instead of a stepwise regression. If a stepwise regression is used, the minimum ratio of subjects to an independent variable (in this case: kcal $ml \cdot kg \cdot min^{-1}$) must be 40 to 1 (Tabachnick and Fidell, 1996). In the present study, the data from only 24 subjects were used for developing the equation, thus a linear regression was more applicable. It was found in the present study that the equation for predicting activity EE could explain the higher percentage of the variability in kcal $ml \cdot kg \cdot min^{-1}$, when it was developed from CSA activity counts, HR and BM. However, it was desirable to develop an equation from activity counts and BM (Freedson et al., 1998). The equation for predicting activity EE in the 1998 Trost et al. study explained about 86% of the variability in $kcal \cdot min^{-1}$, while the equation in the present study explained only 72%, but the SEE (0.91 $kcal \cdot min^{-1}$) was very similar to the SEE found in the 1998 Trost et al. study (0.93 $kcal \cdot min^{-1}$). This is also consistent with the study in adults by Freedson et al. (1998) in which a SEE of 0.85 $kcal \cdot min^{-1}$ was reported. By using the equation in the present study to predict activity EE, the correlations between actual and predicted EE at the three-speed trials were high and significant for slow walking and running speeds, but were moderate for fast walking speed (Table 4.2). The lower correlation (R = 0.66) for the second treadmill condition (level of 6.6 $km \cdot h^{-1}$) appears to be related to the change in gait from walking to running at this speed. That is, the vertical direction in this middle-speed was more inconsistent than in slow walking and running by individuals as the highest standard deviation (SD = 1.36, Table 4.2) was found in this speed condition. This effect can also be noticed in the 1998 Trost et al. study (R = 0.62 in this speed), and possibly indicates a difficulty with accurate use of uniaxial accelerometers such as the CSA monitor when the activity pattern changes. This finding thus, might further assume that the equation for predicting activity EE from the CSA activity monitor is more valid for a group but is not suitable for an individual in the field.

It also should be noted that most of the studies using the CSA activity monitor have been conducted in laboratory settings. The physical activities were limited to treadmill exercises or in some cases (Eston et al., 1998; Louie et al., 1999) limited to a few activities in the laboratory. There have been two studies (Trost et al., 1999a; Trost, Ward, McGraw, and Pate, 1999b) which utilized the new CSA (model 7164) as the criterion measure to validate self-reports for measuring PA in children in the field. However, the correlation coefficients between the CSA counts and the self-report in the Trost et al. (1999 a) study were low (r was from 0.01 to 0.33). In another study, Trost et al., (1999b) reported that the CSA counts were significantly correlated with the vigorous PA (measured by the Previous Day Physical Activity Recall for children) but not with the moderate PA. Sirard et al. (2000) reported moderate correlation coefficients between the CSA counts and the PA diary (r was from 0.49 to 0.65). But this study used young adults (25 ± 3.6 yrs) as the subjects.

The low and discrepant correlations between self-reports and accelerometers might be caused by the limitations from both these instruments as one or the other is not a standard criterion measure. On the one hand, the self-reports used in these studies were different and may not accurately denote daily consistent child PA patterns (Janz, 1994; Janz et al., 1995; Trost et al., 1999a) or perhaps "children tend to overestimate their PA" (Sallis, 1993). On the other hand, the limited measuring ability of the CSA accelerometers, which cannot detect non-vertical movements, may cause the inaccuracy of PA readings on individuals (Janz, 1994; Janz et al., 1995; Trost et al., 1999b).

The validation correlations are different according to subject composition (ie. adult or children subjects) as well the testing environment (ie. laboratory setting or field conditions). Children's physical activities in nature are more transient and diverse compared to adults (Klesges and Klesges, 1987; Janz, 1994; Louie et al., 1999). The CSA activity monitor has also a limitation of measurement to only vertical movements, which is "more sensitive to common adult activities, than common child activities..." (Janz, 1994). Ott et al. (2000) also noted that the MET values, which were commonly used as equivalent EE to intensity levels of each activity, were based on adult data. Therefore, it is difficult to evaluate the validity of the uniaxial or triaxial instruments to convert activity EE from accelerometer counts. Because of these limitations, activity monitors might be more suitable for use in adults than in children. The other limitation of the CSA activity monitor (this would also apply to all such mechanical and electronic instrumentations) is that children, particularly those in developing countries such as in Vietnam, can tamper with the monitor. In this study, when the Vietnamese group first saw the CSA activity and HR monitors they were very curious and wanted to closely examine them. It is also easy for children to forget to re-wear activity monitors in everyday living conditions, for example, after bathing, swimming or sleeping. In addition, PA patterns are also influenced by culture and environment. Vietnamese children may spend a lot of time in sitting activities such as studying or watching television; thus, the CSA activity monitor which is limited to the measurement of vertical movements only, may not provide valid information about the total daily activity EE in a group with a sedentary lifestyle.

In summary, this study was based on the first specific objective of this thesis to develop an objective and quantifiable measure of PA, suitable for use on a Vietnamese adolescent population. Similar to the previous studies, this result suggested that the CSA monitor is a valid instrument for objectively measuring EE in treadmill exercises in Vietnamese adolescents. However, this device also indicates its limitations for measuring PA in the field. That is, it was more valid for a group than an individual; it is expensive, and is not feasible for large samples of children in Vietnam. Furthermore, the two actigraphs malfunctioned (broken beams and cracked cases) during the field data collection, which may have allowed moisture to enter due to the hot and very humid weather in Vietnam. As a conclusion, the CSA activity monitor is limited to laboratory studies rather than to the field situation. It is apparent that the CSA monitor can be used as a criterion measure in the validation of questionnaires. Therefore, in the next studies (2 & 3), questionnaires would be used to measure the PA level of Vietnamese adolescents and are more suitable for these large sample populations.

CHAPTER 5

PHYSICAL ACTIVITY PATTERNS OF VIETNAMESE ADOLESCENTS IN RELATION TO FITNESS, CULTURE AND SOCIO-ECONOMIC STATUS

5.1 Introduction

It is widely acknowledged that PA makes a significant contribution to the maintenance and improvement of health and physical fitness in children and adults (Sallis and Patrick, 1994; Cavill, Biddle and Sallis, 2001). This is equally true for all ethnic populations. Although the beneficial influences of PA on health are apparent, it appears that in Vietnam, because of insufficient resources, the Government has not placed it in the same priority category as medical treatment and education. There is little information or research on PA and health in children and adolescents in Vietnam. However, during recent years, the Vietnamese economy has been growing and with increased affluence, there has been an increased interest in studying the PA patterns and fitness of young people in Vietnam. Therefore, the purpose of this specific study was to evaluate PA levels in relation to physical fitness, and assess cultural and socio-economic factors influencing PA in Vietnamese adolescents.

As Chapter II discussed, the method that is typically used for epidemiological studies with large subject numbers is self-report questionnaires validated by objective measures (Kriska and Caspersen, 1997). This study used this type of procedure to identify the patterns of PA in a Vietnamese adolescent population with the three-day physical activity record being modified and validated by HR reading. Field tests of fitness were also conducted to reveal the fitness level of Vietnamese adolescents and the relationship between PA and fitness in this group.

5.2 Methodology

5.2.1 Subjects

The subjects in this study were aged 12-14 years. A total of 179 (82 male and 97 female) Vietnamese school students were recruited from secondary, urban schools in Dong Da district in Hanoi, Vietnam. This sample group of students was assumed to be representative of the district adolescent population. The subjects were classified into three age groups for males and for females. Their characteristics are described in the Table 5.1 below.

Table 5.1. *Subject characteristics* (mean ± SD) *for three age groups.*

Group (gender)	**Age**	**N**	**BM (kg)**	**Height (cm)**
	12	*32*	32.2 ± 6.16	141.2 ± 8.17
MALE	13	*35*	32.6 ± 4.76	143.7 ± 6.10
	14	*15*	43.0 ± 7.51	153.2 ± 6.06
	12	*33*	32.9 ± 6.20	141.3 ± 7.34
FEMALE	13	*48*	34.8 ± 5.61	146.8 ± 6.05
	14	*16*	40.4 ± 4.63	151.0 ± 4.63

This age cohort was chosen to maximise the validity of self-reported data. It has been shown that younger children (under 12 years) have a lack of ability to record activities accurately from their memory and are unable to quantify the time frame of activity in a self-reported activity recall (Baranowski, 1988; Sallis, 1993).

5.2.2 Measurement Techniques

This study was conducted with Vietnamese school students in Vietnam during the springtime. The PA patterns in the lifestyle of the subjects were assessed using a modified three-day physical activity self-report based on the Bouchard test (Bouchard, Tremblay, LeBlang, Lorth, Sauard, and Therialt, 1983). The subjects were required to report all their activities over the previous 24 hours at the end of each day (two school days and one weekend day). Short-term recalls of activities have previously been reported to be more reliable than long-term recalls (Baranowski, 1988). The type of activity and the time spent on it were recorded on the self-reporting form to the nearest 15 minutes. In the 24-hour table of this form, each hour has time prompts (e.g. am and pm) and was divided into four 15-min segments (see Appendix B). An orientation included an explanation and a demonstration by giving an example of recording activities (see Figure 5.1), and a subsequent interview further improved accuracy of recall (see more detail in the section of *Physical Activity and Energy Expenditure* below, p. 133).

The events and the timeline (the week numbers) for this study are contained in Figure 5.1. General administrative commitments were undertaken in week 1 and week 2. All elements were carried out after permission for conducting this specific study was approved by the Department of Education in Hanoi. The three-day physical activity record was taken when the subjects were still taking normal classes and school activities.

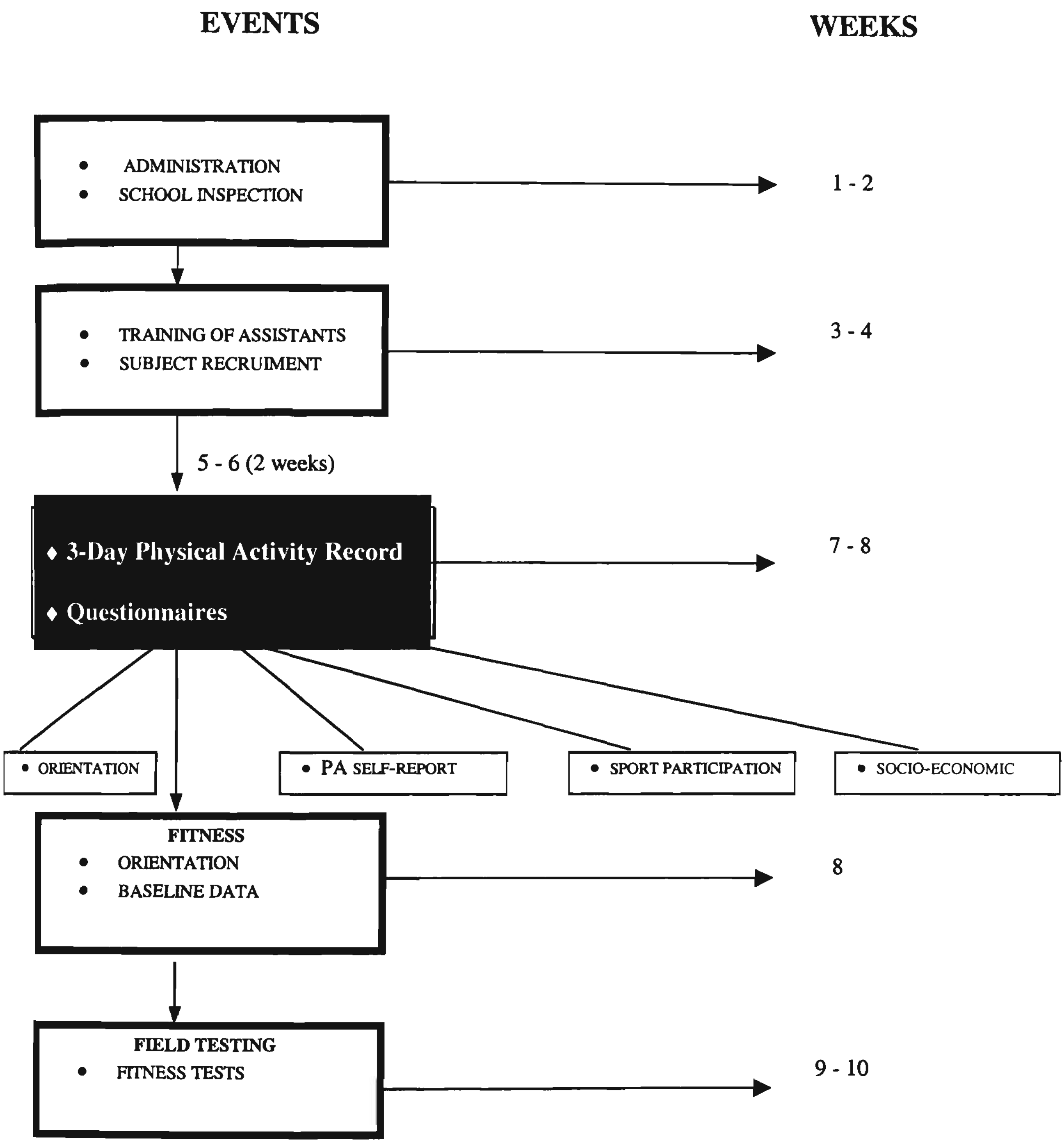


Figure 5.1. *Timeline and phases for the study: the events were carried out from week 1 to week 10.*

Physical Activity and Energy Expenditure

In order to find out the PA patterns and estimate the daily EE among Vietnamese adolescents, this study modified the 3-day Physical Activity Record developed and validated by Bouchard et al. (1983). The activities had to be recorded on any two days during the week and one weekend day. Physical activities were classified into nine (9) intensity categories in a similar fashion to the study conducted with 150 children and 150 adults by Bouchard and his colleagues in 1983 as follows:

1. Sleeping or rest in bed.
2. Sitting.
3. Light activity standing.
4. Slow walking (< 4 $km \cdot h^{1}$).
5. Light manual work.
6. Leisure activities and sports in a recreational environment.
7. Manual work at moderate pace.
8. Leisure and sport activities of higher intensity (not competitive).
9. Intense manual work, high intensity sport activities or sport competition.

Activities in categories from 6 to 9 which have median EE costs of ≥ 4.8 MET's (Bouchard et al., 1983) were classified as moderate to vigorous physical activities (MVPA). These intensity ratings were categorized according to the general type and intensity of activities in which Vietnamese adolescents engaged (see appendix B). The 24 hours of a day were divided into 96 periods of 15 minutes each (one hour equals four 15-min units). However, in order to be suitable for Vietnamese adolescents and based on a pilot study, both the form of the three-day physical activity record and the manner in which it was completed, were modified in the following way:

In each 15-min period, students were asked to write the dominant activity in which they had engaged. The activity during these particular periods was then categorized into 1 to 9 levels by the researcher and the research assistants. During the pilot study, this method was utilized as it showed more advantages than the method as reported by Bouchard et al. (1983) by which children filled in the category corresponding to physical activities. With this modified method, subjects did not need to determine which activity should be listed in which category. Secondly, the children's responses were more specific and included activities not in the list of categories provided. These activities were put into an appropriate category according to the kind, intensity and duration of the activity. For example, if a student wrote: "having a shower in the well", this activity would be categorized in a higher level than having a shower in a normal bathroom. Thirdly, as students indicated exactly the activities they engaged in during a day, activity characteristics were categorized more accurately. This method also provides additional information on the popular activities among Vietnamese adolescents and what might be a reason for a low level of PA in adolescents. For example, under the original Bouchard et al. protocol, a student writes a number two (2) in a 15-min box, indicating a sitting activity but not indicating what form of sitting the student was engaged in (e.g. sitting for study or watching TV). When students have written that they sit for study or for watching TV as under this modified protocol, the level of the activity is known (i.e. Level 2 corresponding to sitting activities), and the specific form of the activity is also known giving a higher level of information.

A table of activities of each category and energy costs was based on popular sports, exercises and daily tasks common to Vietnamese adolescents determined by questionnaires and interview. Energy expenditure in kilocalories was allocated to each activity rating for a 15-min period and per kg of BM ($kcal \cdot kg \cdot 15\ min^{-1}$) based on EE costs provided by Bouchard et al. (1983). If an activity could not be classified as equivalent intensity on the list in Bouchard et al. (1993), the activity EE cost was obtained from "Compendium of Physical Activities" (Ainsworth, Haskell, Leon, Jacobs, Montoye, Sallis, and Paffenbarger, 1993), then the activity was coded by the closest categorical value. An estimate of EE was determined by summing activity energy categories (kilo-caloric outputs) throughout the day (Caspersen et al., 1985) and expressed on a basic daily energy cost per kg of BM (EE, $kcal \cdot kg \cdot d^{-1}$). Daily total EE (total EE, $kcal \cdot d^{-1}$) for each subject was then obtained by multiplying the energy cost and BM. A global physical activity index (PAI) of mean daily EE for adolescent groups was determined by averaging over 3-days for general PA levels.

Before students recorded activities into the questionnaire, the researcher and schoolteachers explained the aim and method of activity recording to students, and an example was also given to them during the orientation session. Questionnaires were given out to students in the classrooms under supervision after the orientation session. They recorded activities completely for two schooldays (any two days during the week) under supervision on the next morning of each chosen school day. During the time this study was being conducted, students were required to attend school for six days with the weekend day being only Sunday. Sunday activities were recorded on the Monday morning under supervision. On the day after recording, if necessary the activity records were checked with students and the researcher clarified activity records.

Additionally, the validity of this modified activity record was investigated on a sub-sample of randomly selected subjects (10 females and 8 males) who wore a heart rate monitor during the days when the Physical Activity Record was taken. Heart rate was monitored by the use of a Polar Vantage NV sensing unit with a transmitter and a receiver unit (see the protocol section in Study 1) that recorded the heart rate for 12-hour waking periods on both a school day and on a weekend day. Since, the subjects recorded their activities every 15-min block, HR beat$\cdot$min^{-1} data averaged over 15-min blocks were compared to PA coding (1-9) and EE values. Time periods from the Physical Activity Record and the type of activities recorded were matched with the printed time periods and the HR beat$\cdot$min^{-1} data from the HR monitor, respectively, to determine the appropriateness of the activity categories for a Vietnamese adolescent population. There was a significant correlation ($p < 0.01$) between the average of activity coding record and the HR recording at 15 min blocks during both the weekday ($r = 0.63$) and the weekend day ($r = 0.47$). This result indicated that the modified three-day activity record was a valid and suitable instrument for assessing PA in Vietnamese adolescents.

The subjects also completed additional sport recall questionnaires to determine the frequency and duration of different sport participation over the past week. This measurement was reproduced from the Physical Activity Questionnaire for Older Children (PAQ-C), which has been validated by Kowalski et al. (1997) as a valid method for measuring PA patterns in adolescents. In the questionnaire, 31 PA activities were randomly listed and space was provided for others that subjects might play but which were not in the list (see Appendix B). Questionnaires were translated from English into Vietnamese by the researcher (a native Vietnamese speaker), and then two English to Vietnamese professional translators carefully corrected the translation. Subsequently these questionnaires were submitted to four adjudicators including two PE teachers in a school in Hanoi. Based on the cultural differences and the pilot study, some sports activities, which do not exist in Vietnam, were replaced by other popular activities among Vietnamese adolescents. For example, skipping, hackey sack (*da cau chinh*) and spaktarkraw replaced cricket, netball and hockey. Subjects were also required to indicate how many times they participated in each of these activities for at least more than 15 minutes (none, 1-2, 3-4, and 5 or more times per week).

The training of assistants was also undertaken over a week period. All research assistants (including the schoolteachers utilised as assistants) were taught the objective of the PA records, and practised filling in the activity categories based on the list of activities and categorical values provided. They initially learned the test requirements and practised test procedures for recording the data.

Fitness Tests

The fitness tests (field tests) were undertaken in the week following completion of the PA self-reports (see Figure 5.1). The research assistants, the schoolteachers and all subjects attended another orientation session at the commencement of the fitness tests. During this orientation, the aim, the list of health-related fitness components, and the test requirements were clearly explained to the subjects. A demonstration of the test commitment was also shown to the subjects before any test. Then the baseline data for the general health and anthropometrical data of each subject encompassing height, BM and skinfolds were obtained in an early morning session of the first day of the tests. The subjects were required refrained from any excessive activity before reporting to the school on this day. All measuring instruments were calibrated before the test. In order to reduce technical errors of measurement, the skinfolds of all subjects were measured by the same anthropometrist. The subjects also had to present their medical record book on the day that the health check was undertaken. The health professional of the school suggested the elimination of some students who were not eligible for the field test, especially the cardiorespiratory fitness test if they had a history of health problems (e.g. cardiovascular diseases or asthma).

The fitness field tests were based on the Australian Health and Fitness Survey 1985 (The Australian Council for Health, Physical Education and Recreation, ACHPER, 1987), and the Australian Fitness Education Award (Walkley, Parker, and Jackson, 1996). After the baseline data were obtained, students were divided into groups (by classes) to take part the field tests by random order except that they took part the 20 m shuttle-run test in the last day separately. The detail of the field tests is as follows:

Anthropometry

Height was measured by a handy height scale (Stature Meter, Mentone Educational Centre, Carnegie, Vic. Australia) reading to the nearest 0.5 centimeter. The height scale was firmly attached to the wall. Students stood tall in contact with the wall, wearing no shoes, with both heels flat on the ground and arms hanging naturally by their sides, and looked straight ahead.

Body mass was measured by a medical spring scale recording to the nearest 0.5 kg. Heavy clothes, other heavy items and shoes were removed. Body mass index (BMI) of each individual was calculated using a formula: BMI = BM/Height^2 (Walkley, 1996). Although BMI can be used as an indirect indicator of obesity for adults and children (Hamer, Kraemer, Wilson, Ritter, and Dornbusch, 1991), the validity of BMI measurements can be affected by the biological maturity of children and adolescents (Lohman, 1989; Rowland, 1996) as has been discussed earlier in the section 2.2.3. Therefore BMI was used in conjunction with the skinfold measure (see below) for the interpretation of the body composition of the subjects in this study.

Skinfolds were measured by a Harpenden skinfold caliper (British Indicators, West Sussex, RH15 9LB, UK) at two sites: triceps and subscapular reading to the nearest 0.1 mm. The skinfold caliper was calibrated prior to the measurement using a constant pressure (10 g/mm^2) over the range of jaw openings (Docherty, 1996). The skinfold measurement was based on Docherty's (1996) technique. All skinfold measurements were taken on the right side of the body while the subject stood with both arms hanging relaxed. Triceps skinfold was measured at the mid-acromiale-line of the upper arm. Subscapular skinfold was marked at 1.0 centimeter below the inferior angle of the scapula, and the caliper was applied 1.0 centimeter infero-lateral to the thumb and index finger of the tester. Two measurements only were undertaken, and if the difference between those was less than 1 millimeter, this score was utilised.

Otherwise, a third measurement was undertaken and the mean of three measures was utilised.

One difficulty, which arose because of the reserved nature of Vietnamese culture, was that students were reluctant to report voluntarily their pubescent status. Thus, an indication of pubertal status of each individual could not be determined for this study. However, based on the biological maturation aspect, the subjects were ranked into three-age groups: 12, 13, and 14 year olds.

To date, no equation using the skinfold thickness for predicting percentage of body fatness in Vietnamese adolescents or in any Southeast Asian adolescent group has been reported or validated. Thus the sum of two skinfolds (triceps and subscapular) of the subjects was also used as a variable for body fat assessment (Rowland, 1996).

Physical Fitness Data

Cardiorespiratory fitness was assessed by the progressive 20 m shuttle-run test (the European version) which was used for predicting $\dot{V}O_2max$ as published by the Australian Coaching Council (Brewer, Ramsbottom, and Williams, 1988). This 20 m shuttle run test (20m-ST) was originally developed by Leger and Lambert (1982) in Canada, and was uniformly adopted by the Council of Europe for cardiorespiratory and motor fitness assessments of school children. Liu, Plowman, Looney (1992) later evaluated the reliability and validity of the 20m-ST in American children (aged 12-15). The intraclass coefficient for test-retest reliability was $r = 0.93$ ($n = 20$), and the validity coefficient, which was obtained by comparing the measured $\dot{V}O_2peak$ (on a treadmill) and the number of laps run by the 20m-ST, was $r = 0.69$ ($n = 48$). Lui et al. (1992) also found no significant difference ($p > 0.05$) between the value of the measured $\dot{V}O_2$peak and the value of the predicted $\dot{V}O_2$max.

There are two types of the 20m-ST, the Canadian version and the European version, currently being utilised (Naughton, Cooley, Kearney, and Smith, 1996). When results of these two types of tests, carried out by Naughton et al. (1996) with 500 Australian school students (aged 12-16 yrs), were compared, there was a significant difference between the $\dot{V}O_2$max values predicted by the two versions ($p < 0.01$). But both were strongly correlated with each other ($r = 0.76$) and with the direct measured $\dot{V}O_2$max test on a treadmill in a sub-sample group ($n = 50$). The correlation coefficients of the direct $\dot{V}O_2$max were $r = 0.93$ with the European version and $r = 0.87$ with the Canadian version. From these findings, Naughton et al. (1996) suggested that both versions were valid tests for use in predicting $\dot{V}O_2$max in children but the European test was more accurate than the Canadian version. Therefore, the European version was used for the present study to predict the $\dot{V}O_2$max value in the subjects.

Although the 20m-ST was evaluated as a reliable and valid predictor of aerobic fitness in Western children and adults, no study, however, validating the 20m-ST has been conducted on Vietnamese children or Southeast Asian children. For the present study, the test was validated by a sub sample of Australian-Vietnamese students (n=20) completing the $\dot{V}O_2$peak evaluation, because of difficulties with access to laboratory equipment in Hanoi, Vietnam. This validated study was undertaken based on the method of the Naughton et al. study in 1996. This sub-sample group underwent a $\dot{V}O_2$peak test conducted directly by the Cardiopulmonary Diagnostic System. The protocol of this $\dot{V}O_2$peak test will be described in more detail in chapter 6 (see section 6.2.2).

The procedure for conducting the 20m-ST test was based on Brewer et al. (1988). The subjects were required to run between parallel lines placed 20 m apart which were marked on a flat surface. A tape of a cassette player was carefully checked before the test started to ensure that the speed of the cassette player was correct, with one-minute intervals between two bleeps at the beginning of the tape. This tape indicated that subjects ran the correct speed during the stages, beginning at 8.5 $km \cdot h^{-1}$ and increasing 0.5 $km \cdot h^{-1}$ at each successive minute, prompted by a cadence tape. The test was graded with approximately one MET between stages (Liu et al., 1992). Prior to commencement of the test, an introduction and a demonstration were given to subjects. Five subjects started the test at the same time and were watched by research assistants who also recorded the level and the shuttles of each student. After the subjects had lined up in the "ready position", each test was started at the end of the descent counting sounds from five to one from the tape and at the same moment that the stopwatch was started. Subjects were required to warm up before the test and encouraged to run as many shuttles as possible until they could no longer keep up with the speed set by the tape. At the end of each shuttle indicated by the "bleep" from the tape, they were required to step on or behind the parallel line before running back. Subjects were terminated from the test, when they were two or more steps from the line for two consecutive bleeps (Brewer et al., 1988). The score of each subject indicated the level and the number of shuttles run. These data were then calculated to predict the $\dot{V}O_2max$ value with the table provided by Brewer et al. (1988).

Abdominal muscular strength and endurance was assessed by the sit-up test. The subjects commenced the test in a supine position on the floor with knees bent at 140°, feet together and both heels in contact with the ground. Subjects slowly curled the trunk upward, their arms then extended along the thighs with fingertips pointing towards the knees until they touched the patella (the tester placed a palm across the top of subject's knees to form a wall). After holding this curl-up position for one second, the subjects slowly returned to the starting position with the back of the head touching the ground. The subjects were required to curl as many times as possible, and each curl-up cycle was for three seconds: one second to curl up, one second to hold the curl-up position, and one second to return to the start position. During all the curl-up cycles, the subjects had to keep their heels in contact with the ground and keep both arms straight. This test procedure, which has been named the partial curl-up, has been validated as a safe test (Dickinson, Bannister, Allen, and Chapman, 1984) and the most suitable evaluation (Jetté, Sidney, and Cicutti, 1984) of abdominal muscular endurance.

Muscle power was assessed by the standing long jump and vertical jump. The long jump test evaluated the explosive strength of the leg muscle, and was conducted on flat ground. Johnson and Nelson (1986) have reported the validity of the test as r = 0.61. The subjects started in a standing position with the feet slightly apart and the toes behind the starting line. From this position, the subjects bent their knees and swung their arms in order to jump as far as possible. The closest landing point of the heel to the starting line was marked and measured by a piece of masking-tape, which was firmly stuck down on the ground. Two measurements were taken and the best score was recorded. If the subject fell over, another chance was given.

Vertical jump test was used to measure the ability to spring in a vertical direction. The subjects dipped the fingertips of the preferred side into power chalk, and then stood with the preferred side near the wall-mounted board covering from 150 to 350 cm. The subjects were standing erect, with arms extended upwards as far as possible, and the reaching height was determined by the fingers. The subjects then sprang upwards to mark the wall at the highest point that was reached by the fingers. The subjects were allowed to crouch momentarily and were allowed to 'bounce' if desired. Two measurements were taken and the best score was recorded. The vertical jump distance (the recorded score) was determined by subtracting the reaching height from the vertical jump height (the highest point) in centimetres.

Flexibility was assessed by a sit-and-reach test. This test is usually used to evaluate the low back and hamstring flexibility (Docherty, 1996). However, Docherty (1996) has mentioned that the validity of this test was reported to be moderate for hamstring flexibility (r = 0.64) but low for low back flexibility (r = 0.28).

This test was undertaken using a sit and reach box with the zero point being where the feet made contact with the box and a 30 cm mark at the rear and a -20 cm mark level at the front of the box (Walkley et al., 1996). After the subjects had a slight warm-up and removed shoes, they sat down with the soles of both feet flat against the front of the box, with an angle of 90° at the ankle. The rear of the box was against the wall. The subjects then stretched slowly forward as far as possible (without jerking), keeping the fingertips of both hands level on the surface of the box. The tester placed a hand on the subject's knees to ensure they remained straight, while the subject held this position for approximately 2-3 seconds. The subjects were allowed two preparatory unscored attempts prior to taking two trials, and the best score was recorded. If any trial did not meet the requirements of the test (e.g. the movement was jerked, fingertips were not level or the subject's knees bent), a third trial was taken. The score was read to the nearest 1.0 centimetre from the zero point on the ruler for each trial.

Socio-Economic Status

Socio-economic status (SES) of the family unit was assessed by parental occupation and education (Huang and Malina, 1996; Blanksby et al., 1996), as derived from questionnaires. Based on the previous SES classification method suggested by the 1996 Huang and Malina study of Chinese adolescents, the occupation of the father was used for SES evaluation. The socio-economic status was classified into low and high variables. Five occupational categories, which were classified according to the father's occupation, are summarized in Table 5.2. According to this Table, from categories 1 (labourer) to 3 (semi- professional) were classified as low SES (value =

1), and categories 4 (professional) and 5 (advanced ranking professional) were classified as high SES (value = 2).

Table 5.2. *Category distribution of the subjects' fathers' occupations*

Rank	Job-Classification	N	Percent
1.	Laborer or related worker *(un-employed, hand-builder, farmer, home duties, moto-driver, bike-keeper, factory-worker)*	28	15.6%
2.	Technical-worker or seller *(carpenter, self-employed, shopkeeper, student)*	69	39.1%
3.	Semi-professional - general officer *(office worker, driver, small business-owner, retiree)*	21	11.7%
4.	Professional or officials *(police, army officer, teacher, journalist, engineer)*	52	28.5%
5.	Advanced ranking professional or senior official *(manager, lawyer, director, doctor)*	4	2.2%
6.	No report	5	2.8%

This was not a perfect method of classifying SES, but Vietnamese culture is also influenced by Confucianism (see 2.6.1), and thus, the father normally dominates and earns the majority part of the family income. Because there was also no standard classification of occupation and income in Vietnam, and because of the economics and the living conditions (General Statistical Office, 2000), many family incomes may be derived from a "silent source" (e.g. self-employed earnings in cash).

If the occupation of the father was not reported or, in the case of subjects living alone with the mother, the occupation of the mother was used, or if neither parent's occupation was reported, parental education was used for the SES classification in the same way as occupation was used (Table 5.3). That is, among those who did not report parental occupation, the father who had an education of completion of secondary or less (no school attendance) was classified into low SES, and the father who had an education of completion of higher than secondary school was classified into high SES.

Table 5.3. *Classifications of the educational level of the father*

Rank	**Educational level**	N	Percent
1	Illiterate or no school attendance	2	1.1%
2	Completion of primary school	18	10.1%
3	Completion of secondary school	86	48.0%
4	College/TAFE graduate	3	1.7%
5	Bachelor /Master or PhD	70	39.1%

5.3 Results

5.3.1 Time Spent for Physical Activities

The average time spent in each activity category (from 1 to 9) for weekdays and weekend days of age groups for males and females is summarized in Table 5.4.

Table 5.4. *The time (average in hours) students spent in each category of activities for a day during weekdays and weekend days for age groups of males and females.*

	Average of hours spent in each category of activity for a day							
	Age group	N	1	2	3	4	5	6 - 9
Weekday								
Male	12	*32*	8.6	10.9	1.3	0.6	1.8	0.8
	13	*35*	8.1	10.7	1.7	0.8	2.1	0.6
	14	*15*	8.3	10.9	1.5	0.8	1.5	1.0
Female	12	*33*	8.6	10.7	2.0	0.7	1.5	0.5
	13	*48*	7.9	10.7	2.1	0.8	2.1	0.4
	14	*16*	8.5	10.7	1.8	0.9	1.8	0.3
Weekend day								
Male	12	*32*	9.7	9.4	1.6	0.8	1.5	1.1
	13	*35*	9.6	7.1	2.6	1.7	1.1	1.9
	14	*15*	9.3	8.9	1.7	0.8	1.5	1.8
Female	12	*33*	9.4	9.1	2.5	1.0	1.5	0.5
	13	*48*	9.8	7.6	3.2	1.0	1.4	1.0
	14	*16*	9.3	8.2	2.4	1.2	2.0	0.9

1= sleep or rest in bed; 2 = sitting activities; 3 = light standing activities; 4 = slow walking; 5 = light manual work; categories from 6 to 9 = MVPA.

Students spent most of any day in the stationary activities (categories 1 and 2). During the weekdays, all age groups of students (regardless of genders) spent the longest time (from 10.7 to 10.9 hours) in the sitting activities (category 2), but during the weekend days these students spent the longest time (from 9.3 to 9.8 hours) in the sleeping or rest in bed activities (category 1). The time spent in MVPA during weekdays was very low, especially for girls (les than a half hour), but the time spent in MVPA was increased during weekend days ($p < 0.05$) except for the 12-year old female group.

5.3.2 Physical activity and Energy Expenditure

Energy Expenditure between Weekday and Weekend

Comparison of estimated daily EE ($kcal \cdot kg \cdot d^{-1}$) between weekdays and weekend days across three age groups for males and females is summarized in Figure 5.2 below. When estimated daily EE was compared between weekdays and weekend days within the age groups, for males, estimated daily EE was significantly higher on weekend days than on weekdays in the 13-year group ($P < 0.01$) and in the 14-year group ($p < 0.05$), but not in the 12-year group. For females, estimated daily EE was significantly increased on weekend days only in the 14-year group ($p < 0.01$). The same magnitude of the differences was found, when the estimated total daily EE per day ($kcal \cdot d^{-1}$) was compared between weekdays and weekend days within these age groups (in Figure 5.3).

Energy Expenditure between the Age Groups

Overall, there was no significant difference in estimated daily EE between the three age groups, for both males and females, on weekdays and weekend days except that the EE in 13-year old males (45.7 $kcal \cdot kg \cdot d^{-1}$) was significantly higher ($p < 0.01$) than the EE in 12-year old males (41.0 $kcal \cdot kg \cdot d^{-1}$) on weekend days (Figure 5.2).

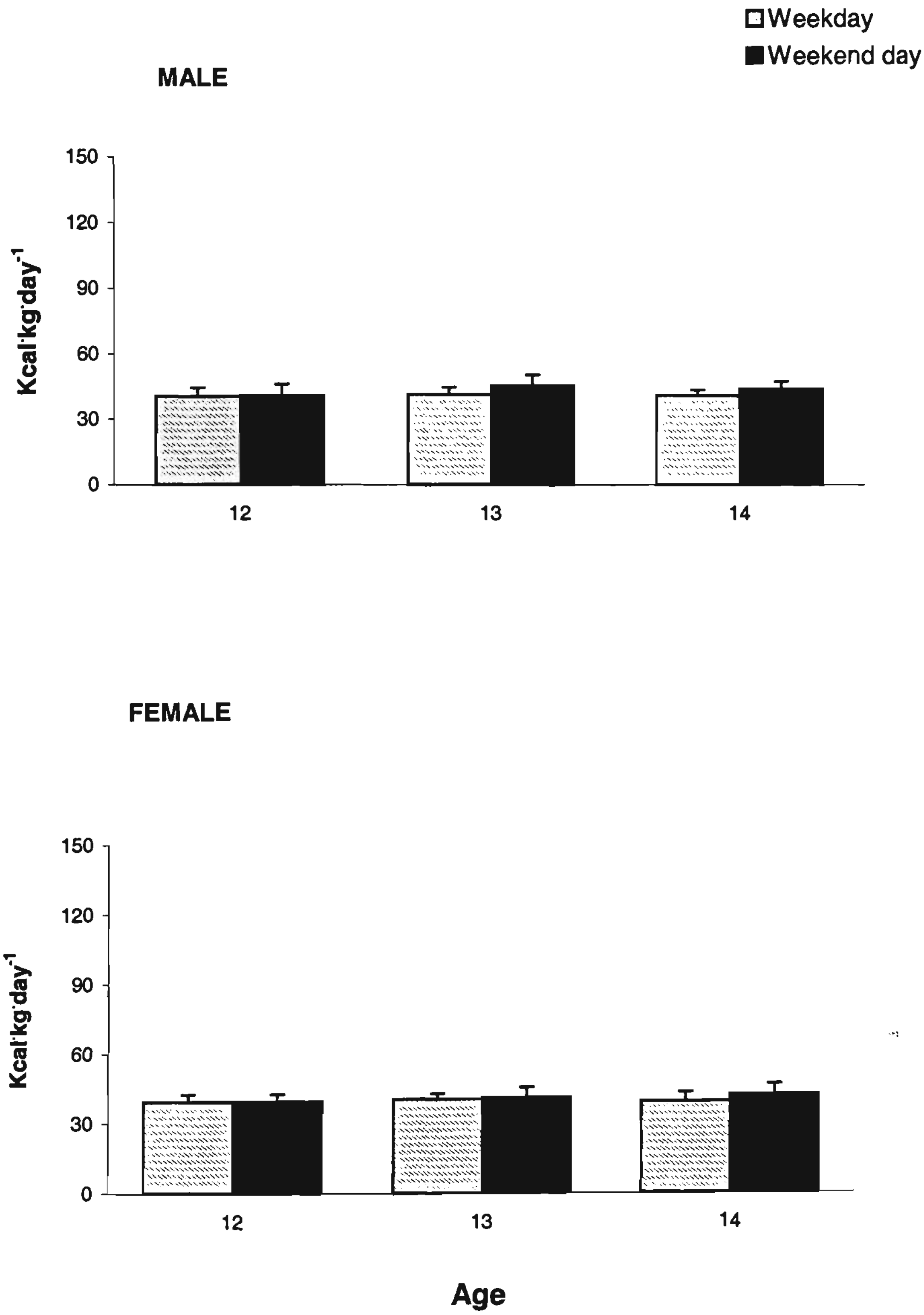


Figure. 5.2. *Estimated daily EE (mean ± SD) for males (top) and females (bottom) on weekdays (□) and weekend days (■) for three age groups.*

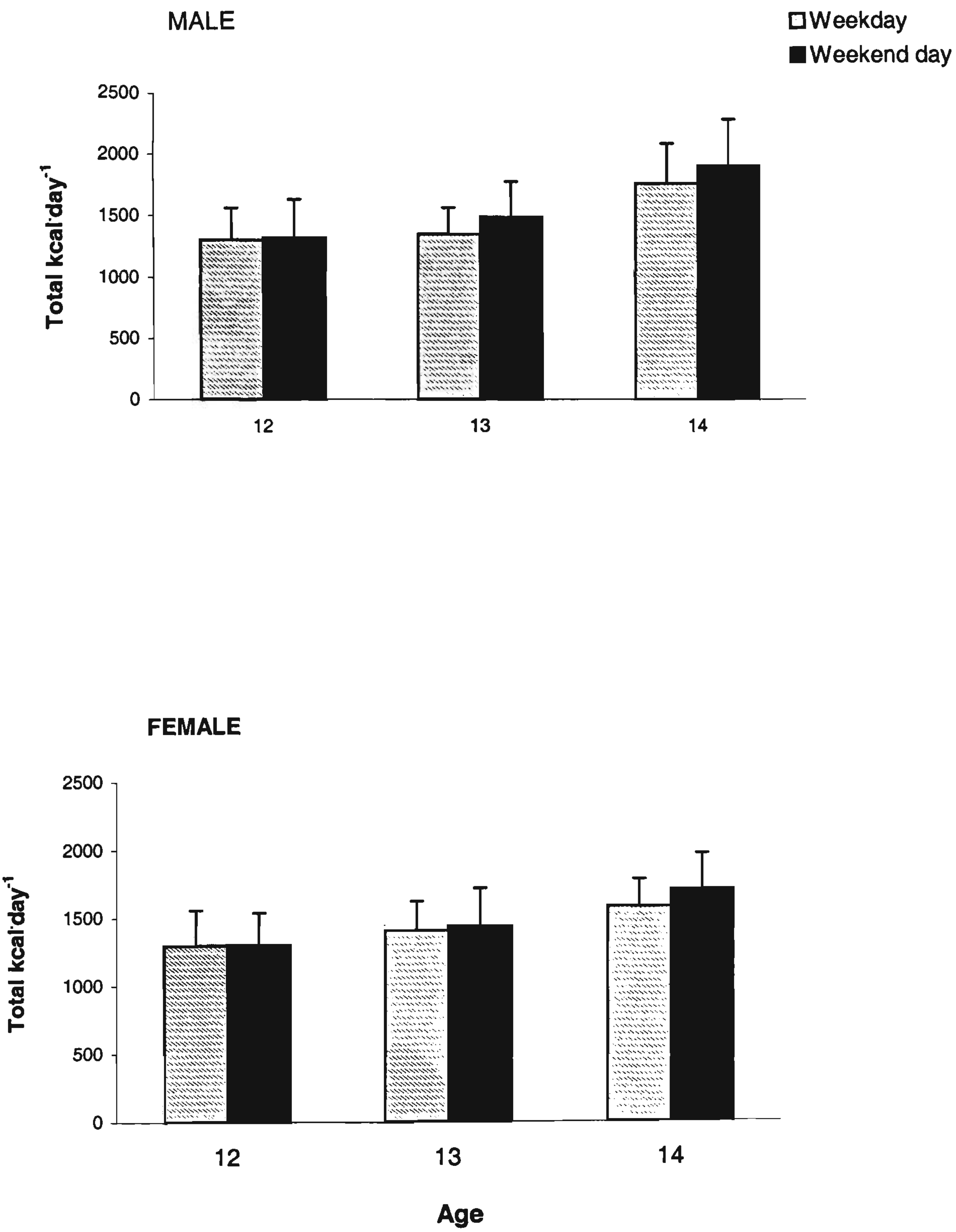


Figure. 5.3. *Estimated total daily EE (mean ± SD) for males (top) and females (bottom) on weekdays (□) and weekend days (■) for three age groups.*

When comparing estimated total daily EE (Figure 5.3) across three age groups, for males, the total EE in 14 year olds was significantly greater than in 13 year olds and in 12 year olds ($p < 0.01$), but no difference in the total EE between 12 and 13 year olds was found ($p > 0.05$) for both weekdays and weekend days. For females, only the total EE between 14 and 12 years was significantly different ($p < 0.01$) for weekdays. But estimated total daily EE in 14 year olds was significantly greater than in 12 and 13 year olds for weekend days. The greater total EE in 14 year olds could be due to a great maturity of BM of post-puberty adolescents, as the BM of 14-year groups was significantly greater than 12-year and 13-year groups for both males and females (Table 5.1).

Activity Energy Expenditure between Genders

The average EE was significantly greater in males than in females during weekdays ($p < 0.05$), and this difference was increased ($p < 0.01$) during weekend days. The averaged total EE however, was not significantly greater in males than in females ($p > 0.05$) for both weekdays and weekend days. The estimated daily EE derived from MVPA was significantly greater in males than in females as boys engaged more in MVPA ($p < 0.01$) for both weekdays and weekend days. Percentages of the total EE per day derived from MVPA were 9.6% for males and 4.8% for females on weekdays, but these percentages were increased noticeably both in males (18.7 %) and in females (9.8%) on weekend days.

Energy Expenditure and Time Spent Sleeping, Studying and TV-Viewing: the Cultural Aspect

Table 5.5 has been included to indicate the amount of time per day that Vietnamese students culturally spent in studying and in major passive leisure activities (viewing TV and sleeping or rest in beds). Despite students spending significantly greater time in sleeping and viewing TV during weekend days than weekdays ($p < 0.01$; Table 5.5), the estimated EE was significantly greater on weekend days than weekdays ($p < 0.05$; see Figure 5.2 & 5.3), regardless of gender or age. Students spent less time studying ($P < 0.01$; Table 5.5), and engaged more in MVPA on weekends than weekdays (Table 5.4) for both males and females.

Table 5.5. *The time (mean ± SD) spent sleeping, studying, and TV viewing on weekdays and weekend days for males and females.*

	Males (n = 82)		Females (n = 97)	
	wd	wk	wd	wk
Sleep	8.36 (0.9)	9.62** (1.3)	8.25 (0.8)	9.55** (1.1)
Study	7.32** (1.5)	3.50 (2.1)	7.43** (1.3)	3.40 (2.0)
TV	2.03 (1.2)	3.05** (1.4)	1.78 (0.9)	2.90** (1.3)

** = *p < 0.01*

Energy expenditure was significantly related to the studying and sleeping time ($p < 0.01$) for both genders on both weekdays and weekend days (Table 5.6). However, no significant negative correlation was found between EE and TV on any of these monitored days for both genders, except that EE was negatively related to TV in females ($p < 0.05$) on weekend days (Table 5.6).

Table 5.6. *Pearson correlation coefficients between EE and time spent sleeping, studying, and TV viewing on weekdays and weekend days for males and females.*

EE (kcal·kg·d^{-1})	Males			Females		
	Sleep	Study	TV	Sleep	Study	TV
EE (wd)	-0.34**	-0.37**	-0.09	-0.51**	-0.41**	-0.07
EE (wk)	-0.30**	-0.45**	-0.08	-0.40**	-0.46**	-0.25*

* = $p < 0.05$; ** = $p < 0.01$

Activity Participation

The percentage of participants in the ten most popular activities among male and female Vietnamese adolescents is summarized in Table 5.7. Among these activities, the most popular activities for males were walking and soccer, while the most popular activities for females were walking and skipping. Overall, the percentages of male participants were greater than the parallel percentages of female participants in seven common activities (in bold font) with the exception of skipping and cycling (Table 5.7). The other three gender specific activities (in italic font) for males were table tennis, martial arts, and hackey sack (*da cau chinh*) and for females were informal games (tag/chasey), aerobics, and chess. These specific activities also reflect the culture and lifestyle of gender differences.

Table 5.7. *The percentage of Vietnamese adolescents engaged in the ten most popular activities for males and females.*

Events	***Participant times in past week*** (> 15 min per time) *None*	*1-2*	*3-4*	*5+*
MALE	%	%	%	%
WALKING	12.2	9.8	13.4	64.6
SOCCER	26.8	11.0	19.5	42.7
CYCLING	37.8	17.1	14.6	30.8
BADMINTON	41.5	23.2	19.5	15.9
SKIPPING	58.5	18.3	13.4	9.8
RUNNING	64.6	17.1	11.0	7.3
GYMNASTICS	74.4	6.1	12.2	7.3
HACKEY SACK	64.6	11.0	12.2	12.2
MARTIAL ARTS	68.3	13.4	9.8	8.5
TABLE TENNIS	78.0	14.6	4.9	2.4
FEMALE				
WALKING	16.5	21.6	13.4	48.5
SKIPPING	18.6	14.4	18.6	48.5
CYCLING	23.7	17.5	16.5	42.3
BADMINTON	48.5	26.8	12.4	12.4
RUNNING	79.4	12.4	5.2	3.1
SOCCER	80.4	12.4	3.1	4.1
GYMNASTICS	89.7	7.2	2.1	1.0
INFORMAL GAMES	78.4	10.3	4.1	7.3
AEROBICS	80.4	15.5	1.0	3.1
CHESS	83.5	5.2	8.2	3.1

5.3.3 Physical Activity and Physical Fitness

The description of Physical fitness variables for males and females are shown in Table 5.8. While there was no significant difference ($p > 0.05$) in BMI between gender groups, sum of skinfold and flexibility in females were significantly greater ($p < 0.01$) than in males. In contrast, all other fitness variables including the 20m-shuttle run in males were significantly greater ($p < 0.01$) than in females.

Correlations of the estimated EE over three days, including the total daily EE derived from MVPA with BM and physical fitness variables for males and females, are summarized in Table 5.9. Overall, correlations ranged from very low $r = - 0.16$ to high $r = 0.79$. In males, the correlation between BMI and TEE was relatively high ($P < 0.01$), whereas, the correlations between the sum of skinfolds, sit-ups, long jump, flexibility, and TEE as well as MVPA were generally moderate ($P < 0.05$). Activity energy expenditure was significantly correlated with the 20m-ST (aerobic fitness), sit-ups and flexibility, but not with other fitness components. In females, BMI was also correlated with TEE ($P < 0.01$), indicating the body size as a main factor in total EE per day. The 20m-shuttle run was significantly correlated with AEE ($p < 0.05$), and with MVPA ($p < 0.01$). However, no significant correlation between the other fitness components and the EE values was found with the exception of the significant correlations between the sum of skinfolds and TEE ($p < 0.01$), and between sit-ups and AEE ($p < 0.05$).

Table 5.8. *Description of fitness variables (mean ± SD) for males and females*

	MALE		FEMALE	
Variables	Mean	SD	Mean	SD
BMI (kg/m^2)	16.3	2.1	16.4	1.9
TRICEP (mm)	7.3	2.6	9.1**	2.7
SUBSCAPULAR (mm)	5.8	1.8	7.7**	2.7
SUM OF SKINFOLD (mm)	13.0	4.2	16.8**	5.9
SIT-UPS (maximal times)	23.1**	12.6	18.7	8.4
LONG JUMP (cm)	179.5**	19.3	168.0	14.7
VERTICAL JUMP (cm)	35.8**	6.7	32.7	4.8
FLEXIBILITY (cm)	8.3	4.1	12.2**	5.5
20m-ST (level)	8.3**	1.7	6.7	1.6

** = $p < 0.01$

The means of height and BM of the Vietnamese adolescent cohort in this study were compared with the national data of the 1975 survey and with the data of the similar age groups of Taiwanese adolescents (Huang and Malina, 1996). The means of height and BM of the Vietnamese adolescent cohort in this study were higher than the data of the 1975 national survey (MOH, 1976), but were lower than the data on the same age groups of Taiwanese adolescents reported in the 1996 Huang and Malina study (Figure 5.4).

Table 5.9. *Pearson correlations between estimated EE and physical fitness variables by gender.*

Variables	Males AEE $kcal \cdot kg \cdot d^{-1}$	Males TEE $kcal \cdot d^{-1}$	Males MVPA $kcal \cdot d^{-1}$	Females AEE $kcal \cdot kg \cdot d^{-1}$	Females TEE $kcal \cdot d^{-1}$	Females MVPA $kcal \cdot d^{-1}$
BMI	-0.06	0.77^{**}	0.27^{*}	-0.09	0.78^{**}	0.17
SUM OF SKINFOLD	-0.16	0.23^{*}	-0.04	-0.05	0.59^{**}	0.15
SIT-UPS	0.26^{*}	0.28^{*}	0.29^{**}	0.28^{*}	0.02	0.08
LONG JUMP	0.17	0.45^{**}	0.24^{**}	0.18	0.13	0.20
VERTICAL JUMP	0.00	0.29^{*}	0.10	0.05	0.06	0.10
FLEXIBILITY	0.27^{*}	0.36^{**}	0.32^{**}	0.04	0.13	-0.01
20m-ST	0.24^{*}	0.02	0.18	0.21^{*}	0.09	0.28^{**}

TEE = total EE averaged over three days; AEE = activity EE averaged over three days. $^{**} = p < 0.01$; $^{*} = p < 0.05$.

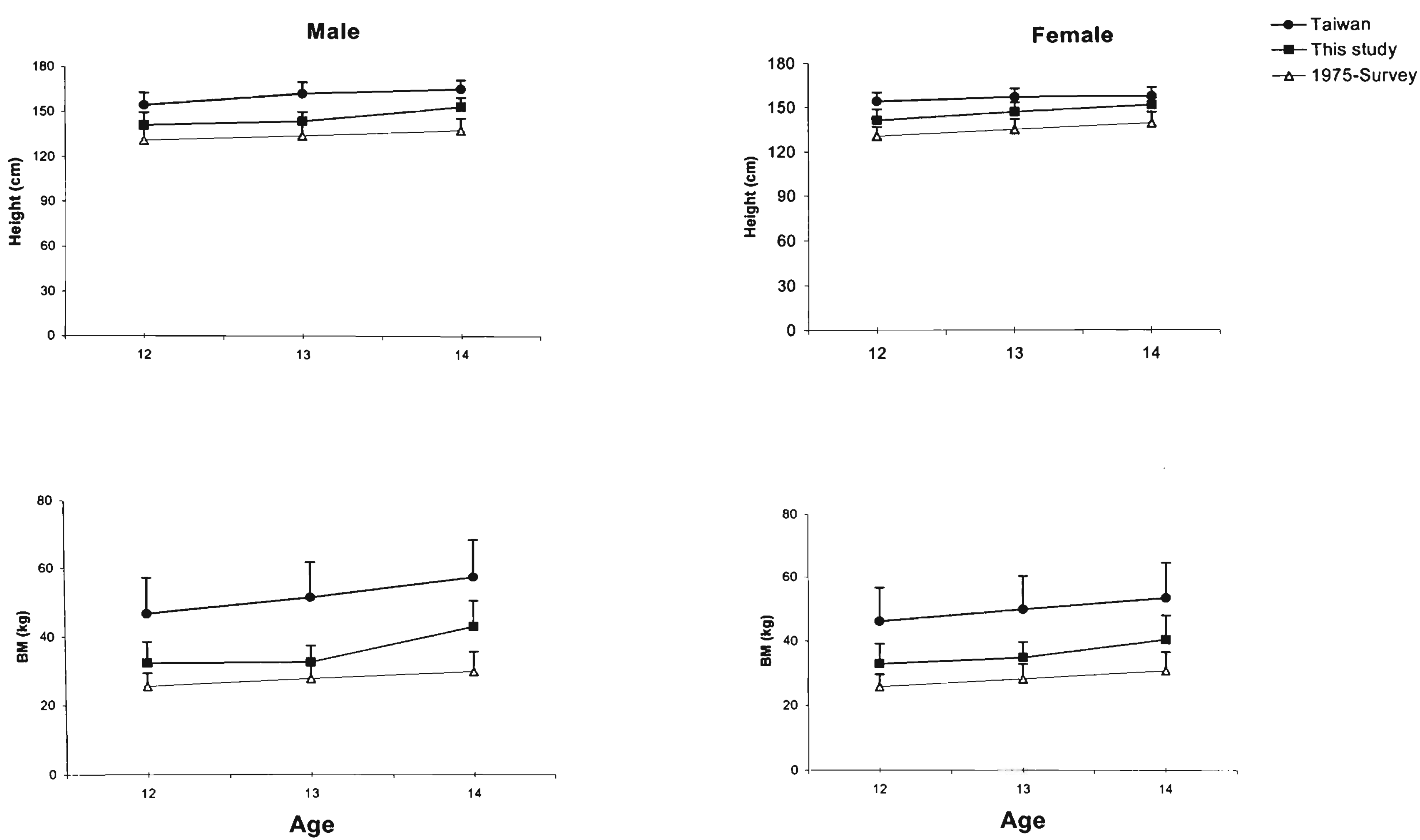


Figure 5.4. *A comparison of height and BM (mean ± SD) of the cohort of this study with the 1975 national survey and a sample of Taiwanese adolescents (Huang and Malina, 1996) for males and females.*

5.3.4 Physical Activity and Socio-Economic Status

The relationship between the estimated EE over three days and SES was analysed using the stepwise multiple regression. Gender and age were also entered as the predictors of AEE ($kcal \cdot kg \cdot d^{-1}$) and TEE ($kcal \cdot d^{-1}$). The results of regression coefficients are shown in Table 5.10. Gender and age together accounted for about 11 % of the explained variance AEE, while the SES variable was excluded from the equation. Thus, the SES variable was not a good predictor of AEE per kilogram of BM for individuals. When the equation was developed to predict TEE, age and SES accounted for 24%, and approximately 2% of that total estimated variance was accounted by SES. In contrast, gender was excluded from this equation.

Table 5.10. *Regression coefficients of estimated EE by socio-economic variables*

	Stepwise regression			
Variables	**r**	**Adjusted R^2**	**F Statistic**	**P Significance**
AEE ($kcal \cdot kg \cdot d^{-1}$)				
Gender	0.28	0.07	14.6	**
Gender & Age	0.35	0.11	12.0	**
SES		Excluded		
TEE ($kcal \cdot d^{-1}$)				
Age	0.48	0.22	52.5	**
Age & SES	0.50	0.24	29.5	**
Gender		Excluded		

AEE = activity EE averaged over three days; TEE = total EE averaged over three days; ** *= $p < 0.01$.*

5.4 Discussion

This study has investigated PA and physical fitness in a group of Vietnamese adolescents and has addressed a number of factors influencing PA. Firstly, the results indicate that the combination of the use of the modified three-day physical activity record and the activity questionnaire identified the patterns of PA in Vietnamese adolescents. The results further confirm reports in the literature that factors such as culture, gender, and SES, influence participation in sports activity by young people. This is the first study to examine these factors as well as the interrelationship between PA and fitness in Vietnamese adolescents.

5.4.1 Modification and Validation of the Three-Day Activity Record

This study modified and validated the three-day activity record (Bouchard et al., 1983) by using the HR monitor. Although Bouchard et al. (1983) have validated this self-report instrument and it has been used in some other studies to estimate daily EE in adolescents (Huang and Malina, 1996; Katzmarzyk et al., 1998), to date no reported study has appeared to have modified and validated the 1983 Bouchard method by HR monitor. Although HR may be affected by psychological factors, especially at a low level of activities, the "heart rate is strongly related to $\dot{V}O2$ during physical activity..." (Sallis et al., 1993). This three-day activity record classified PA into nine levels to estimate EE of activities reported by subjects. Thus, the use of the HR monitor appears to be a good criterion measure for validation of this self-report in terms of estimation of EE. Results in Study 1 also further supported this suggestion, as HR was significantly correlated with $\dot{V}O_2$ (Table 4.4) and sensitive to changes of exercise intensities during treadmill walking and running in the group(s) of

Vietnamese adolescents studied. The activities reported by the subjects were significantly correlated to their HR during the monitoring days, as was previously reported in the *Physical Activity and Energy Expenditure* section. By changing from the original form of this self-report (ie. subjects reported activities instead of coding the activities in 15-min blocks of the record), this modification made the three-day activity record easier to implement for subjects and it yielded a higher level of information. The indication was that the modified three-day activity record appears to be a valid and suitable instrument for assessing PA in Vietnamese adolescents. Consequently, this instrument could then be used to conduct studies in larger representative samples of Vietnamese adolescents.

5.4.2 Physical Activity Patterns and Energy Expenditure in Vietnamese Adolescents

The primary findings in this study revealed a number of indications related to PA patterns, which reflected the lifestyle and culture of Vietnamese adolescents. During the daytime on weekdays, they spent from 10.7 to 10.9 hours in sitting activities including studying and viewing TV (Table 5.4). During weekend days, the number of hours was decreased, but they still spent from 7.1 to 9.4 hours in these activities, including about 3.5 hours in studying (Table 5.5). As the time spent on sitting activities decreased, the percentage of daily total EE derived from MVPA significantly increased on weekend days indicating that students had more time to engage in MVPA. However, it should be noted that Sunday is the only weekend day in Vietnam, thus Vietnamese students have less opportunities for physical activities than their counterparts in Western countries.

With regard to physical inactivity patterns of Vietnamese adolescents, TV was not the main cause of their sedentary lifestyle, as it was with western adolescents. Some previous studies (Guillaume et al., 1997; Andersen et al., 1998) which used Western adolescents as subjects, claimed TV as a major sedentary behaviour. Television viewing is a very popular activity among Vietnamese adolescents, as they spent approximately 2 - 3 hours per day in this activity (Table 5.5). But EE was not significantly related to the TV time among Vietnamese adolescents except during the weekend for the female group (Table 5.6).

Vietnamese children spend time viewing TV nearly every day as they have a lack of recreational and sport facilities during leisure time in Vietnam. Children however, seem to be required to study during the leisure time because of the influence of family honour and Confucianism on Vietnamese culture (both on people and the policy of education; see section 2.7.1). They have to study hard in school for 6 days per week, but they also have to attend extra classes during out-of-school time, including the only weekend day (i.e. Sunday). Another factor causing the study burden on Vietnamese children, which should be noted is the educational policy. According to a recent educational curriculum evaluation of the Minister of Education and Training (MOET, 2000) children have to study too many subjects with many examinations, including difficult entry-exams for every school level (i.e. primary, lower secondary, higher secondary and university). Furthermore, the high population of students and the lack of quality schools, especially in secondary level, led to a lack of desirable spaces for students (MOET, 2000). Consequently, it is very competitive, and thus difficult to get entry into the next school level (i.e. from primary to lower secondary or from the lower secondary to higher secondary levels). It also should be pointed out that in Vietnam, it is very difficult for people to get occupations to support themselves adequately, if they do not have at least a tertiary degree. There are also no unemployment benefits or family support policies in Vietnam. Therefore, students and their family place a priority on study for their future rather than on elective time commitments, such as sport participation. These cultural and practical considerations indicate that Vietnamese children and adolescents appear to have inadequate time for their leisure and sports activities.

From the findings of the present study, it can be concluded that the cultural and physical environment influenced PA patterns among this group of Vietnamese adolescents. The Vietnamese culture which has been influenced by Confucianism, values academic performance. Adolescents were encouraged to spend extensive time in studious activity as a means of supporting the family honour and on gaining better vocational opportunities. Therefore, the burden of study appears to be the main factor causing the sedentary lifestyle of Vietnamese adolescents.

Although various methods of assessing PA including estimation of EE in children and adolescents have been reported in the literature (Baranowski et al., 1992; Welk et al., 2000), none of these methods had been previously used to assess PA and to estimate EE in Vietnamese adolescents. There is also no standard of reference for daily EE for children and adolescents in Vietnam, so it is not possible to claim that this study represents the daily EE level of all Vietnamese adolescents. Whether or not the data in this study are representative of the typical patterns of PA and the daily EE level of Vietnamese adolescents needs to be confirmed by future research.

The physical activity patterns of Vietnamese adolescents had some similar characteristics to the PA patterns of children living in other Asian nations such as Taiwan (Huang and Malina, 1996), Hong Kong (Johns and Ha, 1999) and Singapore (Gilbey and Gilbey, 1995). For example, children in such Asian nations generally engaged in more sedentary activities and in less MVPA than western children as was previously indicated in the literature review. There were also some common causes of low levels of PA among Asian children, such as the densely populated urban environment and thus, the lack of facilities and opportunities for children to participate in sport activities (Gilbey and Gilbey, 1995; Huang and Malina, 1996; Johns and Ha, 1999). Because of the Asian culture, parents appear to over-control their children in the home environment. They might be concerned about the safety of children playing outside without supervision of adults, or they might be anxious about injuries to children during sport participation (Gilbey and Gilbey, 1995; Johns and Ha, 1999). Huang and Malina (1996) have also commented on the influence of the Asian culture in particular the importance played on education, on PA patterns of children. The role of education certainly limits the time for PA participation and was mainly responsible for sedentary activities in both Vietnamese (this study) and Taiwanese (Huang and Malina, 1996) adolescents.

The common factors which caused physical inactivity as mentioned above, can be used to distinguish between PA patterns of Asian children and western children. Other aspects might reflect the difference between the West and the East in terms of PA lifestyle in children and adolescents. While overweight and obesity causing CV diseases are the main issues of concern for western children and adolescents (see discussion in section 2.3.5), they do not appear to be issues of concern among

Vietnamese adolescents. For instance, there was no individual who had a BMI more than 23.0 kg/m^2 among the subject cohort in the present study for both genders. Low development of stature and height or even malnutrition and stunting might be main issues of concerns for children and adolescents in poor developing nations in Asia such as Vietnam (Khoi and Giay, 1994). In agreement with findings of Hop et al. (1997), the means of height and BM of the Vietnamese adolescent cohort in this study were significantly higher than the reference data of the 1975 national survey (MOH, 1976). Although this positive trend of growth of Vietnamese children was evidently associated with the improvement in living conditions in Vietnam since 1986 (Hop et al., 1997), the means of height and BM of the cohort in this study was still significantly lower than those data of Taiwanese adolescents reported in the 1996 Huang and Malina study (Figure 5.4). Among Asian (Vietnamese) children and adolescents, issues, such as the burdens of study and house works, lack of playground and sport facilities, or poor PE intervention programs are the main causes of physical inactivity. Among western children and adolescents, overweight and obesity were related to the low level of PA (Bar-Or and Baranowski, 1994; Ward and Evans, 1995; Guillaume et al., 1997; Rowlands, et al., 1999; Owens et al., 1999; Epstein and Goldfield, 1999; Epstein and Paluch, 2000).

5.4.3 Gender Differences

In support of previous studies, the findings demonstrated that males were more active than females. However, gender differences were also influenced by the Asian culture and were found in the ten most popular activities (recreational and competitive levels) among male and female Vietnamese adolescents (Table 5.7). While walking was a common activity for both genders, soccer was the most popular activity for males (73.2% of students participated at least once per week) and skipping was the most popular activity for females (81.4% of students). Among these ten most popular activities, there were three specific activities (hackey sack, martial arts, and table tennis) played by males, and another three activities (playing games, aerobics, and chess) played by females. The sports facilities and equipment available for children and adolescents in Vietnam are limited, both in the community and in schools. Those ten most popular activities among Vietnamese adolescents provide evidence of this facility limitation, as most of these activities require inexpensive facilities and are easy to participate in.

Because no PA guidelines have been specifically developed for Vietnamese or Asian adolescents, it is difficult to conclude whether or not they undertake a sufficient amount of PA to maintain health. However, if it is estimated according to the guidelines developed by the International Consensus Conference (Sallis and Patrick, 1994), there were 71% of males, but only 32% of females reporting participation in MVPA at least three times (more than 15 minutes) per week. As male students participated in MVPA more than female students, the EE derived from MVPA was significantly higher in males than in females ($P < 0.05$), leading to EE ($kcal \cdot kg \cdot d^{-1}$) being greater in males than in females ($P < 0.05$). There was however, no significant difference in total EE ($kcal \cdot day^{-1}$) between males and females ($p > 0.05$). The similar values of total EE between genders could be due to the fact that BM which was a main factor in total EE, was not significantly different between males and females ($P > 0.05$).

5.4.4 Physical Activity and Physical Fitness

Because the inconsistent link between PA and fitness in children was reported in the literature, the relationship between PA and fitness in Vietnamese adolescents was also examined, addressing specific components of fitness in relation to EE. The activity energy expenditure (AEE) was moderately related to aerobic fitness and abdominal muscle strength and endurance for both genders (Table 5.9). Correlations between EE and each individual component of fitness ranged from low to moderate in Vietnamese adolescents in this study. The range was consistent with previous studies in western children (Pate et al., 1990; Katzmarzyk et al., 1998). In support of another study by Weymans and Reybrouck (1989), the evidence of the relationship between PA and fitness was stronger in Vietnamese male adolescents than in female adolescents. Physical activity variables (EE) were significantly related to most fitness components in male adolescents who were more active and had a higher fitness level than female adolescents, whereas PA variables were not significantly related to most fitness components in female adolescents (Table 5.9).

As discussed earlier however, the relationship between PA and fitness is complex. Correlation coefficients of this relationship were found to be only from low to moderate in some studies, and were not significant in many other studies (see 2.4.3). The complex relationship between PA and fitness could be due to differences in understanding what constitute these two parameters (Pangrazi, 2000). Physical activity and fitness are different in terms of definitions (Shephard, 1995) and in terms of assessments (Strong, 1990; Morrow and Freedson, 1994; Pangrazi, 2000). Physical activity is a process involving body movements, whereas fitness is as an ability to perform PA. Fitness of children was influenced more by heredity rather by PA and other factors (Andersen, 1994; Pangrazi, 2000), but PA was influenced more by social and physical environments such as opportunities to engage in activities (Shephard, 1995; Sallis et al., 2000). The level of fitness can be increased by enhancing sport participation or work tasks, but an increase in fitness by maturation does not always improve the PA level of adolescents (Pangrazi, 2000). For example, PA decreased with age (Sallis et al., 1993). On the other hand, a low fitness level of children does not indicate that they are not active (Pangrazi, 2000).

As was discussed in Chapter 2, both PA and fitness (general aerobic fitness) are also related to gender, age, obesity, ethnicity, environment and health. In addition, the regular activities of adolescents are basically aerobic exercises, such as walking, running, skipping and/or playing some sports, all of which can impact upon aerobic capacity. Because of these common correlates of PA and fitness, PA might be more related to aerobic fitness than other components of fitness. It has been demonstrated that PA is significantly correlated to 20m-shuttle run (the present study), to PWC_{150} (Katzmarzyk et al., 1998), to 1.6 km (Pate et al., 1990) and to ventilatory threshold (Weymans and Reybrouck, 1989).

5.4.5 Physical Activity and Socio-Economic Status

In addition to the overall picture of the influences of PA of Vietnamese adolescents, the relationship between PA and SES was also examined (see Table 5.10). The SES variable was analysed as a predictor of EE. Although students reported that they came from different SES backgrounds, the result showed that SES was not a good predictor of the AEE (the activity EE per kilogram of BM) thus, SES was excluded from the equation - (table 5.10). Only when the SES variable was used to predict the TEE (total EE per day), did SES account for about 2% of the variance in TEE as age alone accounted for 22% of the total estimated variance of TEE. This result was very similar to the study by Huang and Malina (1996) conducted on Taiwanese adolescents. Age was found as a main factor in predicting absolute EE, because of the significance of growth in body size. In fact, it was difficult to classify family SES in Vietnam, because there is no standard classification of occupation. According to the occupations of the subjects' fathers, the majority of the families were classified into a low SES level (66.4%; table 5.2). But the majority of the subjects' fathers had completed secondary school (88.8%; table 5.3) indicating the high value placed on family education. It should be noted that in Vietnam, income of families might not come mainly from wages or salaries of main carers, but rather come from various sources (General Statistics Office, 2000). Therefore, some parents of students may not be high-ranking professionals, but they have a high income. The minor association of SES with TEE but not with AEE could be affected by the interaction of BM, as Hop et al. (1997) previously suggested that growth of body size of Vietnamese children was associated with the improvement of SES. The relationship between PA and SES however, is a complicated issue and it is not easy to compare research from different countries, as studies which have investigated this relationship, have used different methods to classify SES.

In summary, this study has investigated the PA patterns of a group of Vietnamese adolescents, and revealed a number of issues that related to PA of young people such as culture, physical environment and SES. Any claim that the sample group of participants is representative of Vietnamese adolescents would be unwarranted. However, this was the first study which used a modified instrument of assessment of PA and investigated the correlates of PA in Vietnamese adolescents. Subsequently this instrument can be used to conduct studies in a large sample of Vietnamese adolescents to confirm the findings. It revealed a major cause of sedentary lifestyle of Vietnamese adolescents (study) which is related to the culture (ie. the high value placed on education). It also explored the average daily EE of PA of Vietnamese adolescents and its interrelationship with some fitness components in the different age and gender groups. Data from the present study will be used in the study to follow (Study 3) to compare with national data and data from adolescents in different countries. The findings may be used as a basis for more extensive research to be undertaken in future in Vietnam on PA, education and health for adolescents.

CHAPTER 6

PHYSICAL ACTIVITY PATTERNS OF VIETNAMESE ADOLESCENTS IN VIETNAM AND IN AUSTRALIA

6.1 Introduction

The physical activity patterns of a Vietnamese adolescent group living in Vietnam, and the influences on their lifestyle of culture and living conditions, were discussed in the last chapter of this dissertation (Study 2). Possible causes of the sedentary lifestyle of the Vietnamese adolescents were also hypothesised. The study (Study 3) presented in this chapter examines physical activity patterns of an adolescent group of Vietnamese ethnicity living in Australia in order to further identify cultural, physical and environmental factors influencing the choice of PA of Vietnamese adolescents.

In the literature consulted (see section 2.5.2), a number of previous studies have compared PA patterns of children from different ethnic groups but under the same living conditions (Sallis et al. 1996; Myers et al., 1996; Andersen et al., 1998; Wong et al., 1999; Praff et al. 1999). Another study has compared the anthropometry data of Vietnamese children living in Vietnam and Vietnamese migrant children living in a European Country (Hop et al., 1997). However, no study has compared PA patterns of adolescents of one ethnic background (i.e. Vietnamese ethnicity) but living in different countries. This study was designed to compare PA patterns between an adolescent group living in Vietnam and an adolescent group of Vietnamese ethnicity living in Australia. Comparisons such as stature, body mass (BM) and fitness parameters between the two groups were also undertaken to find out more about the influence of physical environment on the maturation of Vietnamese adolescents. This study also compared the PA data of the two Vietnamese adolescent groups with PA data (available in the literature) of adolescents from other nations. In order to create simple names of groups for easy comparison, the adolescent group living in Vietnam was called the Vietnamese native group (VN), and the group of Vietnamese adolescents living in Australia was called the Australian-Vietnamese adolescents (AV).

6.2 Methodology

6.2.1 Subjects

The subject consent forms were distributed to two secondary schools (Gilmore Secondary College and Footscray City Secondary College) in the city of Maribyrnong in Melbourne, where a considerable percentage of the population is of Vietnamese ethnicity. Data from a group of 66 Australian adolescents of Vietnamese ethnicity (aged 12 – 14) were analysed. The subject characteristics are described in Table 6.1 by genders. There were no significant differences between male and female groups ($p > 0.05$).

Table 6.1. *Subject characteristics* (mean ± SD) *of the AV group.*

Gender	N	Age	BM (kg)	Height (cm)
MALE	*29*	13.0 ± 0.78	45.3 ± 6.86	155.6 ± 9.27
FEMALE	*37*	12.9 ± 0.88	42.7 ± 5.45	153.6 ± 4.52

6.2.2 Measurement Techniques

The participants in this study were Australian adolescents of Vietnamese ethnicity living in Australia. The methods used in this study represent a refinement of those previously described in Study 2 for the VN group. However, the measurements of the two groups were achieved using different equipment, field situations and possibly in different environmental conditions. This was perceived as an unavoidable limitation of the study.

Physical Activity and Energy Expenditure

The PA patterns and EE of the AV group were assessed using the modified three-day physical activity record as for the VN group in Study 2. The subjects were required to report all their activities over the previous 24 hours at the end of each day (two school days and one weekend day) as described in section 5.2.2. A table of activities of each category in the three-day physical activity record and the energy costs was based on popular sports, exercises and daily tasks common to Australian adolescents (determined by questionnaires and interview). The estimated daily EE was determined using the same instrument as for the VN group (i.e. averaging over 3-days for general PA levels). Energy expenditure in kilocalories was also allocated to each activity rating per 15-min period and per kg of BM. Because Australian-Vietnamese adolescents living in Australia have two days off during the weekend, the weekend day was either a Saturday or a Sunday.

The subjects also completed the additional sport recall questionnaire to determine the frequency and duration of different sport participation over the past week (as in Study 2: PAQ-C). In the questionnaire however, the list of physical activities was based on popular activities among Australian children and adolescents.

Fitness Tests

The components of the fitness test battery were consistently applied to both VN and AV groups (*Anthropometrical* and *Physical Fitness Data*) using the same equipment (see *Fitness Tests* in 5.2.2). Some differences in details in administration of the fitness test battery are itemised below:

Cardiorespiratory fitness was assessed by the progressive 20 m shuttle-run test to predict $\dot{V}O_2max$ (Brewer et al., 1988). This test was conducted on the Gym floor of the respective schools. The procedure for the test was based on that published by the Australian Coaching Council (Brewer et al., 1988) described in Section 5.2.2. In order to confirm the validity of the 20m-ST test for predicting $\dot{V}O_2max$ in Vietnamese adolescents, a validation study was undertaken in a sub-sample of the Australian-Vietnamese adolescent group (8 males and 12 females). This sub-sample group were randomly chosen to undertake a $\dot{V}O_2max$ test conducted in the Physiology Laboratory, Victoria University. The $\dot{V}O_2max$ test occurred one week after they had undertaken the 20m-ST test. No previous study has reported a validation of the 20m-ST test using a $\dot{V}O_2max$ test with Vietnamese children. The $\dot{V}O_2max$ test was based on a modification of the method published by Naughton et al. (1996) who used a $\dot{V}O_2max$ test to evaluate the validity of two 20m-ST tests (European version and

Canadian version) for Australian adolescent participants (see section 4.2.2). All subjects were given a familiarization period of 5 - 7 minutes with the instrumentation. The subject's $\dot{V}O_2$ and HR were evaluated at rest. Each subject was then required to undertake an incremental exercise test on a treadmill (QUINTON, Q65, USA) to determine $\dot{V}O_2peak$. Subjects commenced walking at 4.0 $km \cdot h^{-1}$. The treadmill speed was increased by 1.0 $km \cdot h^{-1}$ every 2 minutes until 10.0 $km \cdot h^{-1}$ was reached. The gradient of the platform was then incrementally increased 2.5% every 2 minutes until the subject reached voluntary exhaustion. Respiratory data was directly determined every 30 seconds by the Cardiopulmonary Diagnostic System (as described in section 4.2.2). $\dot{V}O_2peak$ was defined as the highest oxygen consumption during a 30 s interval at the peak workrate. Heart rate was monitored by using the *Polar Vantage NV* (Polar Electro Oy, KEMPELE, Finland).

Estimation of the $\dot{V}O_2max$ obtained by the 20 m ST-run test was based on the normative data table supplied by Brewer et al. (1988). The correlation between the measured $\dot{V}O_2peak$ and estimated $\dot{V}O_2max$ was $r = 0.87$. There was no significant difference between the two values ($t = 1.9$; $p < 0.05$), although the value of the estimated $\dot{V}O_2max$ (39.43 $ml \cdot kg \cdot min^{-1}$) was below the value of the measured $\dot{V}O_2peak$ (40.69 $ml \cdot kg \cdot min^{-1}$). The finding was in agreement with previous validation studies of the 20 m ST-run test conducted in western children (see section 5.2.2). The finding indicated that the progressive 20 m shuttle-run test was a valid and suitable test for assessing aerobic fitness in adolescents of Vietnamese ethnicity.

Socio-Economic Status

Socio-economic status was assessed by parental occupation and education according to the method described in Section 5.2.2. Occupations of the AV subjects' fathers were classified into five occupational categories (Table 6.2), and SES was then coded into numerical variables in the same way as for the VN group in Study 2. The occupation variables were based on the Australian standard classification of occupation (Australian Bureau of Statistic, 1120.0, 1997).

Table 6.2. *Category distribution of the subjects' fathers' occupations*

Rank	Job-Classification	N	Percent
1.	Labourers or related workers *(unemployed, home duties, factory -worker, tailor, cleaner)*	19	28.8%
2.	Service-workers or salespersons *(self-employed, shopkeeper, machine-operator, student, driver)*	17	25.8%
3.	Semi-professional or Tradespersons *(office worker, electrician, small business-owner, typist, retiree)*	13	19.7%
4.	Professional or officials *(police, army officer, teacher, journalist, editor, engineer)*	9	13.6%
5.	Advanced ranking professional or senior official *(manager, lawyer, director, doctor, chief executive officer)*	3	4.5%
6.	No report	5	7.6%

Similarly, the father's education was classified and used for SES ranking, if subjects did not report their parent's occupation. The percentage of fathers at each educational level of this Australian-Vietnamese adolescent group is also summarised in Table 6.3.

Table 6.3. *Classifications of the educational level of the father*

Rank	**Educational level**	N	Percent
1	Illiterate or no school attendance	0	0%
2	Completion of primary school	16	24.2%
3	Completion of secondary school	21	31.8%
4	College/TAFE graduate	8	12.1%
5	Bachelor /Master or PhD	21	31.8%

6.3 Results

6.3.1 Comparison of Time Spent in Physical Activities

The differences between the two groups in time spent on selected activities during weekdays and weekend days are displayed in table 6.4 below.

Table 6.4. *Comparison by gender of the amount of time (hours) spent by AV and VN groups on major passive activities and on MVPA during weekdays and weekend days.*

Average of hours spent on selected activities for the two groups	MALE		FEMALE	
	AV (SD)	VN (SD)	AV (SD)	VN (SD)
Weekdays				
SLEEP	9.78** (0.8)	8.36 (0.9)	9.94** (0.8)	8.25 (0.8)
STUDY	4.67 (1.3)	7.32** (1.5)	5.10 (1.3)	7.43** (1.3)
TV	2.68* (1.4)	2.03 (1.2)	2.47** (1.0)	1.78 (0.9)
MVPA	1.37** (0.9)	0.74 (0.7)	1.32** (0.6)	0.41 (0.6)
WEEKEND DAYS				
SLEEP	11.04** (2.1)	9.62 (1.3)	10.57** (1.4)	9.55 (1.1)
STUDY	0.72 (1.2)	3.50** (2.1)	2.02 (1.3)	3.40** (2.0)
TV	4.59** (3.0)	3.05 (1.4)	3.36 (1.2)	2.90 (1.3)
MVPA	1.83 (1.9)	1.57 (1.1)	1.57** (1.1)	0.82 (0.9)

** $= p < 0.01$; * $= p < 0.05$

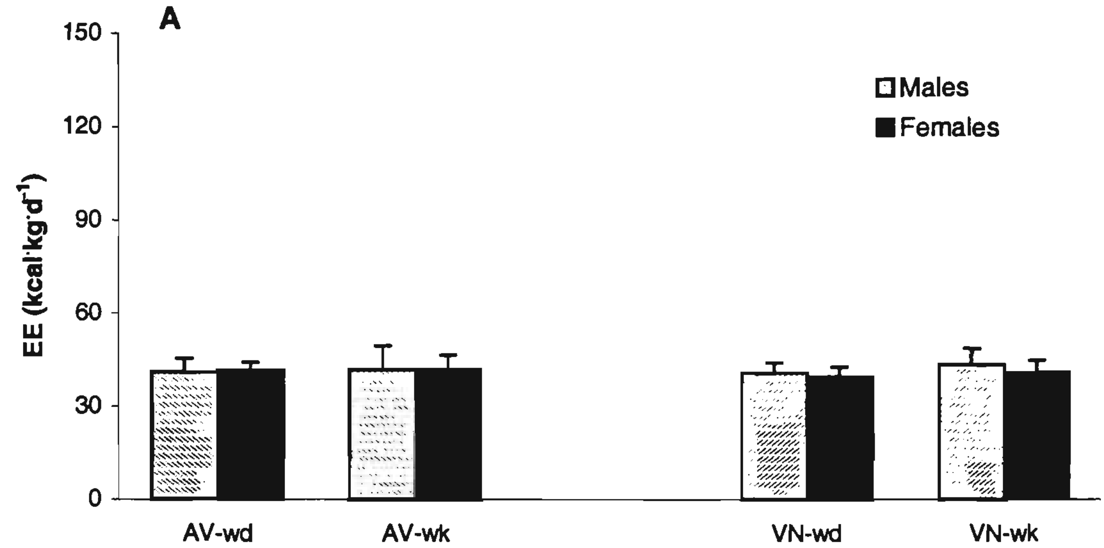
The table shows a trend towards Vietnamese adolescents living in Australia spending significantly greater time in sleeping, watching TV, and less time studying than their counterparts living in Vietnam on any day. An exception is that the comparison of TV time between the two female groups during the weekend showed no significant difference. The Australian-Vietnamese students however, spent significantly greater time on MVPA ($p < 0.01$) than the VN students for both weekdays and weekend days. An exception is that the comparison of MVPA time between the two male groups during the weekend showed no significant difference (Table 6.4).

6.3.2 Physical Activity Patterns and Energy Expenditure

Energy Expenditure Comparison

Energy expenditure of males and females for both AV and VN groups during weekdays and weekend days is shown in Figure 6.1. Within the AV group, there was no significant difference between the gender groups in estimated daily EE (A) and in estimated total daily EE (B) for any monitored day except for weekend days where the total EE was significantly greater in AV males than in AV females ($p < 0.05$).

When the estimated daily EE was compared between AV and VN groups by genders, the daily EE of AV females was significantly greater than the VN females ($p < 0.01$) only during weekdays. No significant differences between males for any monitored day and females for weekend days were found ($p > 0.05$; Figure 6.1, A). However, the estimated total daily EE per day of AV was significantly greater than VN for both genders ($p < 0.01$; Figure 6.1, B). The different coefficients were due to the greater BM of the AV group compared with the VN group ($p < 0.05$).



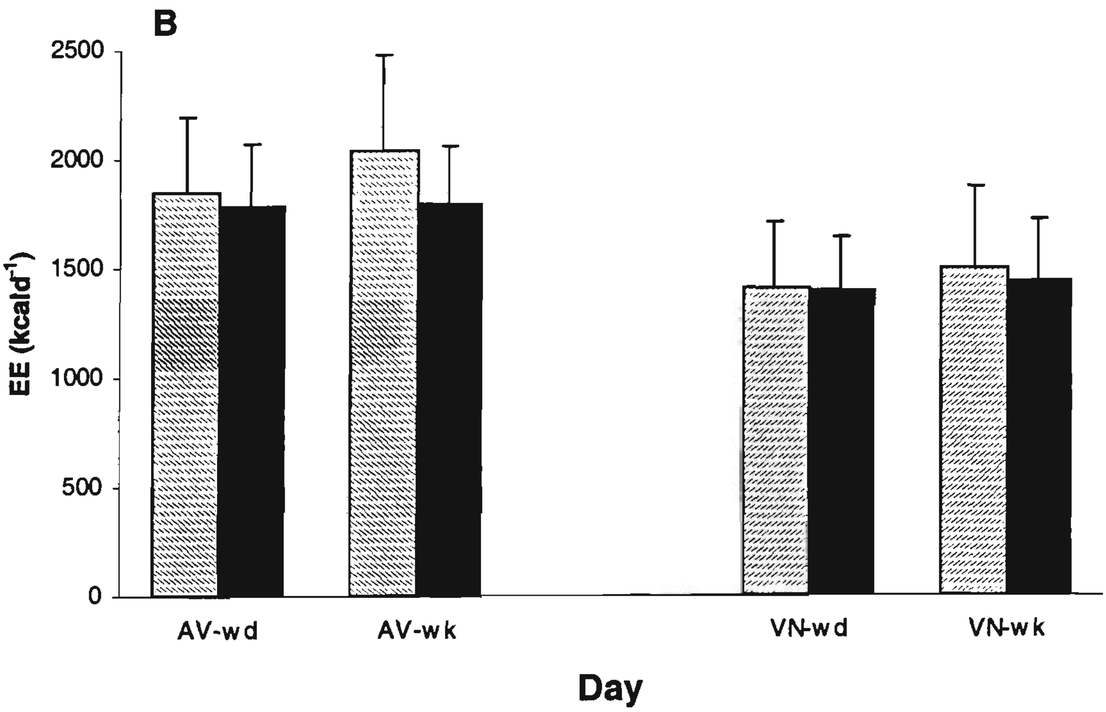


Figure 6.1. *Estimated EE (mean ± SD) for daily EE (A) and total daily EE (B) during weekday (wd) and weekend days (wk) between AV and VN groups for males (□) and females (■).*

The estimated total EE derived from MVPA per day for AV and VN groups by genders is also shown in Figure 6.2. Within the AV group, the total daily EE derived from MVPA was increased in weekend days compared to weekdays (even not significant), regardless of genders. The total daily EE from MVPA was also not significantly different between genders for any day, even though the value for males was shown as higher than the value for females during the weekend ($p > 0.05$; Figure 6.2). Percentages of the total daily EE derived from MVPA were 15% for males and 17% for females on weekdays, which increased to 19 % for males and to 19% for females on weekend days.

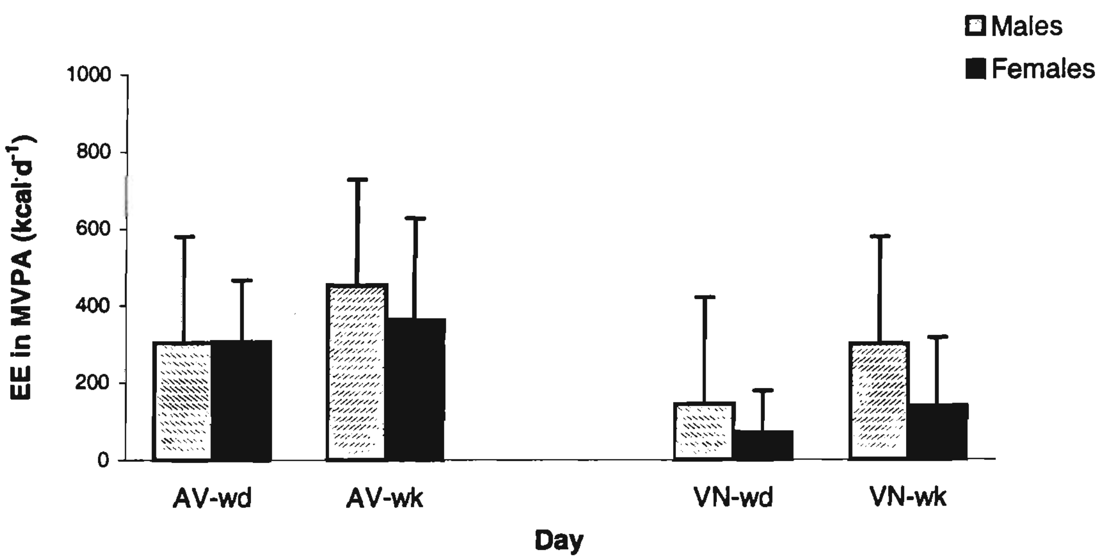


Figure 6.2. *Estimated total daily EE in MVPA (mean ± SD) during weekdays (wd) and weekend days (wk) between AV and VN groups for males (□) and females (■).*

When the value of EE derived from MVPA was compared between AV and VN groups by genders (Figure 6.2), the EE value for AV females was significantly greater than the EE value for VN females for any day ($p < 0.01$). However, the EE value for AV males was significantly greater than that for VN males, for weekdays only ($p < 0.05$).

Determinants of Energy Expenditure between AV and VN Groups

The amount of time spent on the main passive activities and on MVPA was different between AV and VN groups (Table 6.4) because they live in different countries with different cultures, environments, and social expectations. Thus it was necessary to determine which factors made a significant contribution to the measure of activity EE averaged over three days (AEE) in the two similar ethnic groups. Regression analysis was used to compare the different contributions of the predictors of AEE expressed per unit of BM for the two groups (Table 6.5). The amounts of time spent on activities by subjects (sleep, study, TV, and MVPA) for the weekdays and weekend days were collapsed into a single average for each group (i.e. AV & VN). A comparison of the coefficients between the two groups is displayed in Table 6.5. Overall, all four variables together accounted for 84 % and 85% of the explained variance AEE ($kcal \cdot kg \cdot d^{-1}$) for AV and VN groups, respectively. For the VN group, sleep, study, TV and MVPA added significantly to the prediction of AEE ($p < 0.01$). For the AV group, only sleep, TV and MVPA added significantly the prediction of AEE ($p < 0.01$), while study did not significantly affect the prediction of AEE ($p > 0.05$; Table 6.5).

Table 6.5. *Multiple regression coefficients of estimated AEE by selected variables*

Variables	β	t	P
AV group		Adjusted $R^2 = 0.84$	
Constant	48.50	17.18	**
Sleep	-.827	-4.03	**
Study	-.401	-1.87	ns
TV	-.739	-4.92	**
MVPA	3.519	14.50	**
VN Group		Adjusted $R^2 = 0.85$	
Constant	59.36	41.44	**
Sleep	-1.535	-11.64	**
Study	-.908	-11.36	**
TV	-.861	-7.79	**
MVPA	3.048	22.06	**

*Dependent variable: AEE ($kcal \cdot kg \cdot d^{-1}$); ** = $p < 0.01$, ns = not significant*

Activity Participation

The percentage of participants in the ten most popular activities among male and female AV adolescents is summarized in Table 6.6. Among these activities, walking for transport, running and cycling have the highest percentages of the weekly participation for males, while running and walking for exercise have the highest percentages of the weekly participation for females. In general, six activities (in bold font) were popular among both males and females. The percentages of males reporting participation in six common activities for three or more times per week were generally greater than those reported by female participants (Table 6.6).

Table 6.6. *The percentage of AV adolescents engaged in the ten most popular activities for males and females.*

Events	***Participation times in past week*** (> 15 min per time) *None*	*1-2*	*3-4*	*5+*
MALE	%	%	%	%
WALKING-Transport	10.3	13.8	17.2	58.6
RUNNING	20.7	37.9	20.7	20.7
CYCLING	34.5	24.1	13.8	27.6
WALKING-Exercise	41.4	34.5	13.8	10.3
TAG/CHASEY	44.8	31.0	6.9	17.2
BADMINTON	62.1	20.7	17.2	
SOCCER	55.2	24.1	10.3	10.3
TENNIS	69.0	24.1	6.9	
SWIMMING	69.0	31.0		
CRICKET	72.4	3.4	13.8	10.3
FEMALE				
RUNNING	24.3	35.1	24.3	16.2
WALKING-Exercise	37.8	21.6	27.0	13.5
WALKING-Transport	43.2	5.4	10.8	40.5
BADMINTON	48.6	29.7	16.2	5.4
CYCLING	59.5	16.2	13.5	10.8
TAG/CHASEY	59.5	18.9	13.5	8.1
SKIPPING	56.8	32.4	5.4	5.4
NETBALL	35.1	51.4	5.4	8.1
DANCE	73.0	10.8	10.8	5.4
ROLLER BLADING	73.0	18.9	2.7	5.4

The four activities in italic font were gender specific. While males popularly participated in soccer, tennis, swimming, and cricket, females popularly participated in skipping, netball, dance and roller blading.

6.3.3 Physical Activity and Physical Fitness

A comparison of fitness variables between the AV group and the VN group is shown in Table 6.7. (As variances in some fitness parameters of the two groups were unequal, the Mann-Whitney test was performed to control for type 1 error).

Table 6.7. *Comparison of fitness variables (mean ± SD) between the AV group and the VN group by gender.*

Variables	MALE AV (SD)	MALE VN (SD)	FEMALE AV (SD)	FEMALE VN (SD)
BMI (kg/m²)	18.6** (1.6)	16.3 (2.1)	18.1** (2.0)	16.4 (1.9)
SIT-UPS (maximal times)	54.9** (23.5)	23.1 (12.6)	25.3* (14)	18.7 (11.2)
LONG JUMP (cm)	188.5* (21)	179.5 (19)	154.1 (16)	168** (14.7)
VERTICAL JUMP (cm)	39.2** (5.5)	35.8 (6.7)	32.6 (6.8)	32.7 (4.8)
FLEXIBILITY (cm)	5.1 (4.1)	8.3* (4.1)	8.8 (5.9)	12.2** (5.5)
20m-ST (level)	7.8 (2)	8.3 (1.7)	6.2 (5.9)	6.7

** = $p < 0.01$, * = $p < 0.05$.

For males, the fitness scores of AV were significantly greater than VN for BM, sit-ups, vertical jump, and long jump (Table 6.7). For females, the fitness scores of AV were significantly greater than VN for BM and sit-ups, while the fitness scores of VN were significantly greater than AV for long jump and flexibility (Table 6.7).

However, there was no significant difference in 20-ST score between the two groups, regardless of gender ($P > 0.05$).

Within the AV group, while there was no significant difference ($p > 0.05$) in BMI between gender groups, all fitness variables in males were significantly greater ($p < 0.01$) than in females with the exception that flexibility in females was significantly greater ($p < 0.01$) than in males. Because in Australia, a number of AV adolescents were not willing to participate in the skinfold test, thus the data of this fitness variable cannot be presented.

Correlations between physical fitness variables and the estimated EE over three days in AV, including the daily EE derived from MVPA for males and females, are shown in Table 6.8. Only the aerobic fitness variable (20-ST) was significantly correlated with all the EE values for males, and BMI was significantly correlated with the total EE per day over three days (TEE) for females. None of the other fitness variables was significantly correlated with any EE value ($p > 0.05$).

Table 6.8. *Pearson correlation coefficients between estimated EE and physical fitness variables of the AV group by gender.*

Variables	*Males*			*Females*		
	AEE $kcal \cdot kg \cdot d^{-1}$	TEE $kcal \cdot d^{-1}$	MVPA $Kcal \cdot d^{-1}$	AEE $kcal \cdot kg \cdot d^{-1}$	TEE $kcal \cdot d^{-1}$	MVPA $kcal \cdot d^{-1}$
BMI	0.06	0.35	0.09	-0.08	0.82**	0.26
SIT-UPS	-0.13	-0.07	-0.20	-0.14	0.08	-0.18
LONG JUMP	0.10	0.36	0.14	0.05	0.24	-0.01
VERTICAL JUMP	0.09	0.07	-0.05	-0.20	-0.01	-0.26
FLEXIBILITY	-0.10	-0.15	-0.08	0.02	0.26	-0.03
20m-ST	0.50**	0.48**	0.46*	0.07	-0.18	-0.02

*AEE = activity EE averaged over three day; TEE = total EE averaged over three days; ** = $p < 0.01$; * = $p < 0.05$.*

6.3.4 Physical Activity and Socio-Economic Status

The relationship between the estimated EE (AEE and TEE) and SES in the AV group was analysed using a multiple regression, because this AV group was not statistically large enough to perform a stepwise regression (Tabachnick and Fidell, 1996). Similarly to the VN group, SES, gender and age were entered in the equation as predictors of AEE and TEE. The resulting regression coefficients are shown in Table 6.9. For the prediction of AEE, the correlation coefficient was very low and not significant, as none of the three variables added significantly to the prediction of AEE (Table 6.9). For the prediction of TEE, all three variables together accounted for 16 %

of the total explained variance in TEE. The percentage of that total estimated variance was mainly accounted for by age, but SES and gender did not add significantly to the prediction of TEE (Table 6.9).

Table 6.9. *Regression coefficients of estimated EE by socio-economic variables*

Variables	β	t	P
AEE (kcal·kg·d⁻¹)		Adjusted $R^2 = -0.03$	
Constant	36.14	40.25	**
SES	-.456	-.36	ns
Gender	-.516	-.49	ns
Ages	-.524	-.83	ns
TEE (kcal·d⁻¹)		Adjusted $R^2 = 0.16$	
Constant	-402.93	-.57	ns
SES	-720.24	-.68	ns
Gender	142.80	1.65	ns
Ages	165.37	3.17	**

** = *$p < 0.01$; ns = not significant*

6.3.5 Energy Expenditure Comparison in Different Ethnic Groups

Because total daily EE of PA might be more important than intensity, frequency, duration, and types of activities (Boreham and Riddoch, 2001), a further cross-cultural comparison (using Z tests and Cohen's *d* effect sizes) of the estimated total daily EE (averaged over 3 days) between the data of the AV and VN groups and the data of other adolescent groups existing in the literature are shown in Table 6.10.

Table 6.10. *Estimated daily EE in different samples of adolescents*

Studies	Ages	Sex	AEE $kcal \cdot kg \cdot d^{-1}$	SD	TEE $kcal \cdot d^{-1}$	SD
VN group (Study 2)	12-14	M	42.3	3.7	1,453	331
		F	40.4	2.9	1,416	263
AV group (Study 3)	12-14	M	41.3	5.3	1946	475
		F	41.8	2.8	1788	256
Taiwan - Huang and Malina, 1996	12-14	M	41.8		2,167	556
		F	39.1		1,944	360
Canada - Katzmarzyk et al. 1998	13-15	M	46.1	7.4		
		F	42.5	5.3		
Canada - Bouchard et al. 1983	14.4 ± 2.9	M +F			2,222	572

In order to reduce the constraints of the methods used, these studies were selected as they used a similar method of EE estimates based on the three-day physical activity record originally developed by Bouchard et al. (1983). For the estimated daily EE per kg of BM, the EE costs of VN and AV groups are very similar to the Taiwanese adolescents (Huang and Malina, 1996) and significantly lower than the Canadian adolescents (Katzmarzyk et al., 1998) with the exception that the EE costs of AV females are not significantly different with the Canadian females ($p > 0.05$), and are significantly higher than Taiwanese females ($p<0.05$). However, for the estimated total EE per day, the TEE costs of the VN and AV groups are significantly lower than both those values of Canadian and Taiwanese adolescents ($p < 0.01$), regardless of genders. The lowest TEE values of the Vietnamese groups shown in

Table 6.10 are most likely influenced by their smaller body size compared with other groups.

6.4 Discussion

The present study investigated PA and its correlates for Australian-Vietnamese adolescents. The study also compared PA patterns and other factors such as fitness, culture, physical environment and SES that influence PA for two similar ethnic groups of adolescents, one living in Vietnam and the other living in Australia. As a result, a number of issues related to growth, PA, physical inactivity, fitness and the lifestyle of Vietnamese adolescents living in both countries were addressed.

6.4.1 Comparison of Physical Activity Patterns of Vietnamese Adolescents vs Australian-Vietnamese Adolescents: *Cultural and Environmental Aspects*

Findings in this study indicated that the daily EE per kilogram of BM between AV and VN groups was similar with the exception that during weekdays the EE of AV females was greater than the EE of VN females. However, in order to compare the influence of culture and environments on the amount of PA and sport activities in which these two groups of Vietnamese ethnic adolescents have participated, the PA patterns in both countries should be described.

Adolescents who have similar ethnic and cultural backgrounds tend to have similar PA patterns in terms of passive leisure activities. For example, the main passive activities of AV and VN adolescents were sleep, TV and study. However, the time spent on each type of activity was different between AV adolescents and VN adolescents. According to the results, VN adolescents committed more time to study, less time to sleep and to viewing TV, and engaged less in MVPA. Australian-Vietnamese adolescents were diverse in their time allocation (Table 6.4). As explained in the last chapter (Study 2), studious activity was judged to be a major stationary activity leading to the low level of PA for adolescents living in Vietnam, but this was not the case for AV adolescents. During weekdays, the average amount of studying time spent per day by VN students was approximately 1.5 times greater than that spent by AV students for the same school levels (Table 6.4). It should be noticed that school time for both groups is similar, thus the different amount of studying time between the AV and VN groups was mainly due to study during out-of-school time. This different amount of studying time between the two groups became much more significant during weekend days (Table 6.4). Thus, the study variable did not add significantly to the prediction of AEE in the AV group, but this variable was significant for the VN group (Table 6.5).

Australian-Vietnamese adolescents spent less time in studying, but they spent more time in sleeping and viewing TV during both weekdays and weekend days. As mentioned in the literature, TV viewing time is a major sedentary activity for children in western countries (Strong, 1990; Guillaume et al., 1997, Andersen et al., 1998; Gordon-Larsen et al., 2000), and thus TV time can lessen opportunities for children to be active (Kohl and Hobbs, 1998). The evidence in this study showed that adolescents living in Australia spent significantly greater hours viewing TV than adolescents living in Vietnam. Children living in Vietnam also appear to desire to watch TV but they were required to study rather than to watch TV. Sleeping hours spent by AV adolescents (almost 10 hrs on the weekday, and 11 hrs on weekend, Table 6.4) were also significantly greater than those spent by VN adolescents (approximately 8.5 hrs on the weekday, and 9.5 hrs on weekend, Table 6.4). It should be noted that students living in Australia have two weekend days free, while their peers living in Vietnam have only one weekend day free. Vietnamese students then have fewer opportunities for participation in MVPA or recreation than AV students.

The above evidence demonstrates that the burden of study on AV adolescents was not as great as that on VN adolescents, and AV adolescents also have more opportunities to be active than their peers living in Vietnam. In Asian cultures influenced by Confucianism, such as Vietnam (this study) and Taiwan (Huang and Malina, 1996), the education system, family honour and pressure for vocational success (discussion in 5.4.2) mean that young people in such countries have less leisure time available for high intensity activities (especially some sports) in comparison with their peers living in western countries (Huang and Malina, 1996). Although minority ethnic groups living in Australia (such as Asian people) may still want to keep their cultural values in the families for their children in the western society (Health Education Authority, 1997), the new society, new education system and new environmental conditions create pressures on the children to conform to their peers.

Other data showed that AV adolescents engaged in significantly more MVPA than VN adolescents, especially for female adolescents (Table 6.4). There was not only more time available for such activities, but there were also more sport facilities and equipment available (both in schools and in the community) for AV adolescents than for VN adolescents. According to the activity recall and observation in the schools in Vietnam, PE classes were used for other non-PE tasks such as studying or meetings. These alternatives were necessary because of a lack of facilities, open spaces, and PE program planning. Although physical education is a compulsory subject for VN students, it is not considered as important as other subjects such as mathematics, literature, chemistry, and physics. This observation is in agreement with Huang and Malina (1996) who studied Taiwanese students. In contrast, PE classes were good opportunities for AV students to participate in sport activities (MVPA), as they reported in the activity recall.

There were more opportunities for AV adolescents than for VN adolescents to participate in MVPA not only in schools, but also in the community. During out of school time and the weekend, a wide range of sport facilities, open spaces, clubs and community programs offer opportunities for them to be active. Because AV adolescents have more time and facilities for PA, they engaged much more in MVPA than VN adolescents during weekdays (see 6.3.2). Both groups of adolescents however, engaged more in MVPA during weekend days than during weekdays. This finding indicates that leisure time is a very important factor for adolescents to participate in MVPA by which they might gain more health benefits from doing strenuous activities (Sallis and Patrick, 1994; Cavill et al., 2001). The other evidence supporting the importance of the available time for MVPA was that during the single weekend day, the time spent by VN male adolescents on MVPA was as much as twice the time spent during weekdays. This amount of time was lower than that spent by AV adolescents on MVPA during weekend days but no significant difference was found between the two groups (Table 6.4). Although VN male adolescents still had to spend more hours in studying on the only one weekend day (Table 6.4) and had fewer activities to participate in than their AV peers, they tried to take this opportunity to be active by playing some "inexpensive activities" such as hackey sack, running, martial arts or soccer (Table 5.7).

Regarding the gender differences, the greater numbers of the AV females participating in MVPA, as recorded in the comparisons with their male counterparts, may be due to the dominance of western culture over Asian culture in Australian society and/or to the influence of different environments. For example, in the VN group, the total EE derived from MVPA in males was as much as double that in females on both weekdays and weekend days, while in the AV group, the total EE derived from MVPA in males was only greater than in females on weekend days (Figure 6.2). There were some similarities in popular activities between AV adolescents and VN adolescents (Table 6.6 and Table 5.7). For example, soccer was popular among males, and skipping was popular among females in both groups. One difference between the two groups was that AV males preferred to play cricket (non-existent in VN) and tennis, VN males preferred to play hackey sack (*da cau chinh*) and martial arts, while AV females preferred to play netball (non-existent in VN) and dance, VN females preferred to play informal games and chess.

The AV female adolescents have not only more opportunities but also are "freer" to participate in sports activities than their VN peers. The greater numbers of gender differences in PA in Vietnam might also reflect the Asian cultural influence on different prospects and duties of males and females (Huang and Malina, 1996). For example, in Vietnam, females may not be encouraged by either families or society to participate in sports (especially football, basketball, martial arts, wrestling); rather they perform home duties or Participate in some enjoyable activities (chess, skipping, aerobics). In Australia, everyone is encouraged to participate in any sports, regardless of gender, age or ethnicity. Sports participation by AV females is more varied compared with their peers in Vietnam, thus the percentage of AV females participating in sports was similar to the percentage of AV males (Table 6.6).

6.4.2 Physical Activity of Vietnamese Adolescents and Physical Activity Guidelines

No study appears to have previously investigated the relationship between PA and health or reported the daily activity EE of Vietnamese children and adolescents. This dissertation has revealed PA patterns including physical inactivity of the two Vietnamese adolescent groups living both in Vietnam and in Australia. Further work needs to occur to discover whether an intervention programme improving the health of Vietnamese adolescents should be based on the current PA guidelines for adolescents developed by the consensus conference. Because the evidence of gaining health benefits from doing PA for children and adolescents is not as strong as for adults, there is still a debate about the amount and types of PA required for young people (Cavill et al., 2001, Boreham and Riddoch, 2001). In the last decade, an expert consensus process has been endeavouring to develop PA guidelines that should be recommended for adolescents. According to the most recent recommendations of PA for young people aged 5-18 years, they should engage in MVPA for 1 hour per day to gain optimal health (Cavill et al., 2001). Based on the living conditions in VN, it may be difficult for VN adolescents to get opportunities for participating in PA that is appropriate in intensity, frequency and duration.

Vietnamese adolescents have limited opportunities (both in time and in facilities available) to participate in MVPA, particularly during weekdays. Although physical education classes were run twice per week, they were occasionally used for other more sedentary purposes. During the time out of schools and on weekends, they were required to study at home, at other schools and/or to do home duties. Based on the amount of time that VN adolescents spent in MVPA, it might be concluded that the majority of this group do not meet the recommendations of PA for achievement of health benefits. Similarly, as discussed in the literature review of this dissertation, Asian children (both living in their home countries and in migrant countries) have lower levels of PA than western children in terms of participation in MVPA or sports. Huang and Malina, (1996) reported that the TEE of the Taiwanese adolescent sample was lower than the values reported for western adolescent samples but was similar to those values of other Asian samples. Studies previously reported in the literature that the PA levels of children with Asian background both living in some Asian countries (Gilbey and Gilbey, 1995; Johns and Ha, 1999), and living in western countries (Sallis et al., 1996; Booth et al., 1997) were lower than their counterparts with western background. The levels of PA in these studies were assessed by measuring the active time or percentages of participants in MVPA, but not by measuring daily EE. In support of these previous studies in Asian children, the findings of this study were that there was certainly lack of opportunities for the VN adolescents to participate in sport activities, thus their active time engaged in MVPA was lower than their peers living in Australia. Generally, the PA levels (daily EE costs) of both VN and Taiwanese groups (Asian adolescents) were very similar, and were lower than the PA level of the Canadian group (Katzmarzyk et al., 1998) for both genders. The PA level of the AV group who are Asian-adolescents but living in Australia was however, lower than the

Canadian group for males, but was very similar for females (Table 6.10). These findings can further state that the low level of Asian ethnic adolescents participating in MVPA can be improved in the western affluent countries which have better environments and more sport opportunities for adolescents especially for females, than Asian countries.

Constant with Huang and Malina (1996), the daily EE of Vietnamese adolescents in this study was remarkably different between weekdays and weekend days, especially the EE derived from MVPA. The timetable of study and daily tasks for Vietnamese students is very tight on weekdays, and is probably different from students in western countries. Thus, adolescents living in Vietnam tend to be less active than adolescents living in western countries. However, Vietnamese adolescents spend less time sleeping than their peers in western countries (e.g. the sleeping period of the VN group was approximately 1.5 hours less than the sleeping period of AV group, Table 6.4). Vietnamese adolescents need to wake up earlier (normally at 6 am) to go to school to attend classes starting at 7:15 am. They sometimes also have to work to help their parents earn a living for the family, thus they might perform a lot of physical work (supposedly not at high intensity levels) during the daytime. Therefore, the assessment of PA in Vietnamese adolescents needs to be considered with the importance of variations between the weekend and weekdays (Bouchard et al., 1983; Huang and Manila, 1996), and in association with the influence of cultural and environmental conditions.

It should be noted that the international PA guidelines for adolescents (Sallis and Partrick, 1994) or for young people (Cavill et al., 2001) were based on studies conducted in developed countries where living conditions, health conditions, and prevalence of PA are far different from those conditions in developing countries such as Vietnam. In a recent comprehensive review of PA, Boreham and Riddoch (2001) addressed a number of issues which should be debated regarding PA, fitness and health of children. Firstly, no criterion for the amount of PA that adolescents should do in order to gain health benefits has been universally recognized. Secondly, health benefits for children cannot be obtained from only high intensity exercise but might also come from the combination of regular PA patterns of low intensity such as transport (by foot or bicycle), work, and household tasks. Furthermore, because various methods of measurement of PA have been used in different studies, the assessment of high or low levels of PA is dependent on how the criterion measurement of PA has been defined. For example, daily EE or time of participation in moderate to vigorous activities should be used. Consequently, determination of whether children are performing an amount of PA sufficient to provide health benefits will vary according to the criteria utilised (Boreham and Riddoch, 2001). This study also found that the PA level of Vietnamese adolescents was low in term of MVPA and TEE, but not AEE. From this perspective, a conclusion as to whether VN adolescents are sufficiently active for their health benefits is not yet confirmed. A further longitudinal study investigating the relationship between PA and health in Vietnamese children needs to be conducted.

6.4.3 Physical Growth of Vietnamese Adolescents

The growth patterns of Vietnamese children were similar to those patterns reported in other developing countries, but height and BM levels were lower than those observed in western countries (Hop et al., 1997). The low weight and reduced height of Vietnamese children were probably due to the relatively low nutrition level of the children and mothers and to additional health issues for the mothers (Giay and Khoi, 1994; Hop et al., 1997). The main determinants of growth and maturation are heredity, hormones, nutrition and environment (Malina, 1991). While inheritance can determine the initial potential of a child, environmental factors determine the potential for growth of an individual (Malina, 1991). The influence of PA on growth and maturation also cannot be excluded from the contribution of environment to the development of children.

Physical activity plays an important role in the growth and maturation of children (Malina, 1994). The results of this study showed that height, BM and BMI of AV adolescents were also significantly greater than those of VN adolescents ($p < 0.01$). The physical development of Vietnamese children (from birth to 10 years) was inferior to that of children of Vietnamese ethnicity living in France, after the age of 3 months (Hop et al., 1997). The lower body size of Vietnamese children living in Vietnam compared with children of Vietnamese ethnicity living in affluent countries such as Australia and France could be influenced by nutrition, living standards, and environmental conditions. These conditions also influenced the PA patterns of children. That is, Vietnamese migrant children in affluent countries could have participated more in high intensity physical activities, as more sport facilities and open spaces are available for them than for children living in Vietnam. Because Vietnamese migrant children participate more in sport activities, this may positively influence their growth and maturation more than sport participation influences that of their peers living in Vietnam.

6.4.4 Relationship of Physical Activity, Physical Fitness and Socio-Economic Status

The relationship between physical fitness and PA values (EE costs) of adolescents living in Vietnam has been discussed in Chapter 5. This study has examined further this relationship for adolescents living in Australia. The findings indicated that there was a moderate relationship between EE costs and the physical fitness components in the VN group (Table 5.9), but there was a weak relationship in the AV group (Table 6.8). A further comparison of the physical fitness scores between the two groups also found that in general, the fitness scores of the AV group were greater than the scores of the VN group with the exception that the scores of the VN group were significantly greater than AV for flexibility, and there was no significant difference in 20-ST scores between the two groups (Table 6.7). Overall, the findings in both groups were that PA was related to physical fitness more in males than in females, especially in the 20m-ST run, the indicator of cardiovascular fitness. However, the reason for the higher score of flexibility in the VN group compared with the AV group is not known. This result needs further investigation.

In agreement with what has been found in previous studies, PA is more related to aerobic fitness than other fitness components for both the VN group and the AV group. Because there were different gradients of the PA and physical fitness relationship across the VN and AV groups, this relationship might be influenced by culture and environment. Parental support of PA and fitness of children (Sallis et al., 2000) might also be taken into account. In Vietnam, for example, parents of children who have low levels of fitness may be very concerned about their children's safety. If they go out and play with their peers on streets or grounds where the conditions are not safe and contain traffic risks, they may be injured easily. Because of the condensed population, and because of an actual lack of sport facilities such as gyms and stadiums, and YMCA centres in Vietnam, children sometimes played in yards, on streets or in opened spaces which are not set up for sport activities. Additionally, because of the nature of Vietnamese culture, both family structure and social administration are very hierarchical. On the one hand, Vietnamese parents who are followers of Confucius use their power and usually direct the children's attention to their purposes. Children on the other hand, respect their parents and have to follow their concepts. Thus, the parents and children themselves might want to stay home and to be sedentary as much as possible, in particular girls. Some children who have low levels of PA might also have low levels of fitness (aerobic fitness). In Australia, the conditions are different from Vietnam. Because of the influence of western culture, children of Vietnamese ethnicity who are reared in Australia are more independent from the parents than their peers living in Vietnam. There are not only more opportunities, including facilities, but the facilities also have better conditions and are safer for children. Children living in Australia including the AV group (regardless of their fitness levels) thus may get more support for PA from their parents, schools, community and others, for the health benefits of PA. The parents and children themselves might feel more secure and freer to participate in any recreational and sport activities than their peers living in Vietnam, regardless of their fitness levels or family backgrounds. As a result, some children who have low levels of fitness might have high levels of PA.

However, studies on the relationship between PA and fitness have created contradictory results, as this relationship is complex (see 2.4.3). This issue is subject to debate and has several possible explanations, which have been discussed in the last chapter (see 5.4.4). This was also evident the findings of this study as the results of assessments of the relationship between PA and physical fitness were inconsistent between the VN adolescents and the AV adolescents. This inconsistent result of the relationship might be influenced by many interacting factors. The PA patterns of the two groups were influenced by culture, environment, living conditions and social expectations. Physically, the AV group was taller and heavier than the VN group. The different levels of physical fitness could also be influenced by factors such as sport participation, SES and/or nutrition.

The different correlation coefficients of the PA and fitness relationship between the two groups could also be due to the different sample sizes. Although the age range of both the AV and VN groups was similar, the number of AV subjects was not statistically large enough to classify into three age groups (i.e. 12-13-14 yrs) as had been done with the VN group. The comparison of the PA and fitness levels between the two groups might have statistically given better information, if the number of the AV adolescents was similar to that of the VN adolescents. However, it was not possible to generate a large sample of AV adolescents (the Vietnamese student population comprises a minor ethnic group in Australian schools).

This study also examined the relationship between EE costs of activities and SES in the AV group. Similar to findings on the fitness components, the relationship between SES and PA was inconsistent between the AV and VN groups. However, no evidence of significant correlation between SES and the activity EE per kilogram per day (AEE) was found in either group. There are some possible explanations for the different findings of this relationship between the AV and VN groups. Although there was evidence of the association between PA and SES, The relationship between PA and SES might be vary between ethnic groups (Sallis et al., 1996; Myers et al., 1996; Andersen et al., 1998; Praff et al., 1999). In this study, the association was examined in a group of adolescents of Vietnamese ethnicity only. From a statistical aspect, the AV group was also smaller than the VN group and might not have given a good representation of both high and low SES in the Vietnamese population in Australia. It should be noted that the Vietnamese population settled in Australia in the 1980s (after Vietnam War) as a new immigrant population, who had low income and education (Australian Bureau of Statistic, 1997). The parents of the AV adolescents, who were born in Vietnam and have been the first generation of this population in Australia, could have faced many difficulties such as languages, culture and the new law systems in the new society. Thus the majority of families of the Vietnamese population in Australia can be classified as low SES families according to the Australian Standard Classification of Occupations. As a result, the influence of SES on EE costs in this group may not be clearly viewed as the association of SES with PA within one minor ethnic population. In contrast, the VN sample was not only totally larger than the AV group but also they are representative for the main population living in their motherland where they have no difficulties of languages or culture. Thus, this sample of the population might have given a better representation of both high and low SES of the families compared to the AV group. However, the influence of SES on PA found in the VN adolescents or in Taiwanese adolescents (Huang and Manila, 1996) was a minor effect (accounted for about 2%) of the total EE. Some other previous studies (Blanksby et al., 1996; Guillaume et al., 1997; McMurray, Harrell, Deng, Bradley, Cox, and Bangdiwala, 2000) also indicated interaction of high body fat with the relationship between SES and PA in children. But this was not the case in our study, as overweight or obesity did not appear to be an issue in this Vietnamese adolescent population.

6.4.5 Determinants of Physical Activity and Physical Inactivity in Vietnamese Adolescents

From the last chapter (Study 2) and this chapter (Study 3), a number of factors related to the PA patterns of Vietnamese adolescents have been addressed. A comparison of the patterns of PA, physical inactivity and fitness between the two groups of Vietnamese adolescents living in different societies revealed the different influences of cultural and environmental contexts on PA. Based on the results of this study and of other studies in the literature those include Asian children, the determinants of PA and physical inactivity in Vietnamese adolescents not only reflect their cultural and environmental influences but also reflect the difference between western and eastern patterns of PA.

As a result, a summary of the inter-relationships between these variables in Vietnamese adolescents can be described as a Paradigm (Figure 6.3). The strong relationships (moderate to high) found in the present study are expressed as the weighty dashed line with the solid arrow ends. For example, culture and environments determined the PA patterns or culture and passive activities determined physical inactivity patterns. The relationships which were weak to moderate found in the present study and reported in the literature review, are expressed as the light dashed line with the solid arrow ends. For example, the relationship between health and PA, and between health and physical inactivity, or between health and fitness, which was not evaluated by measuring health diseases or CV risk factors in the present study, has been examined in other studies reported in the literature review. The relationships which were weak or were marginal (e.g. the relationships between SES and PA or between SES and health) are expressed by broken lines with small solid arrow ends. The relationships which were only hypothesised (e.g. the relationships between environments and culture or between SES and the passive activities such as study and TV) are expressed by broken lines with open solid arrow ends.

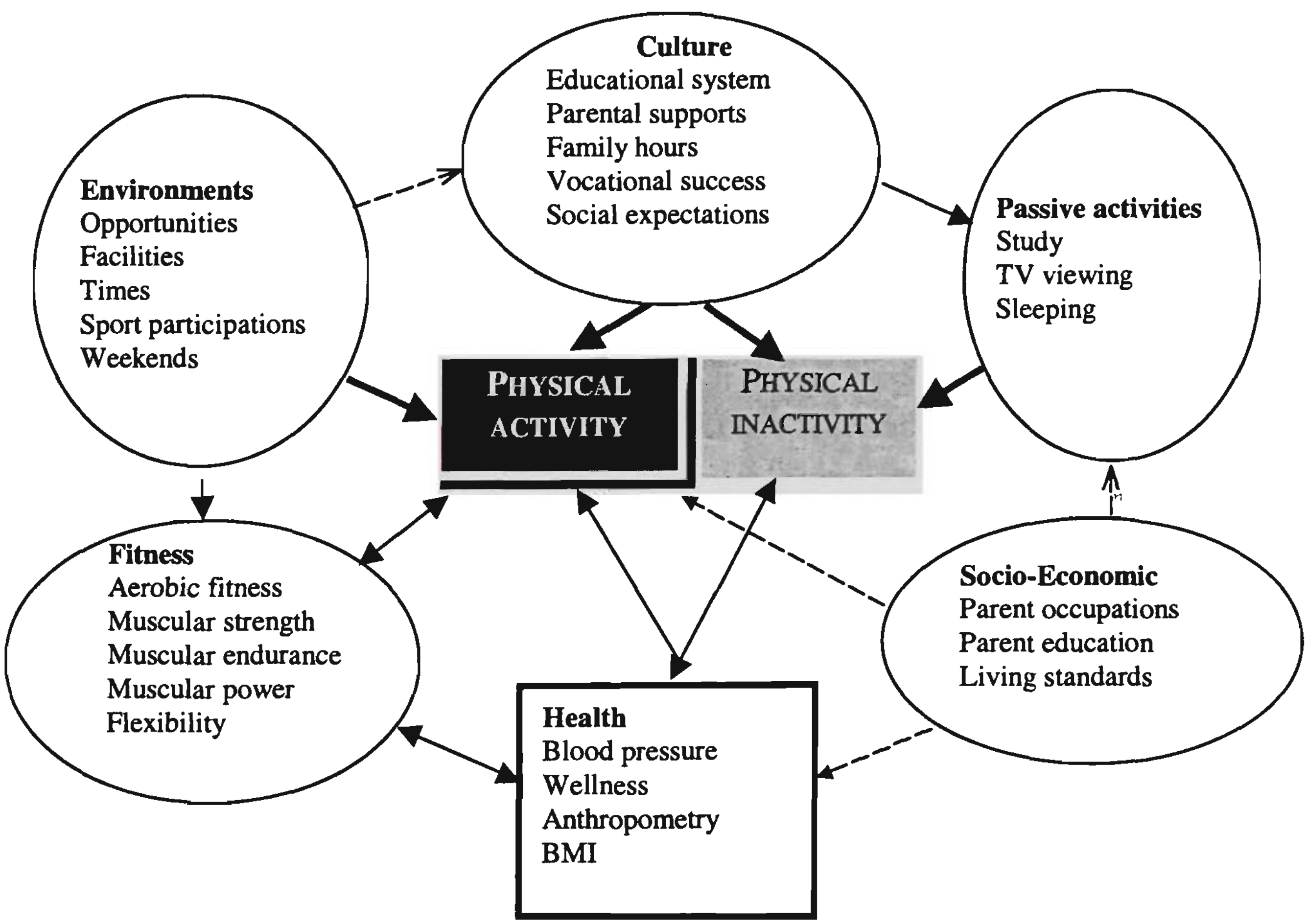


Figure 6.3. *Paradigm of inter-relationships between PA, physical inactivity, fitness, SES cultural and environmental variables in Vietnamese young people.*

In summary, this dissertation provided valuable and original information with respect to the caloric equivalents (EE) of typical PA undertaken by Vietnamese adolescents. The diagram above (Figure 6.3) shows an image of PA patterns of Vietnamese adolescents interrelated with several factors but mainly influenced by their cultural and environmental conditions. The influences upon PA vary considerably across genders. The main barriers to PA of Vietnamese adolescents leading to physical inactivity are lack of opportunities and "no time" due to study and homework commitments. These barriers to PA of adolescents of Vietnamese background are diminished in the western society. Although PA of Vietnamese adolescents can be improved by the influences of new environments their PA level, while similar to other Asian adolescent groups, is still lower than the PA levels of other western adolescents. The low level of PA for Vietnamese adolescents (mainly due to a lack of participation in MVPA) might be associated with some common health issues such as rickets, pulmonary diseases, and cardiovascular diseases. There is still a lack of data on children's health in Vietnam. This association needs to be investigated by further research. The findings reported above can scaffold the limited information with respect to the PA and fitness profiles of Vietnamese children and adolescents. Such information can be useful for the development of recommendations to governments (both in Vietnam and Australia) for improving health promotion, with the emphasis on PE and PA policies for Vietnamese young people.

CHAPTER 7

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

7.1 Summary

This dissertation comprises three studies that principally investigated a number of issues related to the PA assessment and PA patterns of Vietnamese adolescents. It further examined the relationship of PA to fitness, culture, environment and SES. By comparing the data of two similar Vietnamese ethnic groups living in different countries in context with other data reported in the literature, the differences in PA patterns and the PA determinants of children living in other countries in Southeast Asia and East Asia with children living in western countries could be examined. These findings may be useful for the future development of PA consensus guidelines and policy of PA for children and adolescents that are cognisant of Asian cultural and environmental conditions.

The initial task of the dissertation was focused on the development of a PA measure suitable for a Vietnamese adolescent population. The development of electronic and microcomputer technology has introduced new devices, including accelerometers (CSA) and HR monitors, that can provide objective measures of PA; it is for this reason that the CSA and HR monitors were chosen as criterion devices. The CSA monitor is light and small, and can measure the intensity of body movement to provide an estimate of EE without depending on the subjective ability to recall activities (Freedson, 1991; Goran, 1991; Westerterp, 1991). Despite the intensive utilization and validation of these devices in western children, they are still experimental and have not been absolutely standardised. Study 1 would appear to be the first study in which the CSA monitor was utilised to measure EE in Vietnamese adolescents. The assessment of PA needs to address cross-cultural equivalences in different cultural groups (Mâsse, 2000). It was hypothesised that the validation of the CSA monitor for Vietnamese adolescents needed to consider culture specific movement patterns and differences in body size compared to western adolescents.

This study validated the CSA monitor and developed an appropriate equation for the prediction of activity EE for Vietnamese adolescents. The energy expenditure ($kcal \cdot min^{-1}$) was strongly correlated with activity counts ($r = 0.78$) and HR ($r = 0.74$). The equation for prediction of activity EE developed from the CSA counts per minute and BM explained 72% of the variability in $kcal\ ml \cdot kg \cdot min^{-1}$ (adjusted $R^2 = 0.72$). The standard error of the estimate was also relatively high ($SEE = 0.91\ kcal\ ml \cdot kg \cdot min^{-1}$), but the correlations between actual and predicted EE at the three-speed treadmill trials were from moderate (0.66) to high (0.95). This spread of correlation appears to be related to the change in gait from walking to running exercises. This was also noticed in the 1998 Trost et al. study. This is a possibly a manifestation of the limitations of uniaxial accelerometers in measuring movement qualities when activity patterns change, particularly for children.

Another limitation of the CSA monitor was evident in the field measure. Although it was maintained according the frequent advice of the manufacturers and a maintenance schedule, the two actigraphs malfunctioned (broken beams and cracked cases) during the field data collection. According to the provider, the cracked case may have allowed moisture to enter. This could be due to the weather condition in

Vietnam, which is hot, and very humid. The climate conditions, the malfunction of the CSA, time constraints and the costs of repairs of the actigraphs compromised their utility in subsequent field studies and put this element of the data re-collection beyond the scope of a single researcher within the time permitted for completion of a PhD.

With respect to the assessment of PA, the second study contained in this dissertation employed a modified three-day activity record (Bouchard et al., 1983) for measuring the daily PA in Vietnamese adolescents. Although this self-report instrument had been previously validated (Bouchard et al., 1983) and used in other studies as a measurement tool of PA, this study also validated the modified three-day activity record by using the HR monitor as the criterion measure. In order to be suitable for Vietnamese adolescents, both the form of the original three-day physical activity record and the manner of its completion were modified. Subjects were required to indicate precisely the dominant activities engaged in each 15-min block of the record rather than coding the activities. The coding was then done more accurately by the researcher. Although EE in kilocalories was allocated to each activity rating from 1 to 9 (based on EE costs provided by Bouchard et al., 1983), this modified method created an appropriate table of activity categories and energy costs based on popular sports, exercises and daily tasks common to Vietnamese adolescents. The coding record of activities reported by the subjects was significantly correlated to their HR record (in 15-min blocks) during the monitoring days ($p < 0.01$).

Subsequently, this study used the combination of the modified three-day physical activity record and the activity questionnaire (reproduced from Physical Activity Questionnaire for Older Children, PAQ-C) to investigate the PA patterns of a

Vietnamese adolescent group. This was the first study to examine the inter-relationship between PA, fitness, and other factors such as culture, environment, gender, and SES that influence participation in sports activity by young people in Vietnam.

Firstly, the daily EE costs of PA of Vietnamese adolescents were estimated. The daily total EE derived from MVPA was very low (9.6% for males and 4.8% for females) during the weekdays (six days per week). Daily EE costs were significantly higher during weekend days than weekdays, and significantly higher in males than in females ($p < 0.05$). For males, the estimated EE ($kcal \cdot kg \cdot d^{-1}$) was 41.0 and 43.6, and the total EE ($kcal \cdot d^{-1}$) was 1,406 and 1,501 for weekdays and weekend days, respectively. For females, the estimated EE was 39.9 and 40.9, and the total EE was 1,397 and 1,435 for weekdays and weekend days, respectively.

Secondly, the results revealed that several PA characteristics of Vietnamese adolescents were related to the unique culture and environment in Vietnam. The daily EE costs of the Vietnamese adolescents were negatively related to the studying time ($p < 0.01$) for both genders for any monitored day. Unlike the previous studies of western subjects, TV viewing was not the main cause of Vietnamese adolescents' sedentary lifestyle. The daily EE costs were not significantly related to TV time on the monitored days except for females during the weekend. The significant relationship of PA to studying time indicates the influence of Vietnamese culture (dominated by Confucianism) on PA. Because issues of family honour and educational policy put pressure on adolescents to gain better vocational opportunities, they are encouraged to spend extensive time in studious activity comprising 6 days per week in school and extra classes during out of school time including during their only weekend day (i.e. Sunday). This cultural influence (educational values) on PA patterns was similarly noticed in the Taiwanese group in the Huang and Manila study (1996).

The relationship of physical activity values (EE) of the Vietnamese adolescent group with fitness was from weak to moderate. Physical activity was more related to the aerobic fitness (measure by 20m-ST) than other fitness components. Socio-economic status (measured by the parents' occupation and education) accounted for approximately 2% of the total estimated EE (TEE). This study also found that mean body height and BM of the subject cohort were significantly greater than those data of children (the same ages) in the 1975 national survey (Figure 5.4). This finding was consistent with the finding in Hop et al. (1997) suggesting that an increase in the mean body height and BM of the children was associated with dramatic improvements in SES in Vietnam, especially in cities since 1986, as a result of the introduction of a privatised, market-driven economy (Hop et al., 1997).

To further evaluate the PA of Vietnamese adolescents in relation to fitness, culture, environment and SES, the PA patterns and EE between Vietnamese adolescents living in Vietnam (VN group) and Vietnamese adolescents living in Australia (AV group) were compared (Study 3). The methods used in this study represent a refinement of those previously described in Study 2 (i.e. the three-day physical activity record and PAQ-C). The estimated EE per kg of BM for the two groups was similar except that there was significant difference between the AV females and the VN females ($p < 0.01$) during weekdays. However, the value of total

EE per day of AV was significantly greater than VN for both genders ($p < 0.01$) on any monitored day (Figure 6.1). The different coefficients were due to the greater BM of the AV group compared with the VN group ($p < 0.05$). The estimated daily EE costs of both the AV and VN adolescents were similar to the values of Taiwanese adolescents, but were lower than those values of Canadian adolescent samples (Table 6.10).

The AV group spent significantly greater time in sleeping (approx. averaged 1.5 more hours), and watching TV than the VN group, but the VN group spent significantly greater time in studying (approx. 1.5 times) than the AV group (Table 6.4). The studious activity was the major stationary activity influencing the low level of PA for the VN adolescents living in Vietnam, but this was not the case for AV adolescents (Table 6.5). The Australian-Vietnamese group however, spent significantly greater time on MVPA ($p < 0.01$) than the VN group for both weekdays and weekend days. An exception is that the comparison of MVPA time between the two male groups during the weekend showed no significant difference (Table 6.4). It was evident that the AV adolescents have more opportunities (both in time and facilities available) to participate in moderate to high intensity PA than the VN adolescents, particularly during weekdays.

This evidence was clearer when the gender difference of participation in MVPA or sports between the two groups was compared. The total EE derived from MVPA in VN males was as much as double that of VN females on any monitored day, while this same measure for AV males was only greater than for AV females on weekend days (Figure 6.2). There are not only more sport opportunities provided for AV females but they are also "freer" to participate in sports activities than their VN female counterparts. Because the AV adolescents were reared in better environments and living conditions, their anthropometrical data and fitness level were significantly greater than the VN adolescents.

The activity energy expenditure was related more to the fitness components in the VN group than in the AV group, although the estimated EE was moderately related to the aerobic fitness in both groups. There was a minor correlation between SES and the TEE in the VN group but not in the AV group. As the two adolescent groups live in different counties but had very different living standards, it was difficult to classify SES in relation to PA. Therefore, a new criterion for classification of SES in Vietnam needs to be determined in future research, and the association between PA and SES in Vietnamese adolescents (both in Vietnam and in Australia) needs to be further investigated in a larger sample.

7.2 Conclusions

Based on the conditions and results of studies contained in this dissertation with its inherent limitations, the follow conclusions have been obtained:

The CSA monitor is a valid and objective instrument for measuring EE in treadmill exercises in Vietnamese adolescents. The CSA counts and their relationship to EE could be further referenced to the height and BM of Vietnamese adolescents. In agreement with previous studies, the equation for predicting activity EE from the CSA activity monitor was more valid for a group than an individual in the field. However, this instrument is expensive, and is not feasible for large samples of children in Vietnam. This study concludes that using the CSA activity monitor is limited to laboratory studies rather than to the field situation. It is apparent that the CSA monitor can be used as a criterion measure in the validation of questionnaires.

The modified three-day physical activity record can be used as a valid instrument for measuring PA in Vietnamese adolescents. The findings of this study show that the modified three-day activity record was easy to implement in a Vietnamese adolescent group. It yielded a high level of information from each subject. Consequently, this instrument in combination with sport questionnaires could be used to conduct studies in larger representative samples of Vietnamese adolescents. As the accuracy of this measurement is limited by the reliability of each child's recall ability, the accuracy of records can be supplemented by supervision, additional interviews, and by explicitly teaching subjects to record their activities for each time segment across the day.

Estimated daily EE ($kcal \cdot kg \cdot d^{-1}$) of typical PA undertaken by a Vietnamese adolescent group (the VN group) was generally comparable to that of a Taiwanese adolescent group and a Vietnamese migrant adolescent group in Australia (the AV group). The comparable EE value of VN adolescents with other samples is most likely due to their longer waking hours in comparison to their peers in western countries. However, the estimated daily EE derived from MVPA of VN adolescents was lower than that of AV adolescents, especially for females. The lower estimated EE derived from MVPA of VN adolescents is most likely due to their lack of opportunities for PA and sport participation. The total daily EE ($kcal \cdot d^{-1}$) of Vietnamese adolescents (both in Vietnam and in Australia) were generally lower than those of Canadian and Taiwanese adolescents. The lower total daily EE of Vietnamese adolescents is most likely influenced by their smaller body size compared with other groups.

Based on the findings of this dissertation, Vietnamese adolescents do not meet the current consensus PA guidelines for health in adolescents. However, the development of the consensus guidelines was based on studies conducted in western countries only and remains a subject of debate. Environment conditions, health conditions, social influences and the lack of PA facilities in Vietnam make it difficult for Vietnamese adolescents to obtain PA levels that are appropriate in intensity, frequency and duration to existing PA recommendations (i.e. MVPA). Vietnamese adolescents however, may do a lot activity of low intensity (i.e. house work such as cooking, cleaning, washing or other). A criterion for the amount of PA that is appropriate for health of adolescents living in developing country such as Vietnam needs to be defined.

Opportunities (time and sport facilities) and gender are the most likely determinants of PA, while the values of education (study) are the main causes of physical inactivity for Vietnamese adolescents. Vietnamese males were more active than females as males engaged more in MVPA than females, and physical activity values (EE) were related more to the studying time than to the TV viewing time. In contrast, sleeping and TV viewing time is associated with physical inactivity for Vietnamese migrant adolescents in Australia.

Physical activity patterns of Vietnamese adolescents were influenced by culture, environment and living conditions. Similar to other Asian cultures (e.g. Taiwanese culture), Vietnamese culture values academic performance (both individual people and governmental educational policy) leading to children being encouraged to spend extensive time in studious activity. Educational achievement is seen as a means of supporting the family honour and future vocational success. The burden of study, the lack of opportunities for participation in physical and sport activities, and culturally different expectations with respect to gender explain the main differences in the levels of PA between Vietnamese adolescents and their counterparts living in western countries.

The PA values were moderately related to physical fitness, and were weakly related to SES for Vietnamese adolescents, but this was not the case for the Vietnamese adolescent group in Australia with the exception that the PA value was only related to the aerobic component. Because the relationship between these variables was complex, and because the physical fitness levels of the two groups and the living standards of the two countries were different, the variation in the relationship of PA to physical fitness and SES is not clearly understood. A criterion measurement of fitness and SES for Vietnamese children and adolescents may need to be refined in future research. However, activity EE of Vietnamese adolescents is more related to the aerobic component than to other fitness components.

7.3 Recommendations

For assessment of PA and fitness aspects: further validation studies for field methods of assessing PA including utilisation of electronic and mechanical devices in a population of Vietnamese children and adolescents need to be undertaken. The new devices and instruments of measurement of PA and fitness also need to be introduced in epidemiological research in Vietnam. Since no measurable standard has been internationally recognized, acceptable criteria that are feasible, reliable, cost-effective, and time-sustainable but suitable for conditions in Vietnam need to be established. Because questionnaires including PA records are still the most popular instruments (the results of this study has proved the validity, feasibility, and effectiveness of the modified PA record in a group of Vietnamese adolescents), this technique needs to be validated for PA assessments extensively in the Vietnamese population.

For PA patterns in relation to fitness, health, and other factors including culture, environments, and SES: surveys with technical considerations (validity, reliability and suitability) need to be undertaken in a larger sample of the Vietnamese child population and in different seasons and areas (i.e. rural and urban) to determine the PA patterns and fitness levels of Vietnamese children and adolescents. Surveys also need to be undertaken to determine any relationship between PA, fitness and health issues existing among the Vietnamese population. The great challenge in this scientific aspect in Vietnam is to overcome a lack of financial and human resources and a dearth of prominent Vietnamese experts in epidemiology.

Specific recommendations arising from this study are:

A new physical education intervention program for Vietnamese school students (both primary and secondary) should be recommended to promote current levels of PA.

The present education curriculum should be reviewed and modernised in order to reduce the burden of study on Vietnamese school students. Such a revision may reduce their sedentary behaviour and assist them to have more opportunities to participate in adequate levels of PA for their health.

More suitable and accessible facilities that are available for young people in Vietnam need to be created to improve their opportunities for participation in physical activities that promote their PA level.

Future research needs to refine a criterion measurement of PA for Vietnamese adolescents in order to evaluate the amount of PA that can meet their health benefits.

Research on the relationship between PA, environment, nutrition and growth of Vietnamese children needs to be conducted to reveal more of the interacting factors that influence the low growth of Vietnamese children compared to their peers in affluent countries such as Australia.

Factors such as heredity and culture, which influence the PA of the child population of Vietnamese ethnicity in comparison with other ethnic groups in Australia, also need to be revealed in order to improve PA levels for the health promotion of the minor ethnic groups in Australia.

REFERENCES

Ainsworth, B.E., Haskell, W.L., Leon, A.S., Jacobs, Jr., D.R., Montoye, H.J., Sallis, J.F., and Paffenbarger, R.S **(1993).** Compendium of physical activities: classification of energy costs of human physical activities. *Med. Sci. Sports Exerc.* 25(1): 71-80.

Åkerblom, H.K., Viikari, J., Raitakari, O.T., and Uhari, M. **(1999)**. Cardiovascular risk in young Finns Study: general outline and recent developments. The Finnish Medical Society Duodecim. *Ann. Med.* 31 (Suppl. 1): S45-54.

Alpert, B.S., and Wilmore, J.H. **(1994).** Physical activity and blood pressure in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 361-380.

Andersen, L.B. **(1994).** Changes in physical activity are reflected in changes in fitness during late adolescence: A 2-year follow-up study. *J. Sports Med. Phys. Fit.* 34 (4): 390-397.

Andersen, R.E., Crespo, C.J., Bartlett, S.J., Cheskin, L.J., and Pratt, M. **(1998).** Relationship of physical activity and television watching with body weight and level of fatness among children: results from the Third National Health and Nutrition Examination Survey. *JAMA.* 279 (12): 938-942.

Anding, J.D., Kubena, K.S., McIntosh, W.A., and O'Brien, B. **(1996).** Blood lipids, cardiovascular fitness, obesity, and blood pressure: the presence of potential coronary heart disease risk factors in adolescents. *J. Am. Diet. Assoc.* 96 (3): 238-242.

Armstrong, N., Williams, J., Balding, J., Gentle, P., and Kirby, B. **(1991).** Cardiopulmonary fitness, physical activity patterns, and selected coronary risk factor variables in 11 to 16-year olds. *Pediatr. Exerc.Sci.* 3: 219-228.

Armstrong, N., and Simon-Morton, B. **(1994).** Physical activity and blood lipids in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 348-360.

Armstrong, N., And Welsman, J. **(1997).** *Young People & Physical Activity.* New York: Oxford University Press Inc.

Armstrong, C.A., Sallis, J.F., Alcaraz, J.E., Kolody, B., McKenzie, T.L., Hovell, M.F. **(1998).** Children's television viewing, body fat, and physical fitness. *Am. J. Health Promot.* 12 (6): 363-368.

Aurelius, G., Khanh, N.C., Truc, D.B., Ha, T.T., and Lindgren, G. **(1997).** Height, Weight, and body mass, index of Hanoi school children aged 7 – 11 years related to parents' occupation and education. *Vietnamese Pediatrics. Vietnam General Association of Medicine and Pharmacy.* 6 (2): 59-64.

Australian Bureau of Statistic, 1120.0 ASCO, **(1997).** Australian Standard Classification of Occupations (2nd Eds). Canberra. *http://www.abs.gov.au/ausstats/.*

Australian Council for Health, Physical Education and Recreation, **(1987).** *Australian Health and Fitness Survey 1985.* Adelaide: ACHPER.

Bailey, D.A., and Martin, A.D. **(1994).** Physical activity and skeletal health in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 330-347.

Bailey, R.C., Olson, J., Pepper, S.L., Porszasz, J., Barstow, T.J., and Cooper, D.M. **(1995).** The level and tempo of children's physical activities: an observational study. *Med. Sci. Sports Exerc.* 27 (7): 1033-1041.

Baranowski, T., Dworkin, R., Cieslik, C.J., Hooks, P., Clearman, D.R., Ray, L., Dunn, J.K., and Nader, P.R. **(1984).** Reliability and validity of self report of aerobic activity: Family Health Project. *Res. Q. Exerc. Sport.* 55 (4): 309-317.

Baranowski, T. **(1988).** Validity and reliability of self report measures of physical activity: an information-processing perspective. *Res. Q. Exerc. Sport.* 59 (4): 314-327.

Baranowski, T., Bouchard, C., Bar-Or, O., Bricker, T., Health, G., Kimm, S.Y.S., Malina, R., Obarzanek, E., Pate, R., Strong, W.B., Truman, B., and Washington, R. **(1992).** Assessment, prevalence, and cardiovascular benefits of physical activity and fitness in youth. *Med. Sci. Sports Exerc.* 24 (6): S237-S247.

Bar-Or, O., and Baranowski, T. Physical activity, adiposity and obesity among adolescents. *Pediatr. Exerc. Sci.* 6: 348-360, 1994.

Bar-Or, O., and Baranowski, T. **(1994).** PA, adiposity, and obesity among adolescents. *Pediatr. Exerc. Sci.* 6 (4): 348-360.

Bar-Or, O., Foreyt, J., Bouchard, C., Brownell, K.D., Dietz, W.H., Ravussin, E., Salbe, A.D., Schwenger, S., Jeor, S., and Torun, B. **(1998).** PA, genetic, and nutrition considerations in childhood weight management. *Med. Sci. Sports Exerc.* 30 (1): 2-10.

Beilin, L.J., Burke, V., and Milligan, R.A. **(1996).** Strategies for prevention of adult hypertension and cardiovascular risk behaviour in childhood. An Australian perspective. *J. Hum. Hypertens.* 10 (Suppl. 1): S51-54.

Berenson, G.S., McMahan C.A., Voors, A.W., and Webber L.S. **(1980).** *Cardiovascular Risk Factors in Children.* The Bogalusa Heart Study. Oxford: Oxford University Press.

Berenson, G.S., Wattigney, W.A., Tracy, R.E., Newman, W.P., Srinivasan, S.R., Webber, L.S., Dalferes, E.R. Jr., and Strong, J.B. **(1986).** Atherosclerosis of the aorta and coronary arteries and cardiovascular risk factors in persons 6 to 30 years and studied at necropsy (the Bogalusa Heart Study). *Am. J. Cardiol.* 70: 851-858.

Berenson, G.S., Srinivansan, S.R., Wattigney, W.A., and Harsha, D.W. **(1993).** Obesity and cardiovascular risk in children. *Ann. N. Y. Acad. Sci.* 699: 93-103.

Blair, S.N., Kohl, H.W., Paffenbarger, R.S., Clark, D.G., Cooper, K.H., and Gibbons, L.W. **(1989).** Physical fitness and all-cause mortality. A prospective study of healthy men and women. *JAMA.* 262: 2395-2401.

Blair, S.N. **(1993).** McCloy, C.H. research lecture: Physical activity, physical fitness, and health. *Res. Q. Exerc. Sport.* 64 (4): 365-376, 1993.

Blair, S.N., and Connelly, J.C. **(1996).** How much physical activity should we do? The case for moderate amounts and intensities of physical activity. *Res. Q. Exerc. Sport.* 67 (2): 193-205.

Blair, S.N., Brodney, S. **(1999).** Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. *Med. Sci. Sports. Exerc.* 31 (11 Suppl) : S646-662.

Blanksby, B.A., Anderson, M.J., and Douglas, G.A. **(1996).** Recreational patterns, body composition and socioeconomic status of Western Australian secondary school students. *Annals. Hum. Biol.* 23 (2): 101-112.

Booth, M.L., Macaskill, P., McLellan, L., Phongsavan, P., Okely, T., Patterson, J., Wright, J., Bauman, A., and Baur, L.A. **(1997).** *NSW Schools Fitness and Physical Activity Survey, 1997.* Sydney: NSW Department of School Education.

Booth, M.L., Macaskill, P., Lazarus, R., and Baur, L.A. **(1999).** Sociodemographic distribution of measures of body fatness among children and adolescents in New South Wales, Australia. *Int. J. Obes.* 23: 456-462.

Boreham, C., and Riddoch, C. **(2001).** The physical activity, fitness and health of children. *J. Sport. Sci.* 19: 915-929.

Bouchard, C., Tremblay, A., LeBlang, C., Lorth, G., Sauard, R., and Therialt, G., **(1983).** A method to assess energy expenditure in children and adult. *Am. J.Clin. Nutr.*37: 461-467.

Bouchard, C., McPherson, B.D., and Taylor, A.W. **(1992).** *Physical Activity Sciences.* Champaign, IL: Human Kinetics.

Bouchard, C., Shephard, R.J., and Stephens, T. **(1994).** *Physical Activity, Fitness and Health: International Proceedings and Consensus Statement.* (Eds). Champaign, IL: Human Kinetics.

Bray, M.S., Wong, W.W., Morrow, J.R., Butte, N.F., and Pivarnik, J.M. **(1994).** Caltrac versus calorimeter determination of 24-h energy expenditure in female children and adolescents. *Med. Sci. Sports Exerc.* 26: 1524-1530.

Brewer, J., Ramsbottom, R., and Williams, C. **(1988).** *Multistage Fitness Test:* a progressive shuttle-run test for the prediction of maximum oxygen uptake. Melbourne: Australian Coaching Council.

Cale L. **(1994).** Self-report measures of children's physical activity: recommendations for future development and a new alternative measure. *Health Ed. J.* 53: 439-345.

Calfas, K.J., and Taylor, W.C. **(1994).** Effects of physical activity on psychological variables in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 406-423.

Caspersen, C.J., Powell, K.E., and Christenson, G.M. **(1985).** Physical activity, exercise, and physical fitness: Definitions and distinctions for health-related research. *Public Health Rep.* 100: 126-131.

Cavill, N., Biddle, S., and Sallis, S.F. **(2001).** Health enhancing physical activity for young people: Statement of the United Kingdom expert consensus conference. *Pediatr. Exerc. Sci.* 13: 12-25.

Centre Census Steering Committee **(1999)**. *The 1999 Census of Vietnam at Glance.* Preliminary results. Hanoi: The Gioi publishers.

Cohen, J., **(1988).** *Statistical Power Analysis for the Behavioural Sciences.* (2nd ed.). Hillsdale. NJ., Erlbaum.

Cole, T.J., Bellizzi, M.C., Flegal, K.M., and Dietz, W.H. **(2000).** Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ.* 320:1240-1243.

Corbin, C.B., Pangrazi, R.P. **(1992).** Are American children and youth fit? *Res. Q. Exerc. Sport.* 63 (2): 96-106.

Cratty, B.J. **(1986).** *Perceptual Motor development in Infants and Children.* (3^{rd} Ed), Englewood Cliffs, NJ: Prentice-hall.

Cureton, K.J., and Warren, G.L. **(1990).** Criterion-referenced standards for youth health related fitness tests: a tutorial. *Res. Q. Exerc. Sport.* 61 (1): 7-19.

Dahl, M., Uhari, M., Viikari, J., Ákerblom, H.K., Lähde, P.I., and Pesonen, E. **(1985).** Atherosclerosis precursors in Finnish children and adolescents. III. Blood pressure. *Acta. Paediatr. Scand. Suppl.* 318: 89 -102.

Danner, F.M., Noland, M., McFadden, K., Dewait, K., and Kotchen, J.M. **(1991).** Description of the physical activity of young children using movement sensor and observation methods. *Pediatr. Exerc.* Sci. 3: 11-20.

Dennison, B.A., Straus, J.H., Mellits, E.D., and Charney, E. **(1987).** Childhood physical fitness tests: Predictor of adult physical activity? *Pediatrics.* 82: 324-330.

Department of Human Services, **(1999).** *Physical activity patterns and health impacts in Victoria 1998.* Melbourne. Public Health and Development Division Melbourne.

Dickinson, J., Bannister, E., Allen, M., and Chapman, A.E. **(1984).** *Reliability, Validity, Objectivity and Safety of a Proposed Partial Curl-up Test.* Final report. Ottawa, On: Fitness and Amateur sport.

Dien, D.N., Huong, L.G., Ngoc, L.X., Phuoc, T.T., and Dien, P.K. **(1991).** Symbol of malnutrition in children. *Science Monographs for 10 years.* Hanoi. Institute of Protection for Child Health.

Docherty, D. **(1996).** *Measurement in Pediatric Exercise Science.* Champaign, IL: Human Kinetics.

Durant, R.H., Baranowski, T., Davis, H., Rhodes, T., Thompson, W.O., Greaves, K.A., and Puhl, J. **(1993).** Reliability and variability of indicators of heart-rate monitoring in children. *Med. Sci. Sports Exerc.* 25 (3):389-395.

DuRant, R.H., Baranowski, T., Johnson, M., and Thompson, W.O. **(1994).** The relationship among television watching, physical activity, and body composition of young children. *Pediatrics.* 94 (4 Pt 1): 449-455.

Ekelund, U., Sjostrom, M., Yngve, A., Poortvliet, E., Nilsson, A., Froberg, K., Wedderkopp, N., and Westerterp, K., **(2001).** Physical activity assessed by activity monitor and doubly labeled water in children. *Med. Sci. Sports Exerc.* 33 (2): 275-281.

Epstein, L.H. **(1995)**. Exercise in the treatment of childhood obesity. . *Int. J. Obes. Relat. Metab. Disord.* 19 (Suppl. 4): S117-121.

Epstein, L.H., and Goldfield, G.S. **(1999)**. PA in the treatment of childhood overweight and obesity: current evidence and research issues. *Med. Sci. Sports Exerc.* 31 (Suppl. 11): S553-559.

Epstein, L.H., and Paluch, R.A. **(2000).** Decreasing sedentary behaviors in treating pediatric obesity. *Arch. Pediatr. Adol. Med.* 154 (3): 220-227.

Eston, R.G., Rolands, A.V., and Ingledew, D.K. **(1998).** Validity of heart rate, pedometry, and accelerometry for predicting the energy cost of children's activities. *J. Appl. Physiol.* 84 (1): 362-371.

Eveleth, P.B., and Tanner, J.M. **(1990).** *World Variation in Human Growth.* (2nd Eds). Cambridge. Cambridge University Press.

Faith, M.S., Berman, N., Heo, M., Pietrobelli, A., Gallagher, D., Epstein, L.H., Eiden, M.T., and Allison, D.B. **(2001).** Effects of contingent television on physical activity and television viewing in obese children. *Pediatrics.* 107 (5): 1043-1048.

Fenster, J.R., Freedson, P.S., Washburn, R.A., and Ellison, R.C. **(1989).** The relationship between peak oxygen uptake and physical activity in 6- to 8- year old children. *Pediatr. Exerc.* Sci. 2: 127-136.

Fletcher, G.F., Blair, S.N., Blumenthal, J., Caspersen, C., Chaitman, B., Epstein, S., Falls, H., Froelicher, E.S.S., and Pina, I.L. **(1992).** Statement on exercise: Benefits and recommendations for physical activity programs for all Americans. A statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association. *Circulation* 86: 340-344.

Ford, E.S., Merritt, R.K., Heath, G.W., Powell, K.E., Washburn, R.A., Kriska, A., and Haile, G. **(1991).** Physical activity behaviors in lower and higher socio-economic status populations. *Am. J. Epidemiol.* 133(12): 1246-1256.

Foster, F.G., McPartland, R.J., and Kupfer, D.J. **(1978).** Motion sensor in medicine, Part I. A report on reliability and validity. *J. Inter-Amer. Med.* 3: 4-8.

Francis, K. **(1996).** PA in the prevention of cardiovascular disease. *Phys. Ther.* 76 (5): 456-468.

Freedman, S.D., Dietz, H.W., Srinivasan, R.S., and Berenson, S.G. **(1999).** The relation of overweight to cardiovascular risk factors among children and adolescents: the Bogalusa Heart Study. *Pediatrics.* 103 (6): 1175-1182.

Freedson, P.S. **(1989).** Field monitoring of physical activity in children. *Pediatr. Exerc. Sci.* 1 (1): 8-11.

Freedson, P.S. **(1991).** Electronic motion sensors and heart rate as measures of physical activity in children. *J. Sch. Health.* 61 (5): 220-223.

Freedson, P.S., and Evenson, S. **(1991).** Familial aggregation in physical activity. *Res. Q. Exerc. Sport.* 62 (4): 384-389.

Freedson, P.S., Sirard, J., and Debold, N. **(1997).** Validity of two physical activity monitors in children and adolescents. *Children and Exercise XIX.* Promoting health and well being. Armstrong, A., Kirby, B., and Welsman, J. (Eds). London, SE18HN: E & FN Spon.

Freedson, P.S., Melanson, E., and Sirard, J. **(1998).** Calibration of the computer science and application, Inc. accelerometer. *Med. Sci. Sports Exerc.* 30 (5): 777-781.

General Statistical Office **(2000).** *Vietnam Living Standards Survey 1997-1998.* Hanoi: Statistical Publishing House.

Giay, T., and Khoi, H.H. **(1994):** Use of body mass index in the assessment of adult nutritional status in Vietnam. *Euro. J. Clin. Nutri.* 48 (Suppl. 3): S124-S130.

Gilbey, H. and Gilbey, M. **(1995).** The physical activity of Singapore primary school children as estimated by heart rate monitoring. *Pediatr. Exerc. Sci.* 7(1): 26-35.

Gilliam, T.B., Freedson, P.S., Geenen, D.L., and Shahraray, B. **(1981).** Physical activity patterns determined by heart rate monitoring in 6-7 year-old children. *Med. Sci. Sports Exerc.* 13 (1): 65-67.

Gliksman, M.D., Dwyer, T., Wlodarczyk, J. **(1990).** Differences in modifiable cardiovascular disease risk factors in Australian school children: the results of a nationwide survey. *Prev. Med.* 19: 291-304.

Godin, G., and Shephard, R.J. **(1985).** A simple method to assess exercise behavior in the Community. *Can. J. Appl. Sport Sci.* 10 (3): 141-146.

Goran, M.I. **(1998).** Measurement issues related to studies of childhood obesity: assessment of body composition, body fat distribution, physical activity, and food intake. *Pediatrics.* 101 (3): 504-514.

Gordon-Larsen, P., McMurray, R.G., and Popkin, B.M. **(2000).** Determinants of adolescent physical activity and inactivity patterns. *Pediatrics.* 105 (6): E83.

Gortmaker, S.L., Dietz, WH., Sobol, A.M., and Wehler, C.A. **(1987).** Increasing pediatric obesity in the United States. *Am. J. Dis. Child.* 141: 535-540.

Gottlieb, N.H., and Chen, M. **(1985).** Social cultural correlates of childhood sporting activities: their implications for health. *Soc. Sci. Med.* 21: 533-539.

Guillaume, M., Lapidus, L., Björntorp, P., and Lambert, A. **(1997).** Physical activity, obesity, and cardiovascular risk factors in children. The Belgian Luxembourg Child Study II. *Obes. Res.* 5: 549-556.

Hammer L.D., Kraemer H.C., Wilson D.M., Ritter P.L., and Dornbusch S.M., **(1991).** Standardized percentile curves of body-mass index for children and adolescents. *Am. J. Dis. Child.* 145 (3): 259-263.

Haskell, W.L. **(1985).** Physical activity and health: need to define the required stimulus. *Am. J. Cardiol.* 55 (10): 4D-9D.

Haskell, W.L. **(1994).** Sedentary lifestyle as a risk factor for coronary heart disease. In: Pearson TA, Criqui MH, Leupker RV, Oberman A, Winston M (Eds). *Primer in Preventive Cardiology.* American Heart Association: Dallas: 173-187.

Health Education Authority **(1997).** *Young People and Physical Active*? A literature review. London: health Education Authority.

Health Education Authority **(1998).** *Young and Active?* Young people and health-enhancing physical activity-evidence and implications. London: health Education Authority: 3-16.

Hill, M., Nowson, C., Tavener, M., Huggins, R., and Loesch, D. **(1997).** Relationship of dietary restraint and activity patterns to body mass index in Melbourne primary and secondary school children: a preliminary study. *Aus. J. Nutr. Diet.* 54: 118-125.

Hill, O.J. **(1998).** Introduction. International Life Sciences Institute. *Pediatrics.* 101 (3): 497-499.

Himes, J.H., and Dietz, W.H. **(1994).** Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The expert committee on clinical guidelines for overweight in adolescent preventive services. *Am. J. Clin. Nutr.* 59 (2): 307-316.

Hofman, A., Walter, H.J., Connelly, P.A., and Vaughan, R.D. **(1987).** Blood pressure and physical fitness in children. *Hypertension.* 9 (2): 188-191.

Hop, L.T., Gross, R., Giay, T., Schultink, W., Thuan, B.T.N., and Sastroamidjojo, S. **(1997).** Longitudinal observation of growth of Vietnamese children in Hanoi, Vietnam from birth to 10 years of age. *Euro. J. Clin. Nutr.* 51: 164-171.

Horvath, S.M., and Horvath, E.C. **(1973).** The Harvard Fatigue Laboratory: Its history and contributions. Englewood Cliffs, N.J. Prentice-Hall, Inc. in Powers, S.K., and Howley, E.T. (1990). *Exercise physiology*: Theory and application to fitness and performance. Dubuque, IA: Wm C. Brown.

Huang, Y.C., and Malina, R.M. **(1996).** Physical activity and correlates of energy expenditure in Taiwanese adolescents 12-14 years of age. *Am. J. Hum. Biol. 8*: 225-236.

Huttunen, N.P., Knip, M., and Paavilainen, T. **(1986).** PA and fitness in obese children. *Int. J. Obes.* 10 (6): 519-25.

Janz, K.F., Nielsen, D.H., Cassady, S.L., Cook, J.S., Wu, Y., and Hansen, J.R. **(1993).** Cross-validation of the Slaughter skinfold equations for children and adolescents. *Med. Sci. Sports Exerc.* 25: 1070-1076.

Janz, K.F. **(1994).** Validation of the CSA accelerometer for assessing children's physical activity. *Med. Sci. Sports Exerc.* 26 (3): 367-375.

Janz, K.F., Witt, J., and Mahoney, L.T. **(1995).** The stability of children's physical activity as measured by accelerometry and self-report. *Med. Sci. Sports Exerc.* 27 (9): 1326-1332.

Jenner, D.A., Vandongen, R., and Beilin, L.J. **(1992).** Relationship between blood pressure and measures of dietary energy intake, physical fitness, and PA in Australia children aged 11-12 years. *J. Epidemiol. Commu. Health.* 46 (2): 108-113.

Jetté, M., Sidney, K., and Cicutti, N. **(1984).** A critical analysis of sit ups: A case for the partial curl-up as a test of abdominal muscular endurance. *CAHPER J.* 51 (1): 4-9. In Docherty, D., 1996. Measurement in pediatric exercise science. British Columbia Canada: Human Kinetics.

Johns, D.P., and Ha, A.S. **(1999).** Home and recess physical activity of Hong Kong children. *Res. Q. Exerc. Sport.* 70 (3): 319-323.

Johnson, B.L., and Nelson, J.K. (**1986**). Practical measurements for evaluation in physical education (4th ed.). Edina, MN: Burgess International. In Docherty, D., 1996. *Measurement in Pediatric Exercise Science*. British Columbia Canada: Human Kinetics.

Judith A. (**1982**). Berling for the Asia Society's *Focus on Asian Studies,* Vol. II, No. 1 *Asian Religions*, pp. 5-7.

Karvonen, J., and Vuorimaa, T. (**1988**). Heart rate and exercise intensity during sports activities: practical application. *Sport Med.* 5: 303-312.

Karvonen, M.J., Kentala, J.E., and Mustala, O., (**1957**). The effects of training on heart rate. *Ann. Med. Exper. Biol. Fenn.* 35: 308-315.

Katzmarzyk, P.T., Malina, R.M., Song, T.M.K., and Bouchard, C. (**1998**). Physical activity and health-related fitness in youth: a multivariate analysis. *Med. Sci. Sports Exerc.* 30 (5): 709-714.

Kemper, H.C. (**1995**). *The Amsterdam Growth Study*: A longitudinal analysis of health, fitness, and lifestyle. Champaign, IL: Human kinetics.

Kemper, H.C.G., and Mechelen, W.V. (**1996**). Physical fitness testing of children: a European perspective. *Pediatr. Exerc. Sci.* 8 (3): 201-214.

Khoi, H.H., and Giay, T. (**1994**). *The Nutritional Disorders and Health Status of Vietnamese Community.* Hanoi. Medical Publisher.

Khoi, H.H. (**1996**). Some matters on nutrition in the transitional period in Vietnam. Hanoi. *National Institute of Nutrition*. MOH.

Kimm, Y.S.S., and Kwiterovich, O.P. **(1995).** *Childhood Prevention of Adult Chronic Diseases*: rationale and strategies. Cheung, W.Y.L., and Richmond, B.J (Eds). Child health, nutrition, and physical activity. Champaign, IL: Human Kinetics.

Kinra, S., Nelder, R.P., and Lewendon, G.J. **(2000).** Deprivation and childhood obesity: a cross-sectional study of 20,973 children in Plymouth. United Kingdom. *J. Epid. Comm. Health.* 54: 456-460.

Klesges, R.C., Coates, T.R., Klesges, L.M., Holzer, B., Gustavson, J., and Barnes, J. **(1984).** An observational system for assessing physical activity in children and associated parent behavior. *Behav. Assess.* 6: 333-345.

Klesges, R.C., Klesges, L.M., Swenson, A.M., and Pheley, A.M. **(1985).** A validation of two motion sensors in the prediction of child and adult physical activity. *Am. J. Epedemiol.* 122 (3): 400-410.

Klesges, L.M. and Klesges, R.C. **(1987).** The assessment of children's physical activity. A comparison of methods. *Med. Sci. Sports Exerc.* 19 (5): 511-517.

Kohl, H.W., Laporte, R.E., and Blair, SN. **(1988).** Physical activity and cancer: an epidemiological perspective. *Sports Med.* 6: 222-237.

Kohl, H.W., Hobbs, K.E. **(1998).** Development of physical activity behaviors among children and adolescents. *Pediatrics.* 101 (3): 549-555.

Kowalski, K.C., Crocker, P.R.E., and Faulkner, R.A. **(1997).** Validation of the physical activity questionnaire for older children. *Pediatr. Exerc. Sci.* 9 (1): 174-186.

Kriska, A.M., and Caspersen, C.J. **(1997).** Introduction to a collection of physical activity questionnaires. *Med. Sci. Sports Exerc.* 29 (Suppl. 6): S5-S9.

Kriska, A.M. **(2000).** Ethnic and cultural issues in assessing physical activity. *Res. Q. Exerc. Sport.* 71 (2): 47-53.

Kuntzleman, C.T., and Reiff, G.G. **(1992)**. The decline in American children's fitness levels. *Res. Q. Exerc. Sport.* 63 (2): 107-111.

Laporte, R.E., Montoye, H.J., and Caspersen, C.J. **(1985)**. Assessment of physical activity in epidemiologic research: problems and prospects. *Public Health Rep.* 100 (2): 131-146.

Lazarus. R., Wake, M., Hesketh, K., and Waters, E. **(2000).** Change in body mass index in Australian primary school children, 1985-1997. *Int. J. Obes. Relat. Metab. Disord.* 24 (6): 679-684.

Leger, L., and Lambert, J. **(1982).** A maximal multistage 20-m shuttle run test to predict $\dot{V}O_2max$. *Eur. J. Appl. Physiol.* 49: 1- 12.

Liu, N.Y., Plowman, S.A., and Looney, M.A., **(1992).** The reliability and validity of the 20-meter shuttle test in American students 12 to 15 years old. *Res. Q. Exerc. Sport.* 63(4):360-365.

Livingstone, M.B., Coward, W.A., Prentice, A.M., Davies, P.S., Strain, J.J., McKenna, P.G., Mahoney, C.A., White, J.A., Stewart, C.M., and Kerr, M.J. **(1992).** Daily energy expenditure in free-living children: comparison of heart rate monitoring with the doubly labeled watert (2H2(18)O) method. *Am. J. Clin. Nutr.* 56 (2): 343-352.

Livingstone, M.B., Robson P.J., and Totton, M. **(2000).** Energy expenditure by heart rate in children: an evaluation of calibration techniques. *Med. Sci. Sports Exerc.* 32 (8): 1513-1519.

Lohman, T.G. **(1989).** Assessment of body composition in children. *Pediatr. Exerc. Sci.* 1 (1): 19-30.

Lohman, T.G., Boileau, R.A., and Sloughter, M.H. **(1984).** *Body Composition in Children and Youth. In Advance in Pediatric Sport Sciences*. Boileau, R.A., (Eds). Champaign, IL: Human Kinetics. Vol. 1: 29-57.

Londeree, B.R., and Moeschberger, M.L. **(1982).** Effect of age and other factors on maximal heart rate. *R. Q. Exerc. Sport*. 55 (4): 297-304.

Louie, L., Eston, R.G., Rowlands, A.V., Tong, K.K., Ingledew, D.K., and Fu, F.R. **(1999).** Validity of heart rate, pedometry, and accelerometry for estimating the energy cost of activity in Hong Kong Chinese boys. *Pediatr. Exerc. Sci.* 11: 229-239.

Luepker, R.V. **(1999).** How physically active are American children and what can we do about it? *Int. J. Obes*. 23 (Suppl. 2): S12-S17.

Maffeis, C., Pinelli, L., Zaffanello, M., Schena, F., Iacumin, P., and Schutz, Y. **(1995).** Daily energy expenditure in free-living conditions in obese and non-obese children: comparison of doubly labelled water (2H2(18)O) method and heart-rate monitoring. *Int. J. Obes. Relat. Metab. Disord.* 19 (9): 671-677.

Mahoney, L.T., Burns, T.L., Stanford, W. **(1996).** Coronary risk factors measured in childhood and young adults life are associated with coronary artery calcification in young adults: the Muscatine Study. *J. Am. Cell. Cardiol.* 27: 277-284.

Malina, R.M. **(1988).** Physical growth, maturity characteristics of young athletes. In Smoll, F.L., Magill, R.A., and Ash, M.J. *Children in Sport* (3rd Ed). Champaign, IL: Human kinetics. 59-82.

Malina, R.M. Physical activity and fitness of children and youth: Questions and implications. *Med. Exrc. Nutr. Health.* 4: 123-135, 1995.

Malina, R.M. **(1996).** Tracking of physical activity and physical fitness across the lifespan. *Res. Q. Exerc. Sport.* 67 (Suppl. 3): S48-57.

Malina, R.M., and Bouchard, C. **(1991).** *Growth, Maturation, and Physical Activity.* Champaign, IL: Human Kinetics.

Maliszewski, A.F., Freedson, P.S., Ebbeling, C.J., Crussmeyer, J. and Kastango, K.B. **(1991).** Validity of the Caltrac accemerometer in estimating energy expenditure and activity in children and adults. *Pediatr. Exerc. Sci.* 3: 141-151.

Magarey, A.M., Daniels, L.A., and Boulton, T.J. **(2001).** Prevalence of overweight and obesity in Australian children and adolescents: reassessment of 1985 and 1995 data against new standard international definitions. *Med. J. Aust.* 174 (11): 553-455.

Massicotte, D.R., Guathier, R., and Markon, P. **(1985).** Prediction of $\dot{V}O_2max$ from the running performance in children aged 10-17 years. *J. Sport. Med.* 25: 10 - 17.

Mâsse, L. C. **(2000).** Reliability, validity, and methodological issues in assessing physical activity in a cross-cultural setting. *Res. Q. Exerc. Sport.* 71 (2): 54-58.

Mathews, C.E., and Freedson, P.S., **(1995).** Field trial of a three-dimensional activity monitor: comparison with self report. *Med. Sci. Sports Exerc.* 27 (7): 1071-1078.

McArdle, W.D., Katch, F.I., and Katch, V.L. **(1991).** *Exercise Physiology: Energy, Nutrition, and Human Performance.* Philadelphia. Lea & Febiger.

McAuley, D., McCrum, E.E., Stott, G., Evans, A.E., McRoberts, B., Boreham, C.A., Sweeney, K., and Trinick, T.R. **(1996).** PA, fitness, blood pressure, and fibrinogen in the Northern Ireland and activity survey. *J. Epidemiol. Commu. Health.* 50 (3): 258-263.

McAuley, D., McCrum, E., Evans, A., Stott, G., Boreham, C., and Trinick, T. **(1999).** Physical activity, physical fitness and respiratory function--exercise and respiratory function. *Ir. J. Med. Sci.* 168 (2):119-123.

McGill, H.C., McMahan, A., and Malcom, G.E. **(1995).** Relation of glycohemoglobin and adiposity to atherosclerosis in youth. *Arterioscler. Thromb. Vasc. Biol.* 15: 431-440.

McMurray, R.G., Harrell, J.S., Deng, S., Bradley, C.B., Cox, L.M., and Bangdiwala, S.I., **(2000).** The influence of physical activity, socio-economic status, and ethnicity on the weight status of adolescents. *Obes. Res.* 8(2): 130-139.

Melanson, E.L.J.R., and Freedson, P.S. **(1995).** Validity of the computer science and applications, Inc. (CSA) activity monitor. *Med. Sci. Sports Exerc.* 27 (6): 934-940.

Michaud, P.A., Narring, F., Cauderay, M., and Cavadini, C. **(1999)**. Sports activity, physical activity and fitness of 9 to 19-year-old teenagers in the canton of Vaud (Switzerland). *Schweiz. Med. Wochenschr.* 129: 691-699.

Milligan, R.A., Thompson, C., Vandongen, R., Beilin, L.J., Burke, V. **(1995).** Clustering of cardiovascular risk factors in Australian adolescents: association with dietary excesses and deficiencies. *J. Cardiovasc. Risk.* 2 (6): 515-523.

MOH. **(1976).** *Biological Constants of Vietnamese.* Ministry of Health. Hanoi: Medical Publisher.

MOET. **(1996).** *Summary Report – Survey on Refining Body Fitness Criteria in School Students*. Hanoi: Ministry of Education and Training.

MOET. **(2000).** *Educational Statistical Index.* Hanoi: Ministry of Education and Training.

Montoye, H.J., Washburn, R., Servais, S., Ertl, A. and Webster, J.G., Nagle, F.J. **(1983).** Estimation of energy expenditure by portable accelerometer. *Med. Sci. Sports Exerc.* 15 (5): 403-407.

Montoye, H.J., and Taylor, H.L. **(1984).** Measurement of physical activity in population studies: A review. *Hum. Biol.* 56 (2): 195-216.

Montoye, H.J., Kemper, H.C.G., Saris, W.H.M., and Washburn, R.A. **(1996).** *Measuring Physical Activity and Energy Expenditure.* Champaign, IL: Human kinetics: 26-32.

Morris, J.N., and Crowford, M.D. **(1958).** Coronary heart disease and physical activity of work evidence of a national necropsy survey. *Br. Med. J.* 2; 1485-1496.

Morrison, J.A., Barton, B.A., Biro, F.M., Daniels, S.R., and Sprecher, D.L. **(1999).** Overweight, fat patterning, and cardiovascular disease risk factors in black and white boys. *J. Pediatrics.* 135 (4): 451-457.

Morrow, J.R., Jr., and Freedson, P.S. **(1994).** Relationship between habitual physical activity and aerobic fitness in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 315-329.

Mukeshi, M., Gutin, B., Anderson, W., Zybert, P., and Basch, C. **(1990).** Validation of the Caltrac movement sensor using direct observation in young children. *Pediatr. Exerc. Sci.* 2 (3): 249-254.

Murphy, J.K., Alpert, B.S., Christman J.V., and Wiley E.S. **(1988).** Physical fitness in children: a survey method based on parental report. *Am. J. Pub. Health.* 78: 708-710.

Must, A., Jacques P.F., Dallal, G.E., Bajema, C.J., Dietz, W.H. **(1992).** Long-term morbidity and mortality of overweight adolescents: a follow-up of the Harvard Growth Study of 1922 to 1935. *N. Engl. J. Med.* 327:1350-1355.

Must, A. **(1996).** Morbidity and mortality associated with elevated body weight in children and adolescents. *Am. J. Clin. Nutr.* 63 (Suppl): S445-447.

Myers, L., Strikmiller, P.K., Webber, L.S., and Berenson, G.S. **(1996).** Physical and sedentary activity in school children grades 5-8: the Bogalusa Heart Study. *Med. Sci. Sports Exerc.* 28 (7): 852-859.

National Health and Medical Research Council, **(1997).** *Acting on Australia's Weight*: a strategic plan for the prevention of overweight and obesity - Summary Report. Canberra, ACT. Australian Publishing Service.

Naughton, L. Mc., Cooley, D., Kearney, V., and Smith, S. **(1996).** A comparison of two different shuttle run tests for the estimation of $\dot{V}O_2max$. *J. Sports Phys. Fitness.* 36: 85-90.

Nhan, N.T. **(1988).** *Situation of Health and Diseases in Vietnamese Children - An Observation Over the Periods.* Science Monographs 1980-1985. Hanoi: Medical Publsher.

Ott, A.E, Pate, R.R., Trost, S.G., Ward, D.S., and Saunders, R. **(2000).** The use of uniaxial and triaxial accelerometers to measure children's "free-play" physical activity. *Pediatr. Exerc. Sci.* 12 (4): 360-370.

Owens, S., Gutin, B., Allison, J., Riggs, S., Ferguson, M., Litaker, M., and Thompson, W. **(1999).** Effect of physical training on total and visceral fat in obese children. *Med. Sci. Sports Exerc.* 31 (1): 143-148.

Pangrazi R.P. **(2000).** Promoting physical activity for youth. *J. Sci. Med. Sport.* 3 (3): 280-286.

Park, R.J. **(1995).** History of research on physical activity and health: selected topics, 1867 to the 1950s. *Quest* (Champaign, Ill). 47 (3): 274-287.

Pate, R.R. A new definition of youth fitness. **(1983).** *Phys. Sports Med.* 11 (4): 77-83.

Pate, R.R. **(1989)**. The case for large scale physical fitness testing in American youth. *Ped. Exerc. Sci.* 1: 290-294.

Pate, R.R., Dowda, M., and Ross, J.G. **(1990).** Associations between physical activity and physical fitness in American children. *Am. J. Dis. Child.* 144: 1123-1129.

Pate, R.R., Burgess, M.L., Woods, J.A., Ross, J.G., and Baumgartner, T. **(1993).** Validity of field tests of upper body muscular strength. *Res. Q. Exerc. Sport.* 64 (1): 17-24.

Pate, R.R., Long, B.J., and Heath, G. **(1994).** Descriptive epidemiology of physical activity in adolescents. *Pediatr. Exerc. Sci.* 6 (4): 434-447.

Powell, K.E., and Dysinger, W. **(1987).** Childhood participation in organised school sports and physical education as precursors of adult physical activity. *Am. J. Prev. Med.* 3: 276-281.

Powell, K.E., Thompson, P.D., Carsperson, C.J., and Kendrick, J.S. **(1987).** Physical activity and the incidence of coronary heart disease. *Annu. Rev. Public Health* 8: 253-287.

Powell, K.E., Caspersen, C.J., Koplan, J.P., and Ford, E.S. **(1989).** Physical activity and chronic diseases. *Am. J. Clin. Nutr.* 49: 999-1006.

Powell, K.E., and Blair, S.N. **(1994).** The public health burdens of living habits: theoretical but realistic estimates. *Med. Sci. Sports Exerc.* 26 (7): 851-856.

Power, C., Lake, J.K., and Cole, T.J. **(1997).** Measurement and long-term health risks of child and adolescent fatness. *Int. J. Obes. Relat. Metab. Disord.* 21:507-526.

Praff, M., Macera, C.A., and Blanton, C. **(1999).** Levels of physical activity and inactivity in children and adults in the United States: current evidence and research isues. *Med. Sci. Sports Exerc.* 31(Suppl. 11): S526-S533.

Puhl, J., Greaves, K., Hoyt, M., and Baranowski, T. **(1990).** Children's Activity Rating Scale (CARS): description and calibration. *Res. Q. Exerc. Sport.* 61 (1): 26-36.

Raitakari, O.T., Porkka, K.V.K., Rönnemaa, T., and Ǻkerblom, H.K. **(1994).** Clustering of risk factors for coronary heart disease in children and adolescents, the Cardiovascular Risk in Young Finns Study. *Acta. Paediatr.* 83: 935-940.

Reginald, L.W. **(1999).** Intervention to reduce cardiovascular risk factors in children and adolescents. *Am. Fami. Phys.* 59 (8): 2211-20.

Richard, T.P., and Katherine, F.M. **(1998).** Overweight children and adolescents: description, epidemiology, and demographics. *Pediatrics.* 101 (3): 497-506.

Rissel, C.E. **(1991).** Overweight and television watching. *J. Public Health.* 15 (2): 147-150.

Robinson, T.N., **(2001).** Television viewing and childhood obesity. *Pediatr. Clin. North. Am.* 48 (4): 1017-1025.

Ross, J.G., and Pate, R.R. (**1987**). The National Children and Youth Fitness Study II: A summary of findings. *J. Phys. Educ. Recr. Dance.* 58: 51-56.

Roudier, M.D., and Tomblin, B.E. (**1994**). Childhood obesity: school base nutrition and intervention. *Pub. Heal. Reports.* 109 (2): 179-180.

Rowland, T.W., (**1989**). Fitness testing in children: Where from here? *Ped. Exerc. Sci.* 1: 289.

Rowland, T.W. (**1990**). *Exercise and Children's Health.* Champaign. IL: Human kinetics.

Rowland, T.W. (**1996**). *Developmental Exercise Physiology.* Champaign, IL: Human Kinetics.

Rowlands, A.V., Eston, R.G., and Ingledew, D.K. (**1997**). Measurement of physical activity in children with particular reference to the use of heart rate and pedometry. *Sports Med.* 24 (4): 258-272.

Rowlands, A.V., Eston, R.G., and Ingledew, D.K. (**1999**). Relationship between activity levels, aerobic fitness, and body fat in 8 to 10-yr-old children. *J. Appl. Physiol.* 86 (4): 1428-1435.

Rowlands, A.V., Ingledew, D.K., and Eston, R.G. (**2000**). The effect of type of physical activty measure on the relationship between body fatness and habitual physical activity in children: a meta-analytic. *Ann. Hum. Biol.* 27 (5): 479-497.

Safrit, M.J. (**1990**). The validity and reliability of fitness tests for children. A review. *Pediatr. Exerc. Sci.* 2: 9-28.

Safrit, M.J. **(1995).** *Complete Guide to Youth Fitness Testing*. Champaign IL: Human Kinetics.

Sallis, J.F., Patterson, T.L., Buono, M.J., and Nader, P.R. **(1988).** Relation of cardiovascular fitness and PA to cardiovascular risk factors in children and adults. *Am. J. Epidemiol.* 127 (5): 933-941.

Sallis, J.S., Buono, M.F., Roby, J.J., Carlson, D. and Nelson, J.A. **(1990).** The Caltrac accelerometer as a physical activity monitor for school-age children. *Med. Sci. Sports Exerc.* 22 (5): 698-703.

Sallis, J.F., Simons-Morton, B.G., Stone, E.J., Corbin, C.B., Epstein, L.H., Foucette, N., Iannotti, R.J., Killen, J.D., Klesges. R.C., Petray, C.K. Rowland, T.W., and Taylor, W.C. **(1992).** Determinants of physical activity and interventions in youth. *Med. Sci. Sports Exerc.* 24 (6): S248-S357.

Sallis, J.F. **(1993).** Epidemiology of physical activity and fitness in children and adolescents. *Crit. Rev. Food Sci. Nutr.* 33 (4/5): 403-408.

Sallis, J.F., Buono, M.J., Roby, J.J., Mical, F.G. and Nelson, J.A. **(1993).** Seven-day recall and other physical activity self-reports in children and adolescents. *Med. Sci. Sports Exerc.* 25 (1): 99-108.

Sallis, J.F., and Patrick, K. **(1994).** Physical activity guidelines for adolescents: Consensus statement. *Pediatr. Exerc. Sci.* 6 (4): 302-314.

Sallis, J.F., Zakarian, J.M., Hovell, M.F., and Hofstetter, C.R. **(1996).** Ethnic, socio-economic, and differences in physical activity among adolescents. *Clin. Epidemiol.* 49 (2): 124-134.

Sallis, J.F., Prochaska, J.J., and Taylor W.C.A. (**2000**). A review of correlates of physical activity of children and adolescents. *Med. Sci. Sports Exerc.* 32 (5): 963-975.

Saris, W.H.M., and Binkhorst, R.A. (**1977**). The use of pedometer and actometer in studying daily physical activity in man. Part I: Reliability of the pedometer and actometer. *Eur. J. Appl. Physiol.* 37: 219-228. Part II: Validity of the pedometer and actometer measuring the daily physical activity. *Eur. J. Appl. Physiol.* 37: 229-235.

Saris, W.H.M. (**1986**). Habitual physical activity in children: methodology and findings in health and disease. *Med. Sci. Sports Exerc.* 18 (5): 253-263.

Schulman, J.L. and Reisman, J.M. (**1959**). An objective measure of hyperactivity. *Am. J. Ment. Def.* 64: 455-456.

Seefeldt, V. and Vogel, P. (**1989**). Physical fitness testing of children: A 30-year history of misguided efforts? *Pediatr. Exerc. Sci.* 1: 295-302.

Shephard, R.J. (**1984**). Physical activity and child health. *Sports Med.* 1: 203-233.

Shephard, R.J. (**1995**). Physical activity, fitness, and health: the current consensus. *Quest*, 47: 288-302.

Shephard, R.J., and Bouchard, C. (**1995**). Relationship between perceptions of physical activity and health-related fitness. *J. Sports Med. Phys. Fitness.* 35 (3): 149-158.

Simons-Morton, B.G., Parcel, G.S., O'Hara, N.M., Blair, S.N., and Pate, R.S. (**1988**). Health-related physical fitness in childhood: Status and recommendations. *Ann. Rev. Public Health.* 9: 402-425.

Simons-Morton, B.G., O'Hara, N.M., Parcel, G.S., Huang, I.W., Baranowski, T., and Wilson, B. **(1990).** Children's frequency of participation in moderate to vigorous physical activities. *Res. Q. Exerc. Sport.* 61(4):307-314.

Siconolfi, S.F., Lasater, T.M., McKinlay, S., Boggia, P., and Carleton, R.A. **(1985).** Physical fitness and blood pressure. *Am. J. Epidemiol.* 122 (3): 452-457.

Sirard, J.R., Melanson, E.L., Li, L., and Freedson, P.S. **(2000).** Field evaluation of the computer science and applications, Inc. physical activity monitor. *Med. Sci. Sports Exerc.*32 (3): 697-700.

Slattery, M.L., Schumacher, M.C., Hunt, S.C., and Williams, R.R. **(1993).** The associations between family history of coronary heart disease, physical activity, dietary intake and body size. *Int. Sports Med.* 14 (2): 93-99.

Slaughter, M.H., Lohman, T.G., Boileau, R.A., Horswill, C.A., Stillman., R.H., Van Loan., M.D., and Bemben, D.A. **(1988).** Skinfold equations for estimation of body fitness in children and youth. *Hum. Biol.* 60: 709-723.

Sleap, M., and Warburton, P. **(1992).** Physical activity levels of 5-11 year old children in England as determined by continuous observation. *Res. Q. Exerc. Sport.* 63 (3): 238-245.

Sleap, M., and Tolfrey, K. **(2001).** Do 9- to 12 yr-old children meet existing physical activity recommendations for health? *Med. Sci. Sports Exer.* 33 (4):591-596.

Sneidell, J.C. **(1995).** Obesity in Europe: scaling an epidemic. *Int. J. Obes. Relat. Metab. Disord.* 19 (Suppl. 3): S1-S4.

Son, N.V., and Dien, D.N. **(1997).** Efficient treatment of rickets in children. Hanoi. *Pediatrics*. Vietnam Medicine and Pharmacy Foundation.

Spyckerelle, Y., Fournier, B., Steinmetz, J., and Collignon, O. **(1995).** Changes in the cardiovascular risk indicators in adolescents between 1980 and 1991. *Arch. Mal. Coeur. Vaiss.* 88 (11): 1561-1567.

Srinivasan, S.R., Bao, W., Wattigney, W.A., and Berenson, G. **(1996).** Adolescents overweight is associated with adult overweight and related multiple cardiovascular risk factors: The Bogalusa Heart Study. *Metabolism.* 45: 223-240.

Strong, W.B. **(1990).** Physical activity and children. *Circulation.* 18 (5): 1697-1701.

Sytkowski, P.A., Kannel, W.B., and D'Agostino, R. **(1990).** Changes in risk factors and the decline in mortality from cardiovascular disease: the Framingham Heart Study, *N. Engl. J. Med.* 322: 1635-1641.

Tabachnick B.G., and Fidell, L.S. **(1996).** *Using Multivariate Statistics*. HarperCollins. New York. College publishers.

Taras, H.L., Sallis, J.F., Patterson, T.L., Nader, P.R., and Nelson, J.A. **(1989).** Television's influence on children's diet and physical activity. *J. Dev. Behav. Pediatr.* 10(4):176-180.

Taylor, W., and Baranowski, T. **(1991).** Physical activity, cardiovascular fitness and adiposity in children. *Res. Q. Exerc. Sport* 62 (2): 157-163.

Taylor, W.C., and Sallis, J.F. **(1997).** Determinants of physical activity in children. *World. Rev. Nutr. Diet.* 82:159-167.

Taylor, W.C., Blair, S.N., Cummings, S.S., Wun, C.C., and Malina, R.M. **(1999).** Childhood and adolescent physical activity patterns and adult physical activity. *Med. Sci. Sports Exerc.* 31 (1): 118-123.

Tell, G.S., and Vellar, O.D. **(1988).** Physical fitness, physical activity, and cardiovascular disease risk factors in adolescents: the Oslo Youth Study. *Prev. Med.* 17(1):12-24.

Thinh, P., Van Tien, N., and Khac Son, N. **(1991).** *Cardio-Physiological Indices in Primary School Students*. Science Monographs 1981-1990. Hanoi: MOH.

Tremblay, A., and Doucet, E. **(1999).** "Influence of intense physical activity on energy balance and body fatness." *Proc. Nutr. Soc.* 58 (1): 99-105.

Treuth, M.S., Hunter, G.R., Pichon, C., Figueroa-Colon, R., and Goran, M.I. **(1998).** Fitness and energy expenditure after strength training in obese prepubertal girls. *Med. Sci. Sports Exerc.* 30 (7): 1130-1136.

Troiano, R.P., and Flegal, K.M. **(1998)**. Overweight children and adolescents: description, epidemiology, and demographics. *Pediatrics.* 101 (3): 497-505.

Trost, S.G., Pate, R.R., Dowda, M., Saunders, R., Ward, D.S., Felton, G. **(1996).** Gender differences in physical activity and determinants of physical activity in rural fifth grade children. *J. Sch. Health.* 66(4): 145-150.

Trost, S.G., Ward, D.S., Moorehead, S.M., Watson, P.D., Riner, W. and Burke, J.R. **(1998).** Validation of the computer science and applications (CSA) activity monitor in children. *Med. Sci. Sports Exerc.* 30 (4): 629-633.

Trost, S.G., Pate, R.R., Ward, D.S., Saunders, R., and Riner, W. (**1999** a). Correlates of objectively measured physical activity in preadolescent youth. *Am. J. Prev. Med.* 17 (2): 120-126.

Trost, S.G., Ward, D.S., McGraw, W.B., and Pate, R.R. (**1999** b). Validation of previous day physical activity recall (PDPAR) in fifth-grade children. *Pediatr. Exerc. Sci.* 11 (4): 341-348.

Trost, S.G., Ward, D.S., Moorehead, S.M., Watson, P.D., Riner, W., and Burke, J.R. **(2000).** Validity of the computer science and applications (CSA) activity monitor in children. *Med. Sci. Sports. Exerc.* 30 (4): 629-633.

Twisk, J. W., Kemper, H.C., Mellenbergh, G.J., and van_Mechelen, W. **(1997).** A new approach to tracking of subjects at risk for hypercholesteremia over a period of 15 years: The Amsterdam Growth and Health Study. *Eur. J. Epidemio.* 13 (3): 293-300.

Twisk, J.W., Boreham, C., Cran, G., Savage, M., and Mechelen, W., **(1999).** Clustering of biological risk factors for cardiovascular disease and the longitudinal relationship with lifestyle of an adolescent population: The Northern Ireland Young Hearts Project. *J. CV. Risk.* 6: 355-362.

Twisk, J.W., Kemper, H.C., and Mechelen, W. **(2000).** Tracking of activity and fitness and the relationship with cardiovascular disease risk factors. *Med. Sci. Sports. Exerc.* 32 (8): 1455-1461.

Twisk, J.W., Snel, J., Vente W., Kemper, H.C., and Mechelen W. **(2000).** Positive and negative life events: the relationship with coronary heart disease risk factors in young adults. *J. Psychosom. Res.* 49 (1): 35-42.

Twisk, J.W. **(2001).** Physical activity guidelines for children and adolescents: a critical review. *Sports Med.* 31 (8): 617-627.

U.S. Public Health Service, Healthy people 2000, **(1990).** *National Health Promotion and Disease Prevention Objectives.* Washington, DC: U.S. Government Printing Office.

Vanhala, M., Vanhala, P., Kumpusalo, E., Halonen, P., and Takala, J. **(1998).** Relation between obesity from childhood to adulthood and the metabolic syndrome: population based. *Brit. Med.* J. 317 (7154): 319-321.

Vern Weitzel and Coombs Computing Unit, ANU, **(1998).** Research Schools of Social Sciences & Pacific and Asian Studies. Canberra. Australian National University. *http://coombs.anu.edu.au/WWWVLPages/VietPages/WWWVL-Vietnam.html.*

Walkley, J. Parker, S., and Jackson, M. **(1996).** *Australian Fitness Education Award.* Canberra: Australian Council for Health (ACHPER).

Wallace, J.P., Mckenzie, T.L., and Nada, P.R. **(1985).** Observed vs recalled exercise behavior: a validation of a seven-day exercise recall for boys 11 to 13 years old. *Res. Q. Exerc. Sport.* 56: 161-165.

Ward, D.S., and Evans, R. **(1995).** PA, aerobic fitness and obesity in children. Med. *Exerc. Nutr. Health.* 4: 3-16.

Ward, D.S., Trost, S.G., Felton, G., Saunders, R., Parsons, M.A., Dowda, M., and Pate, R.R. **(1997).** PA and fitness in African-American girls with and without obesity. *Obes. Res.* 5 (6): 572-577.

Wasburn, R.A., and Laporte, R.E. (**1988**). Assessment of walking behavior: Effect of speed and monitor position on two objective activity monitors. *Res. Q. Exerc. Sport.* 59: 83-85.

Welk, G.J., Corbin, C.B., and Dale, D. (**2000**). Measurement issue in the assessment of physical activity in children. *Res. Q. Exerc. Sport.* 71 (2): 59-73.

Westerterp, K.R. Physical activity assessment with accelerometers (**1999**). *In. J. Obes.* 23 (3): 45-49.

Weymans, M., And Reybrouck, T. (**1989**). Habitual level of physical activity and cardiorespiratory endurance capacity in children. E*ur. J. Appl. Physiol.* 58: 803-807.

WHO, (**1948**). Definition of Health. Quoted in: WHO as an Organization. *www.who.int. 2001.*

Whitfield, D. (**1976**) *Historical and Cultural Dictionary of Vietnam.* Metuchen, NJ: Scarecrow Press.

Wilcken, D.E.L., Lynch, J.F., Marshall, M.D., Scott, R.L., and Wang, X.L. (**1996**). Relevance of body weight to apolipoprotein levels in Australian children. *Med. J.* 164: 22-25.

Wong, W.W., Butte, N.F., Ellis, K.J., Hergenroeder, A.C., Hill, R.B., Stuff, J.E., and Smith, E.O. (**1999**). Pubertal African-American girls expend less energy at rest and during physical activity than Caucasian girls. *J. Clin. Endocrinol. Metab.* 84 (3): 906-911.

Zack, P.M., Harlan, W.R., Leaverton, P.E., and Cornoni-Huntley, J. (**1979**). Longitudinal study of body fatness in childhood and adolescence. *J. Pediatr.* 95: 126-130.

APPENDIX A

STUDY 1

- *Subject informed consent statements*
- *Raw data sheets*

School of Human movement, Recreation & Performance
Victoria University
PO Box 14428
Melbourne City MC
Melbourne, 8001

VICTORIA UNIVERSITY OF TECHNOLOGY

STANDARD CONSENT FORM FOR SUBJECTS INVOLVED IN EXPERIMENTS

CERTIFICATION BY PARENTS /GUARDIAN OF ADOLESCENT PARTICIPANTS

We would like to invite your son/daughter to be part of our study into developing a measure of physical activity by using the physical activity monitor for Vietnamese adolescents.

I, ...
Parent/guardian of...
(Address)..Telephone.................

certify that I am the parent/guardian of ....and that I voluntarily give my consent for my son/daughter to participate in the experiment entitled :

"Validation of the computer science applications (CSA) as an objective measure of energy expenditure in Vietnamese adolescents."

being conducted at Victoria University of Technology by :
Professor David Lawson, Mr. Binh B. Chu, and Dr. Geraldine Naughton.

I certify that the objectives of the testing, together with any risks to me associated with the procedures listed hereunder to be carried out in the study, have been fully explained to me by:

Professor David Lawson, Mr. Binh B. Chu, and Dr. Geraldine Naughton.

and that I freely consent to my son/daughter's participation involving the use of these procedures.

Procedures

On one occasion, your son /daughter will be required to attend the Exercise Physiology Laboratory (Room L329, Building L), at the Footscray Campus of Victoria University of Technology. A group of students will be taken by the researchers and teachers from their School to the University and bring them back to the School after testing.

After a familiarisation session, He / She will be required to perform three bouts of exercise consisting: 1) slow walking at 4.5 $km{\cdot}h^{-1}$; 2) fast walking at 6.6 $km{\cdot}h^{-1}$; and 3) jogging at 8.8 $km{\cdot}h^{-1}$ on a motorised treadmill. Each bout of exercise will be lasting for 5 minutes with a 5-minute rest period in between. These speeds will be categorised as typical of young people's activity patterns into three (3) caloric categories (ie. light, moderate, and high). During these tests, he / she will breathe room air through a mouthpiece so that the amount of oxygen can be analysed through a system. These tests will take approximately 25 minutes including two 5 minute rest intervals. During the 5 minute rest periods he / she will be quietly sitting on a chair. A small physical activity monitor (5.1 x 3.8 x 1.5 cm; 45 g) which is housed in a small nylon bag will be worn around each hip. A heart rate monitor will also be worn. This consists of a thin elastic strap worn at chest level and a wrist watch (information receiver) from which the heart rate can be recorded.

There will be no blood tests taken and no invasive procedures used in this study

Measures

Oxygen consumption, physical activity monitor readings, and heart rate evaluation will be recorded and averaged from each exercise bout. Tables showing oxygen consumption, caloric output equivalent, heart rate and physical activity monitor readings will be calculated.

Benefits

At this time there is no measure of physical activity suitable for use on the Vietnamese population in the international literature. This study will develop such a tool by using a new model of physical activity monitor to measure (especially for adolescents) and also provide valuable and original information on the caloric equivalents of typical physical activity

Risks

There is a small possibility of a feeling dizzy or tired following the jogging test. In this situation, the test will be stopped and the emergency procedures will be followed by the researchers. There will be always at least two researchers standing near the student during the test.

The uncertainty that may challenge some students during the laboratory testing will be minimised through a familiarisation session with each student to assure them of the minimal risks and requirements involved in participation.

I have been informed that the confidentiality of the information I provide will be safeguarded.

Signed: .... }

Witness other than the experimenter: } Date: ....

....}

By signing the informed consent form you are indicating that the tests and procedures have been explained to you and are understood by you. Also, it is accepted by the investigators that your son/daughter is participating voluntarily in the study and that your son/daughter is free to withdraw from the investigation at any time. It will be also ensured that you will receive documented feedback related to your son/daughter performance.

Thank you for your co-operation.

Any queries about your son/daughter participation in this project may be directed to the researchers:

Mr. Binh B. Chu	***03-9688 4066***	***Fax: 03-9688 4891***
Professor David Lawson	***03-9688 4005***	***03-9688 5036***

If you have any queries or complaints about the way you have been treated, you may contact the secretary, University Human Ethics Committee, Victoria University of Technology, PO Box 14428, Melbourne City MC, Melbourne, 8001 (telephone No: 03-9688 4710).

MEDICAL HISTORY
FOR PARENTS OF ADOLESCENT PARTICIPANTS- CONFIDENTIAL

Student surname:...................... **Given names:**...
Parent surname: ....**Given names:** ....
Telephone(home)...................... **(business)** ....
For the test safety, we need you to answer all the following questions before your son / daughter takes part in the testing at Victoria University.

Is son / daughter currently engaged any form of regular exercises?	Y / N
What was the date of last medical examination:	
Does your son / daughter take any prescribed medication?	Y / N
If yes, please list:	
Has your son / daughter had major surgery or injuries in the past 3 years?	Y / N
If yes, please describe:	
Is there a history of coronary heart disease in your family?	Y / N
Doctor's name:	
Address:	Phone:

Does your son / daughter, or has your son / daughter suffered from any of the following?

	YES	NO	NOT SURE
Difficulty in breathing			
Pain / Tightness in the chest			
Faint spells / Dizziness			
Heart condition			
High blood pressure			
Low blood pressure			
High cholesterol / Triglyceride			
Blood Clots			
Allergies			
Asthma			
Stomach / Duodenal Ulcer			
Diabetes / Type			
Epilepsy			
Arthritis / Muscular, or joint pain			
Spinal Abnormalities			
Lower back pain			
Are there any other medical conditions which may affect your son / daughter undertaking these exercise tests:			

Please give Comments (If necessary):

Date: / / **Signed:**

VIỆN ĐẠI HỌC VICTORIA

BẢN KHAI CHO NHỮNG NGƯỜI TỰ NGUYỆN THAM GIA VÀO CHƯƠNG TRÌNH NGHIÊN CỨU

XÁC NHẬN CỦA CHA MẸ NHỮNG HỌC SINH THAM GIA

Tôi tên là: ....

Cha /mẹ của:..

Địa chỉ:..**Telephone**................

Xác nhận rằng tôi là cha, mẹ / người bảo lãnh của: .... và tôi tự nguyện cho phép con tôi tham gia vào công trình nghiên cứu với tiêu đề:

"Nghiên cứu độ tin cậy của máy đo hoạt động thể chất (CSA) cho thiếu niên Việt Nam"

Sẽ được tiến hành tại Viện Đại Học Victoria do:
Giáo sư David Lawson, ông Chu Bá Bình, Tiến sĩ Genaldine Naughton.

Tôi thừa nhận rằng các ông bà có tên nêu trên đã giải thích một cách đày đủ những mục tiêu, cũng như những rủi ro có thể xảy ra liên quan đén quá trình tiến hành kiểm tra cho con chúng tôi.
Và tôi tự nguyện cho phép con tôi tham gia vào chương trình đó.

TRƯƠNG TRÌNH KIỂM TRA BAO GỒM CÁC BƯỚC SAU:

Học sinh sẽ đến phòng thực nghiệm Sinh Lí Học Tập Luyện (phòng L329, toà nhà L) tại khu Footscray, Viện Đại Học Victoria. Giáo viên hoặc nghiên cứu viên sẽ dẫn học sinh theo từng nhóm dến tận phòng nói trên và sẽ trả các em về trường ngay sau khi kiểm tra xong. Nếu cần sẽ có xe đưa đón tận nơi.
Sau khi phần làm quen với các dụng cụ, học sinh sẽ thực hiện ba bài tập trên băng chạy gồm: 1) đi bộ bình thường với tốc độ 4,5 km/ giờ; 2) đi bộ nhanh với tốc độ 6,6 km/giờ; 3) chạy với tốc độ 8,8 km/giờ. Mỗi bài tập sẽ kéo dài 5 phút, thời gian nghỉ giữa các bài tập là 5 phút. Đây là những bài tập được phân loại theo các hoạt động điển hình của thiếu niên Việt Nam và được chia thành 3 mức độ nhẹ, trung bình, va nặng. Trong thời gian đang chạy hoặc đi bộ lượng ô xi thở ra của học sinh sẽ được đo qua một hệ thống để tính năng lượng tiêu hao. Học sinh cũng sẽ đeo một dụng cụ nhỏ (dài 5,1 cm, rộng 3,8 cm, dầy 1,5 cm và nặng chỉ 45 g) ở thắt lưng để đo hoạt động thể chất, và đeo một đai nhựa ở ngực cùng với một đồng hồ đeo tay để đo nhịp tim. Trong thời gian nghỉ học sinh sẽ được ngồi trên gế tựa.

CÁC CHỈ SỐ SẼ ĐO GỒM:
Lượng ô xy hít vào cơ thể, nhịp tim, lượng ca lo tiêu thụ, và chỉ số đọc được trên máy đo hoạt động thể chất.

Học sinh sẽ hoàn toàn không phải lấy máu hoặc tiêm chích bât cứ thứ gì vào người.

ÍCH LỢI CỦA CUỘC KIỂM TRA:
Đây là một nghiên cứu đầu tiên về phương pháp đo các hoạt động thể chất của thiêu niên Việt Nam tại Uc. Nghiên cứu này nhằm cung cấp các thông tin về năng lượng tiêu hao của các hoạt động thể chất điển hình của thanh thiếu niên Việt Nam tại Uc cũng như tại Việt Nam.

CÁC RỦI RO:
Sẽ không có các rủi ro lớn có thể xảy ra, tuy nhiên có thể có trường hợp trong lúc chạy một vài học sinh có thể cảm thấy mệt hoặc chóng mặt. Trong trường hợp như vậy các thủ tục cấp cứu sẽ được tiến hành ngay. Sẽ luôn luôn có ít nhất 2 nhân viên thí nghiệm đứng bên cạnh học sinh khi đang kiểm tra.
Trong phần làm quen học sinh sẽ được thử và khởi động để làm quen và giảm các rủi ro có thể xảy ra.

Tôi cũng đã được thông báo rằng những thông tin mà tôi cung cấp sẽ được giữ kín.

Kí tên: ....

Ngày tháng năm

Người làm chứng (không phải là nhân viên làm thí nghiệm)

kí tên: .... Ngày tháng năm

Khi quí vị đồng ý kí vào bản khai này, có nghĩa rằng quí vị đã được giải thích và hiểu về cuộc kiểm tra. Đồng thời quí vị cũng như những nhân viên tiến hành kiểm tra đều đồng ý rằng con của quí vị hoàn toàn tự nguyện tham gia và có toàn quyền từ bỏ cuộc kiểm tra này bất cứ lúc nào. Quí vị cũng sẽ nhận được kết quả của con em quí vị sau khi thí nghiệm hoàn thành.

Rất cảm ơn sự giúp đỡ của quí vị

Nếu quí vị cần hỏi bất cứ điều gì liên quan đến cuộc kiểm tra xin liên hệ đến các ông bà có tên sau:

Ông Chu Bá Bình 03-9688 4066 Fax: 03-9688 4891
Giáo sư: David Lawson 03-9688 4005 03-9688 5036
Nếu quí vị có bất cứ yêu cầu hoặc phàn nàn gì về phương cách con em của quí vị bị đối xử, quí vị có thể liên hệ với thơ kí của Uỷ ban bảo vệ con người của Viện đại học Victoria (University Human Committee, Victoria University of Technology), PO Box 14428, Melbourne City MC, Melbourne, 8001. Tel: 03 9688 4710

TIỀN SỬ VỀ BỆNH TẬT

MẪU ĐƠN DÙNG CHO CHA MẸ CỦA HỌC SINH THAM GIA - BẢO ĐẢM GIỮ BÍ MẬT THÔNG TIN

Họ tên học sinh:................................ Họ tên cha mẹ:...
Điện thoại (ở nhà)................................(ở nơi làm việc)..
Để bảo đảm an toàn xin quí vị trả lời tất cả các câu hỏi dưới đây trước khi con của quí vị tham gia vào cuộc kiểm tra tại viện đại học Victoria.

Con em của quí vị có tham gia tập luyện môn thể thao nào không ?	Y / N
Ngày đến khám bác sĩ cho con của quí vị gần đây nhất là ngày nào:	
Con em của quí vị có đang uống loại thuốc nào không?	Y / N
Nếu có, xin hãy gi lại:	
Con em của quí vị có phải mổ hoặc bị thương trong vòng 3 năm vừa qua không?	Y / N
Nếu có, xin hãy gi rõ thêm:	
Trong gia đình của quí vị có tiền sử về mắc bệnh tim mạch không ?	Y / N
Họ tên của bác sĩ:	
Địa chỉ:	Phone:

Con em của quí vị có đang hoặc đã phải chịu những chứng bệnh dưới đây không?

	Có	Không	Không rõ
Khó thở			
Đau hoặc tức ngực			
Chóng mặt/ngất			
Bệnh tim			
Huyết áp cao			
Huyết áp cao			
Lượng cholesterol cao			
Máu đóng cục			
Dị ứng			
Hen xuyễn			
Dạ dày/ khối u			
Đái			
Động kinh			
Đau cơ, khớp xương			
Cột sống không bình thường			
Đau dưới lưng			
Có điều kiện nào kèm theo đây mà có thể gây ảnh hưởng đến con em của quí vị trong khi tham gia cuộc kiểm tra không?:			

Xin vui lòng góp ý (nếu thấy cần thiết):

Ngày tháng năm Kí tên:

Rất cảm ơn sự giúp đỡ của quí vị

VICTORIA UNIVERSITY OF TECHNOLOGY
Exercise Test Appointment Sheet for the study

"Validation of the computer science applications (CSA) as an objective measure of energy expenditure in Vietnamese adolescents."

NAME:	«firstname» «lastname» «title»
TYPE OF EXERCISE TEST:	**«TEST»**
DATE OF APPOINTMENT:	«date»
TIME OF APPOINTMENT:	«time»
PLACE OF APPOINTMENT:	Room «place»

Building L is located on the **Footscray** campus of the university; park in the carpark opposite the campus on Ballarat Road (near the corner of Geelong Road); the building is located near the city end of the campus, behind the new red brick building.

PHONE NO:	(03) 688 4066 (Mr. Binh Chu)
FAX:	(03) 688 4891

==

INSTRUCTIONS:

1. Do not exercise 4 hours prior to the test.

2. If exercising on the day before the test, then make it light exercise.

3. Eat a light meal 2-3 hours prior to the test, or as directed.

4. Bring running shoes and shorts, or tracksuit.

5. Females wear bikini top or sports bra. Wear a T-shirt over the top.

6. Change and shower facilities are available (bring towel.)

7. Bring any other papers that have been sent to students, and ensure that parents/guardian of students have supplied the information where indicated and signed the forms.

8. Other instructions: ....

24 random subject raw data sheet (the CSA counts and VO2)

Subjects	sex	Height	BM	age	sw3	sw4	sw5	Fw3	fw4	fw5	run3	run4	run5	VOsw3	VOsw4	VOsw5	VOfw3	VOfw4	VOfw5	VOru3	VOru4	VOru5
1	M	156.0	37.0	12	3025	2837	3048	5867	5694	5329	9500	9964	10838	14.7	13.3	15.3	24.5	24.7	26.2	33.0	35.5	36.0
2	M	156.0	38.0	14	3042	3296	3473	6950	6969	7142	9082	10162	9373	15.0	15.4	16.0	23.8	25.0	25.1	36.3	37.5	38.6
3	M	132.0	26.0	11	3031	3377	3220	4893	4592	5260	6853	7372	8127	17.1	17.9	17.8	26.9	27.0	26.1	29.5	36.2	36.7
4	M	146.0	35.0	14	2039	2015	2262	3541	4129	4086	5781	6245	6611	16.5	16.9	16.4	27.5	28.4	29.3	33.2	35.0	35.3
5	M	155.0	40.0	14	1917	1988	1955	3469	3516	3489	6033	6072	6224	15.6	15.7	17.1	26.2	27.1	27.5	35.6	36.0	35.7
6	M	159.5	45.0	13	2873	2764	2815	4256	4144	4382	5101	5460	5517	15.7	15.4	13.4	23.0	25.7	25.6	31.1	33.5	34.0
7	M	154.0	38.0	14	3333	3319	3261	6081	5957	6108	7457	7612	7555	16.3	15.0	16.8	22.5	24.2	24.5	32.0	33.1	34.7
8	M	143.0	30.0	14	2178	2227	2183	4059	4369	4612	5137	4820	5279	15.4	17.0	15.6	26.7	28.2	28.6	33.0	34.5	36.2
9	M	148.0	41.5	14	2358	2378	2413	3340	3224	3402	6564	6823	7038	16.2	15.1	13.8	22.4	23.5	22.6	25.2	26.5	27.7
10	M	154.0	45.5	14	2245	2090	1991	4402	4491	4548	7548	8017	8876	16.6	16.2	16.1	23.3	24.5	24.8	31.2	26.7	36.0
11	M	171.5	60.0	15	2795	2965	3041	5716	5436	5894	8921	8936	9140	12.6	13.1	12.7	19.8	21.1	20.9	28.8	30.6	31.3
12	M	163.5	51.0	14	2617	2802	2847	4208	4395	4779	5652	5973	6868	13.2	13.5	13.5	22.5	23.4	23.0	29.2	31.2	32.6
13	M	150.3	39.0	14	1813	1867	1937	2113	2041	2537	6424	6585	6416	17.1	16.4	16.4	27.0	26.9	28.0	37.8	39.2	39.8
14	M	158.8	43.5	14	2445	2268	2329	4122	4385	4264	6299	6289	6325	15.3	14.7	13.7	24.9	26.4	26.3	29.4	30.3	32.2
15	F	159.0	50.0	14	2828	2727	2719	4219	4383	4176	6853	7121	7199	11.7	12.0	12.1	20.1	20.3	20.4	25.7	26.2	26.9
16	F	157.6	49.5	14	1957	2334	2363	4310	4260	4193	6779	7577	8145	11.3	10.7	11.0	15.1	15.4	15.4	25.6	27.7	28.5
17	F	161.0	51.0	14	1980	1912	1911	4353	4135	3897	6031	6278	6367	13.1	13.7	13.6	23.3	24.5	24.8	30.1	32.2	33.4
18	F	158.0	45.0	14	2140	2112	2117	4402	4491	4548	4854	5287	5594	14.5	15.2	15.4	23.3	24.5	24.8	27.2	29.0	29.3
19	F	156.8	37.5	14	2960	3066	3281	6605	6773	5917	7556	7771	7848	14.2	15.2	15.5	24.1	27.2	25.9	32.5	27.7	33.4
20	F	148.0	46.5	13	2431	2401	2132	5105	5306	5502	9316	8978	9085	14.6	14.7	14.4	23.0	25.9	25.9	29.9	31.8	33.1
21	F	153.0	42.0	13	2787	2784	3005	5334	5812	5923	7319	6981	7076	12.6	12.9	13.3	22.6	25.0	27.2	27.9	29.0	30.4
22	F	146.0	41.0	13	1905	1930	2000	3526	3654	3568	7427	7078	6504	16.5	16.2	16.6	25.2	26.8	27.5	28.4	31.5	31.5
23	F	161.0	50.0	14	2367	2364	2337	4507	4506	4752	7120	6694	6807	14.9	14.6	15.0	21.8	23.5	24.4	25.1	28.1	28.9
24	F	156.5	50.0	14	2032	2191	2139	3549	3608	3733	6086	6109	6346	15.2	15.6	15.5	22.2	23.9	24.7	30.4	32.1	32.9

sw = slow walking; fw = fast walking; ru = running; 3, 4, 5 denote minutes 3 to 5.

Continued...(HR and kcal)

Subjects	sex	Height	BM	age	hrsw3	hrsw4	hrsw5	hrfw3	hrfw4	hrfw5	hrru3	hrru4	hrru5	calsw3	calsw4	calsw5	calfw3	calfw4	calfw5	calru3	calru4	calru5
1					131	129	135	159	156	158	179	182	185	2.7	2.4	2.8	4.5	4.4	4.8	6.1	6.5	6.6
2					142	143	145	158	160	161	181	189	192	2.8	2.9	3.0	4.4	4.6	4.7	7.0	7.6	7.8
3					132	137	136	156	151	159	178	183	183	2.1	2.3	2.2	3.4	3.4	3.3	3.9	4.7	4.8
4					134	138	135	153	159	162	180	185	185	2.7	2.8	2.8	4.6	4.8	5.0	5.5	6.0	6.0
5					127	128	136	147	164	166	187	193	190	3.1	3.0	3.3	5.0	5.2	5.3	6.9	7.1	6.9
6					127	128	128	137	139	139	172	174	173	3.4	3.4	2.9	5.0	5.6	5.6	6.7	7.3	7.5
7					128	130	129	161	160	162	169	174	176	3.1	2.9	3.2	4.2	4.4	4.6	5.9	6.2	6.6
8					126	132	130	162	168	169	179	176	178	2.3	2.6	2.3	3.9	4.2	4.2	5.0	5.2	5.5
9					121	123	125	143	146	147	166	165	169	3.3	3.1	2.8	4.6	4.9	4.6	5.2	5.4	5.7
10					136	138	139	148	151	152	173	179	180	3.7	3.7	3.7	6.5	6.8	6.9	7.1	7.9	8.4
11					107	110	109	131	133	132	151	152	154	3.8	4.0	3.8	6.2	6.5	6.5	8.8	9.6	9.6
12					122	124	123	139	142	141	163	164	166	3.3	3.4	3.4	5.6	6.0	5.9	7.3	7.9	8.3
13					136	135	138	178	179	181	202	204	205	3.3	3.2	3.5	5.4	5.2	5.5	7.3	7.8	7.9
14					129	126	127	150	152	152	189	191	192	3.3	3.1	3.0	5.3	5.6	5.7	6.2	6.6	7.0
15					121	124	125	127	139	142	162	167	169	2.9	2.9	3.0	4.9	5.0	5.1	6.2	6.4	6.6
16					125	127	129	138	141	147	163	164	169	2.8	2.6	2.6	3.7	3.8	3.8	6.2	6.9	7.1
17					117	119	119	139	141	142	162	165	164	3.2	3.3	3.3	6.5	6.8	6.8	7.4	8.2	8.3
18					126	125	126	151	153	152	169	173	174	3.1	3.3	3.3	5.5	5.6	5.8	5.9	6.4	6.5
19					126	127	127	142	145	146	173	172	175	2.7	2.8	2.9	4.3	4.9	4.7	6.0	5.1	6.2
20					132	136	138	171	174	174	179	184	183	3.3	3.3	3.3	5.4	6.1	6.1	6.8	7.3	7.7
21					127	128	131	157	159	160	189	187	188	2.6	2.6	2.8	4.7	5.3	5.8	5.9	6.3	6.5
22					140	142	145	174	174	175	195	197	198	3.3	3.2	3.3	5.2	5.5	5.7	5.7	6.5	6.5
23					129	131	132	158	157	159	169	169	171	3.7	3.6	3.7	5.4	5.9	6.1	6.3	7.2	7.4
24					137	138	140	163	165	165	192	193	195	3.5	3.7	3.7	5.4	6.1	6.2	7.4	7.8	8

sw = slow walking; fw = fast walking; ru = running; 3, 4, 5 denote minutes 3 to 5.

Predicted kcal by the equation for 10 subjects and compare to the actual values

subject	gender	constant	monitor-B	average Counts	BM-B	BM	predict-kcal	measured Kcal	difference
Slow-walk									
1	M	-1.398	0.0006	2082	0.08	32.5	2.5	*2.3*	0.2
2	M	-1.398	0.0006	1865	0.08	56.5	4.3	*4.3*	0.0
3	M	-1.398	0.0006	2040	0.08	40.0	3.1	*2.9*	0.1
4	M	-1.398	0.0006	3374	0.08	62.0	5.7	*4.1*	1.6
5	M	-1.398	0.0006	2443	0.08	34.0	2.9	*2.5*	0.3
6	M	-1.398	0.0006	2282	0.08	40.5	3.3	*3.1*	0.2
7	F	-1.398	0.0006	1993	0.08	51.0	3.9	*3.7*	0.3
8	F	-1.398	0.0006	2612	0.08	50.5	4.3	*3.7*	0.6
9	F	-1.398	0.0006	2741	0.08	52.0	4.5	*3.7*	0.8
10	F	-1.398	0.0006	1720	0.08	34.0	2.4	*2.4*	0.1
Fast-walk									
1	M	-1.398	0.0006	3734	0.08	32.5	3.5	*4.2*	-0.7
2	M	-1.398	0.0006	3629	0.08	56.5	5.4	*6.7*	-1.3
3	M	-1.398	0.0006	3033	0.08	40.0	3.7	*4.8*	-1.0
4	M	-1.398	0.0006	6679	0.08	62.0	7.7	*6.3*	1.5
5	M	-1.398	0.0006	4299	0.08	34.0	4.0	*3.9*	0.1
6	M	-1.398	0.0006	2421	0.08	40.5	3.4	*5.2*	-1.9
7	F	-1.398	0.0006	2960	0.08	51.0	4.5	*6.6*	-2.1
8	F	-1.398	0.0006	5067	0.08	50.5	5.8	*6.8*	-1.0
9	F	-1.398	0.0006	4689	0.08	52.0	5.7	*5.6*	0.1
10	F	-1.398	0.0006	4561	0.08	34.0	4.2	*4.2*	0.0
Run									
1	M	-1.398	0.0006	6755	0.08	32.5	5.4	*4.9*	0.5
2	M	-1.398	0.0006	8427	0.08	56.5	8.4	*9.7*	-1.3
3	M	-1.398	0.0006	7533	0.08	40.0	6.5	*6.7*	-0.1
4	M	-1.398	0.0006	6994	0.08	62.0	7.9	*9.9*	-1.9
5	M	-1.398	0.0006	5217	0.08	34.0	4.6	*4.9*	-0.3
6	M	-1.398	0.0006	7337	0.08	40.5	6.4	*7.4*	-1.0
7	F	-1.398	0.0006	6982	0.08	51.0	7.1	*8.2*	-1.1
8	F	-1.398	0.0006	7298	0.08	50.5	7.2	*8.2*	-1.0
9	F	-1.398	0.0006	7407	0.08	52.0	7.4	*7.6*	-0.2
10	F	-1.398	0.0006	6840	0.08	34.0	5.6	*5.2*	0.4

	Model Summary			
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.85	0.72	0.72	0.91

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.398	0.68		-2.04	0.045
	MONITOR	0.0006	0.00	0.78	12.35	0.000
	WEIGHT	0.08	0.01	0.35	5.49	0.000

a) Predictors: (Constant), WEIGHT, MONITOR

b) Dependent Variable: KCAL

AV subject data

subject	Sex	BM	Height	Age	sw3	sw4	sw5	fw3	fw4	fw5	run3	run4	run5	HRsw3	HRsw4	HRsw5
1	F	42.0	152.0	12	2539	2841	2746	4021	4108	4208	7323	8376	8361	119	124	126
2	F	43.0	150.0	13	2797	2717	2705	4025	4852	3850	6644	6381	6812	118	119	121
3	F	37.0	143.0	12	1905	2039	2072	3590	3410	3292	4982	4963	5380	114	113	115
4	F	60.5	152.5	13	1753	2262	2710	3741	3670	3995	4874	4874	4553	129	130	134
5	F	42.5	153.5	12	2136	2159	2172	3250	3404	3676	7348	6942	7186	114	115	117
6	F	41.5	157.5	13	2379	2445	2360	3183	3478	3462	6319	6728	6247	134	136	136
7	F	38.5	146.0	11	1745	1604	1737	3258	3228	3216	3997	4044	4108	121	123	123
8	M	39.0	140.0	12	2509	2592	2521	4452	4481	4448	5859	5794	5693	120	123	126
9	M	38.5	142.0	12	2282	2204	2262	3327	3436	3349	6464	6593	7098	134	138	134
10	M	47.5	160.5	15	2174	2217	2138	5096	4968	5485	7786	8309	8644	128	128	131
11	M	35.5	141.0	11	2356	2364	2554	4323	4555	4329	6447	5858	5185	129	130	133
12	M	36.5	140.5	12	2799	2621	2681	5352	5031	5234	7590	8110	8237	127	130	134
13	M	39.0	153.5	12	1982	2018	1949	3141	3192	3164	4953	4962	4992	125	126	127
14	M	46.5	160.0	15	3088	3089	3044	5330	5400	5413	9091	9734	9029	138	140	141

subject	HRfw3	HRfw4	HRfw5	HRru3	HRru4	HRru5	VOsw3	VOsw4	VOsw5	VOfw3	VOfw4	VOfw5	VOru3	VOru4	VOru5
1	149	147	151	178	184	177	18.79	18.20	19.19	27.84	27.06	27.37	37.21	37.32	37.40
2	139	141	149	161	176	181	16.83	16.79	17.27	25.15	25.21	25.21	37.60	37.26	38.39
3	142	151	152	175	177	180	15.75	16.32	15.29	28.37	28.81	30.39	35.39	35.45	36.82
4	156	161	165	169	173	178	16.98	15.52	17.87	24.98	24.58	25.84	29.77	30.12	32.02
5	160	168	171	182	187	190	15.53	13.08	15.09	21.90	23.86	26.25	35.31	35.14	37.45
6	138	139	146	167	181	186	15.33	15.76	15.81	21.87	21.89	23.38	32.92	33.48	34.54
7	158	165	164	179	183	176	16.62	16.18	17.92	29.71	29.10	33.14	37.56	41.29	42.59
8	150	150	152	175	183	187	16.79	18.15	18.19	28.47	29.16	27.42	33.22	36.50	36.02
9	172	174	175	195	201	204	15.25	15.01	16.11	28.60	28.96	29.32	37.97	37.50	38.43
10	150	149	152	171	180	183	17.03	17.96	17.40	32.13	32.19	31.55	37.58	38.16	38.70
11	155	162	161	169	170	177	19.79	20.02	20.39	25.82	26.08	26.08	32.48	34.79	37.05
12	160	162	166	169	178	176	17.57	19.58	18.26	26.29	28.57	27.69	34.28	38.66	36.03
13	165	175	173	185	188	187	14.44	14.38	15.06	31.04	32.01	31.33	38.21	39.88	39.02
14	162	165	167	191	197	198	17.43	17.36	17.36	28.66	27.49	27.22	38.34	41.25	44.00

APPENDIX B

STUDY 2 & 3

- *Subject informed consent statements*
- *Table of activities*
- *The three-day physical activity record*
- *Table of entering data*
- *Physical activity questionnaires*

School of Human movement, Recreation & Performance
Victoria University
PO Box 14428
Melbourne City MC
Melbourne, 8001

VICTORIA UNIVERSITY OF TECHNOLOGY

STANDARD CONSENT FORM FOR SUBJECTS INVOLVED IN EXPERIMENTS

CERTIFICATION BY PARENTS /GUARDIAN OF ADOLESCENT PARTICIPANTS

We would like to invite your son/daughter to be part of our study into identifying physical activity patterns and examining a selection of factors influencing participation in physical activity in adolescents.

I, ...
Parent/guardian of ....
(Address)...Telephone....................

certify that I am the parent/guardian of ....and that I voluntarily give my consent for my son/daughter to participate in the experiment entitled :

"Physical Activity and Fitness of Vietnamese, cultural, environemtnal and socio-economic factors"

being conducted at Victoria University of Technology by :
Professor David Lawson, Mr. Binh B. Chu, and Dr. Geraldine Naughton.

I certify that the objectives of the testing, together with any risks to me associated with the procedures listed hereunder to be carried out in the study, have been fully explained to me by:

Professor David Lawson, Mr. Binh B. Chu, and Dr. Geraldine Naughton.
and that I freely consent to my son/daughter's participation involving the use of these procedures.

Exercise Testing procedures:

Following approval from the Directorate of Education, school councils and parents, the baseline data on each subject that will be obtained includes blood pressure, resting heart rate, height, weight, and skinfold measurement.

In order to assess physical activity levels, participants will be asked to fill in a physical activity record about how active they are over three days (two school days and one weekend day). Types and time spent in activities will be recorded to the nearest 15-min. Participants will be also asked to fill in a questionnaire about what kinds of activities and how many times thay have participated in the past week.

A physical fitness field test will be conducted to measure physical fitness parameters including the following:

- Muscular muscular endurance will be assessed by sit up.
- Muscle power will be assessed by standing long jump and vertical jump.
- Flexibility will be assessed by a sit-and-reach test.

Aerobic fitness will be assessed using a continuous multi-stage shuttles run (beep test). Some participants will be asked to do VO_2 max test (measurement of maximal oxygen consumption) to validate the multi-shuttles run test.

Socio-economic status (SES) of the family unit will be assessed by both interview and questionnaires (about parent's education and occupation.

The procedure of all the tests will be introduced more detail during a meeting of prospective subjects where students will have a chance to ask any question before they agree to participate voluntarily in the study.

There will be no blood test taken and invasive procedures used in this study

Benefits

The subjects will have the benefits of knowing about their general health, physical fitness level, and the opportunity to reflect on their lifestyle physical activity levels. In addition they will be asked to think about and describe any barriers that might be stopping them from doing physical activities.

Risks

There is a small possibility of a feeling dizzy or tired following the shuttle run or $VO_{2\,max}$ test (see the additional sheet). In this situation the researchers will help the subjects to recovery. There will be always at least two researchers who have current First Aid Certificate standing near the student during the test. A familiarisation session with each student will be conducted to assure them of the minimal risks and requirements involved in participation.

I have been informed that the confidentiality of the information I provide will be safeguarded.

Parent/guardian of.................................(participant)

Signed : ....)

Witness other than the experimenter: Date : ....

....

By signing the informed consent form you are indicating that the tests and procedures have been explained to you and are understood by you. Also, it is accepted by the investigators and by yourself that your son/daughter is participating voluntarily in the study and that your son/daughter is free to withdraw from the investigation at any time. It will be also ensured that you will receive documented feedback related to your son/daughter performance.

Thank you for your co-operation.

Any queries about your son/daughter participation in this project may be directed to the researchers:

Professor David Lawson	***Phone: 03-9688 4005***	***Fax: 03-9688 5036***
Mr. Binh B. Chu	***03-9688 4066***	***03-9688 4891***

If you have any queries or complaints about the way you have been treated, you may contact the secretary, University Human Ethics Committee, Victoria University of Technology, PO Box 14428, Melbourne City MC, Melbourne, 8001 (telephone No: 03-9688 4710).

VO_2max Test

All subjects (who participate voluntarily VO_{2max} test) will be given a familiarization period of 5 - 7 minutes with the instrumentation. The subject's $\dot{V}O_2$ and HR were evaluated at rest. Each subject will be then required to undertake an incremental exercise test on a treadmill (QUINTON, Q65, USA) to determine $\dot{V}O_2peak$. Subjects commence walking at 4.0 $km \cdot h^{-1}$. The treadmill speed will be increased by 1.0 $km \cdot h^{-1}$ every 2 minutes until 10.0 $km \cdot h^{-1}$ was reached. The gradient of the platform will be then incrementally increased 2.5% every 2 minutes until the subject reached voluntary exhaustion. Respiratory data will be directly determined every 30 seconds by the Cardiopulmonary Diagnostic System. During these tests, he / she will breathe room air through a mouthpiece so that the amount of oxygen can be analysed through a system. This test will take approximately 20 minutes. $\dot{V}O_2peak$ will be defined as the highest oxygen consumption during a 30 s interval at the peak workrate. Heart rate will be monitored by using the *Polar Vantage NV* (Polar Electro Oy, KEMPELE, Finland).

VIỆN ĐẠI HỌC VICTORIA

BẢN KHAI CHO NHỮNG NGƯỜI TỰ NGUYỆN THAM GIA VÀO CHƯƠNG TRÌNH NGHIÊN CỨU

XÁC NHẬN CỦA CHA ME NHỮNG HOC SINH THAM GIA

Tôi tên là: ....

Cha /mẹ của:...

Địa chỉ:...**Telephone**................

Xác nhận rằng tôi là cha, mẹ / người bảo lãnh của: ....và tôi tự nguyện cho phép con tôi tham gia vào công trình nghiên cứu với tiêu đề:

"Nghiên cứu thể chất của thiếu niên Việt Nam với các yếu tố văn hóa, môi trường và kinh tế xã hội "

Sẽ được tiến hành tại Viện Đại Học Victoria do:
Giáo sư David Lawson, Tiến sĩ Genaldine Naughton, ông Bình Chu Bá.

Tôi thừa nhận rằng các ông bà có tên nêu trên đã cung cấp đày đủ những mục tiêu, cũng như những khả năng có thể xảy ra liên quan đén quá trình tiến hành kiểm tra cho con chúng tôi.
Và tôi tự nguyện cho phép con tôi tham gia vào chương trình đó.

TRƯƠNG TRÌNH KIỂM TRA BAO GỒM CÁC PHẦN SAU:

Sau khi được chấp nhận của sở giáo dục, hội đồng nhà trường va cha mẹ, các chỉ số sẽ được kiểm tra bao gồm cân nặng, chiều cao, nhịp tim, huyết áp, tỉ lệ mỡ dưới da.

Để xác định các hoạt động thể chất hàng ngày, con em qúi vị sẽ được yêu cầu điền vào phiếu phỏng vấn các hoạt động thể chất trong ba ngày (hai ngày trong tuần và một ngày cuối tuần). Các loại hoạt động và thời gian sẽ được ghi lại trong vòng it nhất 15 phút. Các em cũng sẽ được yêu cầu trả lời câu hỏi phỏng vấn về các loại hoạt động nào và bao nhiêu lần mà các em đã tham gia vao trong vòng một tuần trước đó. Một vài em sẽ được yêu cầu đeo đồng hồ đo nhịp tim với một cai đai nhỏ quấn vong quang ngực. Máy đo nhịp tim này để kiểm tra đồ chính xác về loại hình hoạt động mà các em ghi lại.

Thể lực sẽ được kiểm tra theo các phần sau:

- Sức bền của cơ sẽ được đánh giá bằng bài kiểm tra ngồi dậy gập bụng.
- Sức mạnh của cơ sẽ được đánh giá bằng bài kiểm tra bật xa và bật cao tại chỗ.
- Độ dẻo của cơ sẽ được đánh giá bằng bài kiểm tra ngồi gập dẻo.
- Sức bền tim mạnh sẽ được đánh giá bằng bài kiểm tra chạy con thoi (lặp lại hai mươI mét)

Tình trạng kinh tế của gia đình sẽ được đánh giá bằng câu hỏi phỏng vấn về học vấn và nghề nghiệp của cha mẹ.

Học sinh sẽ hoàn toàn không phải lấy máu hoặc tiêm chích bất cứ thứ gì vào người.

ÍCH LỢI CỦA CUỘC KIỂM TRA:

Những học sinh tham gia vào chương trình kiểm tra sẽ được biết về sức khỏe chung, mức độ phát triển thể chất, tỉ lệ của lớp mỡ của cơ thể các em và đây cũng là cơ hội để biết được cách thức hoạt động thể chất trong cuộc sống của các em có phù hợp hay không. Thêm nữa các em sẽ có cơ hội được hỏi để suy nghĩ và miêu tả những gì đã cản trở các em tham gia vào các hoạt động thể chất.

CÁC RỦI RO:

Có thể có trường hợp rất nhỏ là trong lúc chạy hoặc kiểm tra một vài học sinh có thể cảm thấy mệt hoặc chóng mặt. Đây là một trường hợp bình thường và các nhân viên kiểm tra sẽ giúp học sinh hồi phục ngay. Sẽ luôn luôn có ít nhất 2 nhân viên đang có bằng sơ cấp cứu luôn đứng bên cạnh học sinh khi đang kiểm tra. Phần kiểm tra sức khỏe chung và buổi làm quen với dụng cụ trước khi tiến hành kiểm tra sẽ giúp học sinh làm quen với dụng cụ và giảm các rủi ro có thể xảy ra.

Tôi cũng đã được thông báo rằng những thông tin mà tôi cung cấp sẽ được bảo đảm tuyệt đối giữ kín.

Kí tên:................................Là cha, mẹ/ người bảo lãnh của

học sinh:... (người tham gia)

Người làm chứng (không phải là nhân viên kiểm tra) kí tên:..................................

Ngày tháng năm

Khi quí vị đồng ý kí vào bản khai này, có nghĩa rằng quí vị đã được giải thích và hiểu về cuộc kiểm tra. Đồng thời quí vị cũng như những nhân viên tiến hành kiểm tra đều đồng ý rằng con của quí vị hoàn toàn tự nguyện tham gia và có toàn quyền từ bỏ cuộc kiểm tra này bất cứ lúc nào. Quí vị cũng sẽ nhận được kết quả của con em quí vị sau khi thí nghiệm hoàn thành.

Chân thành cảm ơn sự hợp tác của quí vị.

Nếu quí vị cần hỏi bất cứ điều gì liên quan đến cuộc kiểm tra xin liên hệ đến các ông bà có tên sau:

Ông Chu Bá Bình ***03-9688 4066*** ***Fax: 03-96884891***
Giáo sư: David Lawson ***03-9688 4005*** ***03-9688 5036***

Table B1. *The 24-hour recording sheet*

THE MODIFIED THREE-DAY PHYSICAL ACTIVITY RECORD

(this record is only for the research purpose)

Last Name: -------------------------- Day: 1 (Monday... Sat/Sun) Date:____/___/

First name: ------------------------- D.o.B:------------

Note: We are trying to **find out your level of physical activity.** *During 24 hours in each 15-minute box of a hour, please write the main activities that you have carried out during this 15 minutes. If an activity is carried out over a long period for more than 15 minutes (for example, sleeping) you can draw a continuous line in the boxes until such a time when there is a change to other activity (we suggest that you may take a look at the example provided).*

Minute / Hour	0-15	16-30	31-45	46-60
0 am				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

Minute / Hour	0 - 15	16 - 30	31 - 45	46 - 60
12 pm				
13				
14				
15				
16				
17				
18				
19				
20				
21				
22				
23				

Note: Each day is divided into 96 periods of 15-min.

Table B2. *List of activities, energy costs, and conresponding catergorical values*

Activity Code for the Three-Day Physical Activity Record

(Modified from Bouchard et al., 1983)

Category of activity	Example of activity for each category	Approximate energy expenditure (kcal/kg/min)
1	Lying down: - sleeping - resting in bed	0,26
2	Seating: - listening, discussing or revision in class - eating, chatting or resting - writing by hand or tying - reading, listening to the radio or T. V. - working on computer or playing games - taking a bath	0,38
3	Standing light activity: - washing oneself, - combing hair - dusting - pack up for going to school - cooking - packing up clothes - playing music instruments	0,57
4	Slow walking (< 4km/h): - taking a walk (strolling) - taking a shower - driving a car - getting dressed - hanging clothes - going out for breakfast - driving motorcycle	0,69
5	Light manual work: - washing clothes - playing with dog - doing the bed - lab work - painting - riding a moped - ironing - tailor - grass cutting - baker - housework (washing windows, weeping, cleaning. etc) - moderately quick walking (going to school, shopping)	0,84

Category of activity	Example of activity for each category	Approximate energy expenditure (kcal/kg/min)
6	Light sport or leisure activities: - playing ball games - skipping - physical education class - volleyball, table tennis - hand wrestling - rowing, golf - cycling (leisure) - Skateboarding - golf - bowling	1.20
7	Moderate manual work: - working in the farms (transplant, seedling to hoe grass...) - cars and motorcycle washing - repairing a fence - loading bags or boxes - plantation work	1,40
8	Moderate sport or leisure activities of higher intensity (not competitive): - material arts - netball - badminton - canoeing - wrestling - cross- country - cycling (race bike) - brisk walking - gymnastics - dancing - tennis - slow running - spaktacraw - swimming (leisure)	1,50
9	Intense manual work: - working in the farms or factory - felling a tree with an ax - sawing with a hand-saw - cutting tree branches Intense sport or leisure activities: - playing sports in selected teams or special schools for sports - team sports for competitions - soccer - running in a race - swimming - boxing - squash - basketball - hockey - judo - skating	2.0

Note: the table does not comprise all activities that were reported by subjects. When an activity reported by a subject was not on the list, the activity was coded by the closest categorical value. For example, out dooor informal games was categorised No 6.

EXAMPLE FOR RECORDING THE MODIFIED DAILY PHYSICAL ACTIVITIES

(this record is only for the research purpose)

Last Name:..... Le.............. **Day: 1 (Tuesday)** **Date:** __25 / 04/ 00__

First name: .....Karen......

Note: We are trying to **find out your level of physical activity.** *During 24 hours in each 15 minute box of a hour, please write the main activities that you have carried out during this 15 minutes. If an activity is carried out over a long period for more than 15 minutes (for example, sleeping) you can draw a continuous line in the boxes until such a time when there is a change to other activity.*

Minute / Hour	0-15	16-30	31-45	46-60
0 am	Sleeping	———	———	———
1	———	———	———	———
2	———	———	———	———
3	———	———	———	———
4	———	———	———	———
5	———	———	———	———
6	———	———	———	———
7	Wake up & brush teeth	Have break fast & Make my lunch for school	Get my bage ready & do my hair	Wake my brother up & make his break fast
8	Leave home & walk to the bus stop	Arrive at school & walk to the class	Catch up on gossip with friends	Start class: study English
9	———	———	———	———
10	———	Recess: walk & talk with my best friend	———	Start class: Physical education
11	Play netball	———	———	Class: economics

Minute / Hour	0 - 15	16 - 30	31 - 45	46 - 60
12 pm				Eat lunch
13		Play games with my friends	Dancing & singing with my group	Start class: mathematics
14				
15	Leave school & get on the bus	Walk home & unpack my bage	Watch TV	Walk to my friend house
16	Study (home work)		Walk home & help my mum With house chores	Do washing & ironing
17	Prepare tea with mum	Help my brother with his home work	Eat dinner tea	Listen to music
18	Play keyboard & learn new song	Watch TV		
19	Clearn up the kitchen	Go to mum's friends' house by her car	Seating & talking	
20			Go back home & pack up clothes	Watch TV
21		Brush my teeth & take a shower	Go to bed sleeping	
22				
23				

EXAMPLE FOR CODING ACTIVITIES CARRIED OUT BY THE SUBJECT

(undertaken by the researcher & asistant)

DAY : (1)

Last name: Le

First name: Karen

In each box, write the number which consponds to the activity which the participant has filled on his/her physical activity record during this 15 min period. Please consult the activity code (category of activity) that follows to Establish the proper coding.

Minute / Hour	0-15	16-30	31-45	46-60
0 am	1	------------	------------	------------
1	------------	------------	------------	------------
2	------------	------------	------------	------------
3	------------	------------	------------	------------
4	------------	------------	------------	------------
5	------------	------------	------------	------------
6	------------	------------	------------	------------
7	3	2	3	------------
8	4	------------	2	2-ST
9	------------	------------	------------	------------
10	------------	4	------------	6
11	8	------------	------------	2-ST
12 pm	------------	------------	------------	2
13	------------	6	8	2-ST
14	------------	------------	------------	------------
15	4	------------	2-TV	4
16	2-ST	------------	4	5
17	3	2	------------	------------
18	2	2-TV	------------	------------
19	3	3	2	------------
20	------------	------------	3	2-TV
21	------------	4	1	------------
22	------------	------------	------------	------------
23	------------	------------	------------	------------

2-ST denotes coding No 2 studying; 2-TV denotes coding No 2 watching TV

Table B3. *Entering Data: EE Estimation for Day 1(AV student)*

Category	1	2	2-ST	2-TV	3	4	5	6	7	8	9	Total/day
Hours	*9.50*	*3.00*	*4.25*	*1.50*	*1.75*	*2.25*	*0.25*	*Total 6 - 9 (MVPA)* *1.50*				***24.0 hr***
n x 15-min =	38	12	17	6	7	9	1	2		4		**96**
	x	x	x	x	x	x	x	x		x		
kcal/kg/15 min	0.26	0.38	0.38	0.38	0.57	0.69	0.84	1.2	1.4	1.5	2.0	
Daily EE (kcal/kg) =	9.88	4.56	6.46	2.28	3.99	6.21	0.84	2.40	0.0	6.0	0.0	**= 42.62** $kcal \cdot kg \cdot d^{-1}$
BM of individual = 46.0 kg → Total daily EE = 46.0kg x 42.62 = **1960.52** ($kcal \cdot d^{-1}$) expended for Day 1												

2-ST denotes coding No 2 studying; 2-TV denotes coding No 2 watching TV; categories 6 - 9 = MVPA = moderate to vigorous PA

Example: EE expended for category 1 (9.50 hrs) = 38 15-min periods x 0.26 kcal/kg/15 min = 9.88 $kcal \cdot kg \cdot d^{-1}$

Table of activities, energy costs, and conresponding catergorical values in Vietnamese

MÃ SỐ CÁC LOẠI HÌNH HOẠT ĐỘNG ĐƯỢC GHI LẠI TRONG BA NGÀY

(dựa theo bảng mẫu của Bouchard, 1983)

Phân các hoạt động theo mã số	Ví dụ những loại hình hoạt động cho mỗi nhóm	Dự báo năng lượng tiêu hao (kcal/kg/15 phút)
1	Nằm: - ngủ, nghỉ trên giường - nằm trên giường	0,26
2	Ngồi: - trong lớp học, ngồi chơi ở nhà - tự học, truy bài - ăn hoặc ngồi chơi nói chuyện - viết hoạc đánh máy - đọc sách báo, truyện - nge nhạc, xem T.V, video, và chơi games - đánh máy vi tính - tắm bồn	0,38
3	Đứng: hoạt động loại nhẹ: - thu, gấp quần áo - cạo râu, chải đầu, đánh răng, rửa mặt, - rửa tay chân - nấu cơm, rửa bát đĩa, rau... - phủi bụi, - chuẩn bị sách vở đi học - chơi chuyền, cờ - tập đàn	0,57
4	- Mặc quần áo, giặt quần áo bằng máy, phơi quần áo - Tắm rửa (tắm vòi hoặc tắm giếng) - đi ăn sáng, trông em - đi đổ rác, chơi ở nhà (có thể đứng hoặc đi lại) - đi bộ (đi dạo) - Lái xe, ngồi xe máy - xếp hàng vào lớp	0,69
5	Lao động chân tay cường độ nhẹ: - chơi đùa, tập thể dục toàn trường, kê bàn ghế - Việc nhà (giặt rũ, dọn dẹp nhà, lau cửa sổ, quét nhà, lau nhà, tưới cây, bơm nước...) - trực nhật - thợ mộc, may, thợ nề - làm bánh mì - chặt cây, in ấn - làm thí nghiệm - đóng giầy, là quần áo - chăn nuôi, cơ khí - dọn giường, lau chùi, sơn - tập nghi thức đội - đi bộ bình thường (đi học, đi chợ, đưa đón em...) - đạp xe đến trường, đón em và giúp cha mẹ việc nhà	0,84

Phân các hoạt động theo mã số	**Ví dụ những loại hình hoạt động cho mỗi nhóm**	**Dự báo năng lượng tiêu hao (kcal/kg/15 phút)**
6	Hoạt động thể thao, giải trí cường độ nhẹ (chơi vui): - chạy nhẩy ngoài sân, nhẩy dây, chạy TD sáng - học giờ thể dục, - bóng chuyền, bóng bàn, vật tay, chơi bi-a... - đua ca nô loại nhẹ - đánh gôn, chơi bóng ngựa, đá cầu, cầu lông không có lưới - thuyền buồm, đua thuyền - bóng chày (trừ cầu thủ vụt bóng)	1.20
7	Lao động chân tay cường độ trung bình: - làm việc nhẹ ngoài đồng ruộng (nhặt cỏ, sới rau, gánh nước...) - thợ máy (ngành xây dựng) - chữa hàng rào - đóng hộp - công việc trồng trọt - lao động lâm nghiệp (cưa máy & xếp gỗ)	1,40
8	Hoạt động thể thao, giải trí cường độ trung bình: - cầu lông, - chơi các môn bóng - vật võ - chạy dài - ca nô - đi bộ thể thao - đua xe đạp - bơi lội - dancing - thể dục dụng cụ - tennis - trượt tuyết giải trí - bóng chày (người giao bóng)	1,50
9	lao động nặng: - chặt cây bằng rìu - xẻ gỗ - làm đồng với cào và liềm - chặt cành cây - gánh lúa, gánh phân Hoạt động thể thao, cường độ cao (trong các đội tuyển thể thao, trường năng khiếu...): - các môn bóng - chạy trên đường đua - quyền anh - juđo - khúc côn cầu - trượt băng - leo núi - bóng đá - chạy việt dã nhanh	2.0

Note: bảng mẫu không bao gồm tất cả các hoạt động mà học sinh đã khai. Khi học sinh khai một hoạt động mà không nằm trong bảng này, hoạt động đó sẽ được xếp vào mã số của những hoạt động có chỉ số calo tieu thụ gần nhất với hoạt động đó.

Example for recording daily activities in Vietnamese

BẢNG GHI CÁC HOẠT ĐỘNG HÀNG NGÀY CỦA CÁ NHÂN

(bản khai này chỉ dùng cho mục đích nghiêu cứu)

Họ và tên: Quang Hưng **Ngày thứ: 1 (thứ tư)** **Vào ngày:** __**10/ 02 / 00**__

Ghi chú: Để có thể biết được **mức độ hoạt động thể chất của bạn**, *trong mỗi ô hãy ghi lại tất cả các loại hoạt động mà bạn đã làm trong 15 phút đó. Nếu một hoạt động được tiến hành trong một thời gian dài (ví dụ như ngủ), bạn có thể kẻ một đường thẳng dọc theo các ô tới thời điểm bạn đổi sang hoạt động khác.*

Minute / Hour	0-15	16-30	31-45	46-60
0 am	Ngủ	______	______	______
1	______	______	______	______
2	______	______	______	______
3	______	______	______	______
4	______	______	______	______
5	______	______	______	______
6	Ngủ dậy và đánh răng	ăn sáng và chuẩn bị túi đi học	đi bộ đến trường	đến trường và truy bài dưới sân
7	Truy bài rồi đi lên lớp	Ngồi học trong lớp	______	______
8	______	______	______	Ra chơi: tập thể dục dưới sân
9	______	Ngồi học trong lớp	______	______
10	______	______	Tập nghi thức đội	______
11	Ngồi học trong lớp	______	______	______

Minute / Hour	0 - 15	16 - 30	31 - 45	46 - 60
12 pm	Đi bộ về nhà	Xem TV với em		
13		Ăn cơm trưa	Rửa bát	Dọn dẹp nhà cửa
14		Đi bộ đưa em đi học	Đi học thêm bằng xe đạp	Chơi đùa dưới sân
15	Ngồi vào lớp học			
16			Về nhà bằng xe đạp	Xem TV
17		Đi đón em về	Đi đánh bóng bàn	
18			Đi tắm	Xem TV
19		Ăn cơm tối		Rửa bát
20	Tự học bài			
21				
22			Xem TV	
23	Đi ngủ			

BẢN MẪU

GHI CÁC SỐ PHẢN ÁNH HOẠT ĐỘNG THỂ CHẤT HÀNG NGÀY CỦA CÁ NHÂN

ngày thứ: nhất

Họ tên: Quang Hưng

Trong mỗi ô hãy viết mã số phản ánh loại hoạt động mà bạn đã tiến hành trong 15' đó Hãy dựa vào bảng ghi các loại hoạt động đã được đánh số (bảng mẫu).

Nếu một hoạt động được tiến hành trong thời gian dài (ví dụ như ngủ) bạn có thể kẻ một đường thẳng dọc theo các ô tới thời điểm đổi sang hoạt động khác.

Giờ \ Phút	0-15	16-30	31-45	46-60
0 am	1	---------	---------	---------
1	---------	---------	---------	---------
2	---------	---------	---------	---------
3	---------	---------	---------	---------
4	---------	---------	---------	---------
5	---------	---------	---------	---------
6	3	2	5	3
7	---------	2-ST	---------	---------
8	---------	---------	---------	5
9	---------	2-ST	---------	---------
10	---------	---------	5	---------
11	2-ST	---------	---------	---------
12 pm	5	2-TV	---------	---------
13	---------	2	3	5
14	---------	---------	---------	6
15	2-ST	---------	---------	---------
16	---------	---------	5	2-TV
17	---------	5	6	---------
18	---------	---------	4	2-TV
19	---------	2	---------	3
20	2-ST	---------	---------	---------
21	---------	---------	---------	---------
22	---------	---------	2-TV	---------
23	1	---------	---------	---------

Table B4. *Entering Data: example of EE Estimation for Day 1 (VN student)*

Category	1	2	2-ST	2-TV	3	4	5	6	7	8	9	Sum
								Total 6 - 9 (MVPA)				
Hours	*7.00*	*1.00*	*7.75*	*2.50*	*1.25*	*0.25*	*3.00*	*1.25*				***24.0 hr***
n x 15-min =	28	4	31	10	5	1	12	5				**96**
	x	x	x	x	x	x	x	x				
kcal/kg/15 min	0.26	0.38	0.38	0.38	0.57	0.69	0.84	1.2	1.4	1.5	2.0	
Daily EE (kcal/kg) =	7.28	1.52	11.8	3.80	2.85	0.69	10.08	6.00	0.00	0.00	0.00	**= 44.00** kcal·kg·d^{-1}

BM of individual = 40.0 kg → Total daily EE = 40.0kg x 44.0 = **1760.00** (kcal·d^{-1}) expended for Day 1

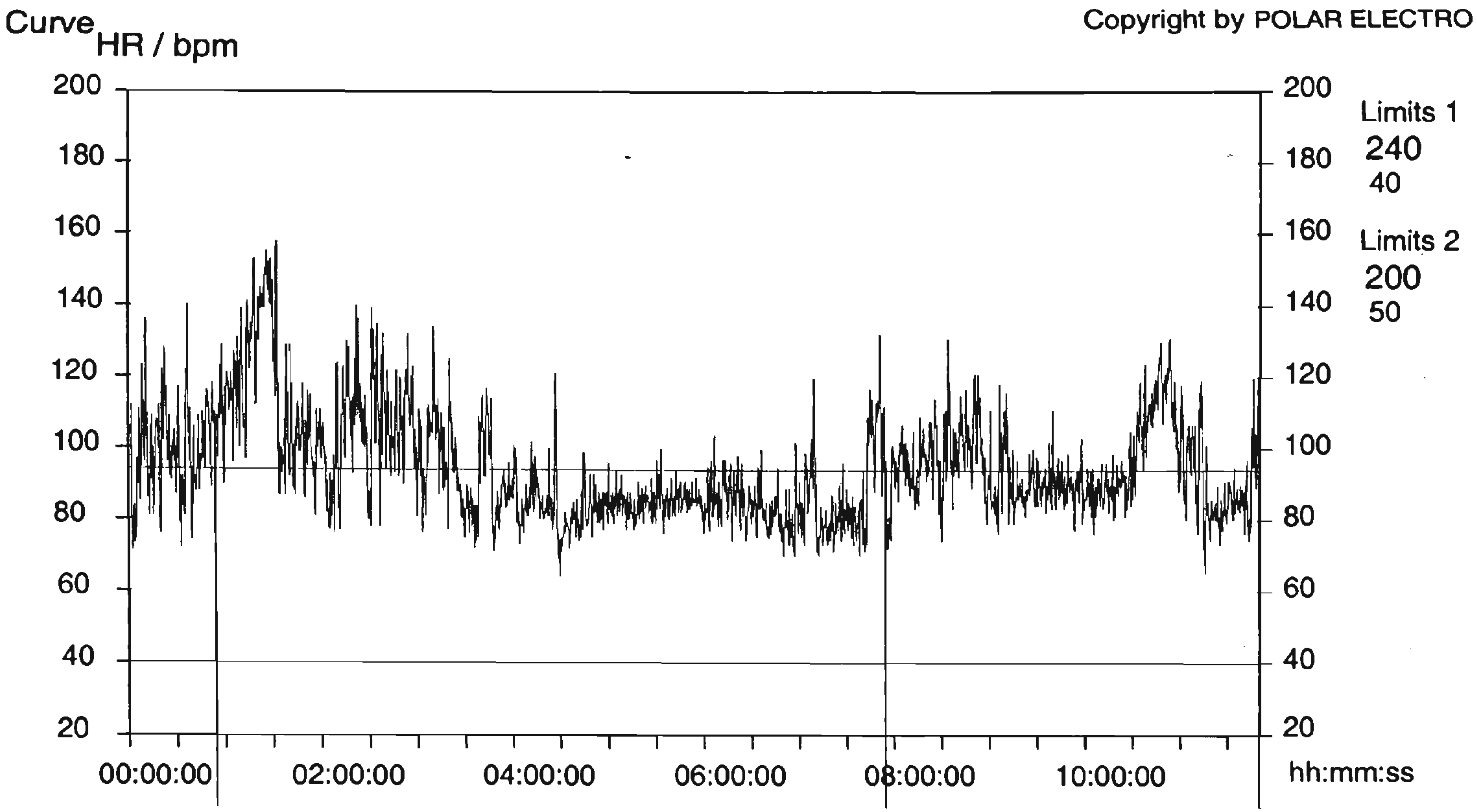
2-ST denotes coding No 2 studying; 2-TV denotes coding No 2 watching TV; categories 6 - 9 = MVPA = moderate to vigorious PA

Example: EE expended for category 1 (7.0 hrs) = 28 15-min periods x 0.26 kcal/kg/15 min = 7.28 kcal·kg·d^{-1}

Table B5.4. *The averaged hours for each category of activities that students spent for a day during weekday and weekend days*

			Average of hours spent in each category for a day												
Time-Hours	Age group	N	1	sd	2	sd	3	sd	4	sd	5	sd	6 - 9	sd	Total
WEEKDAY															
	12	32	8.6	0.9	10.9	1.5	1.3	0.9	0.6	0.6	1.8	1.0	0.8	0.8	24.0
Male	13	35	8.1	0.8	10.7	1.5	1.7	0.6	0.8	0.6	2.1	0.8	0.6	0.7	24.0
	14	15	8.3	1.1	10.9	1.2	1.5	0.6	0.9	0.3	1.5	1.0	1.0	0.5	24.0
	12	33	8.6	0.9	10.7	1.2	2.0	0.7	0.7	0.6	1.5	0.5	0.5	0.8	24.0
Female	13	48	7.9	0.8	10.7	1.3	2.1	0.7	0.8	0.5	2.1	0.8	0.4	0.4	24.0
	14	18	8.5	0.6	10.7	1.6	1.8	0.7	0.9	0.7	1.8	1.1	0.3	0.7	24.0
WEEKEND DAY															
	12	32	9.7	1.5	9.4	2.1	1.6	1.0	0.8	0.7	1.5	1.4	1.1	1.2	24.0
Male	13	35	9.6	1.2	7.1	1.7	2.6	1.6	1.7	1.5	1.0	1.0	1.9	1.1	24.0
	14	15	9.3	1.2	8.9	2.0	1.7	0.5	0.8	0.7	1.5	0.9	1.8	0.8	24.0
	12	33	9.3	1.1	9.1	1.7	2.5	1.1	1.0	1.0	1.5	1.1	0.5	0.5	24.0
Female	13	48	9.8	1.1	7.6	2.1	3.2	1.9	1.0	1.2	1.4	1.1	1.0	1.1	24.0
	14	18	9.3	0.9	8.2	2.0	2.4	1.3	1.2	1.0	2.0	1.1	0.9	1.0	24.0

1= sleep or rest in bed; 2 = sitting activities; 3 = light standing activities; 4 = slow walking; 5 = light manual work; categories from 6 to 9 = MVPA.



Person	A 14-yr old girl	Day	1	Average	94	Recovery	0
Exercise	Daily physical activity	Time	6:11:23	Duration of exercise: 11:50:05.2			
Note							

Figure B1. *A typical plot of 12-hour waking period monitored minute-by-minute heart rate record*

ACTIVITY QUESTIONNAIRE

(These questionnaires are only for research purposes)

Name: ______________________ Sex: M / F Age: ______

Grade: ________ School: _________________________ Date: / /

We are trying to find out your level of physical activity. This includes sports or dance that make your legs feel tired, or games that makes you breath heard, like tag, skipping, running, climbing and others.

Remember:

- This is a survey and not a test.
- Please answer all the questions as honestly and accurately as you can - this is very important

---

1. Have you done any of the following physical activities over the past week (for more than 15 minutes), including activities done at school, after school, at home, and on weekends? If yes, how many times?

Activity	None	1-2	3-4	5 or more
Walking for transport . . .	( )	( )	( )	( )
Walking for exercise . . .	( )	( )	( )	( )
Skipping . . .	( )	( )	( )	( )
Rowing/Canoeing . . .	( )	( )	( )	( )
Roller blading . . .	( )	( )	( )	( )
Tag/Chasey . . .	( )	( )	( )	( )
Callisthenics . . .	( )	( )	( )	( )
Bicycling . . .	( )	( )	( )	( )
Jogging or running . . .	( )	( )	( )	( )
Aerobics . . .	( )	( )	( )	( )
Gymnastics . . .	( )	( )	( )	( )
Dance . . .	( )	( )	( )	( )
Swimming . . .	( )	( )	( )	( )
Baseball, softball . . .	( )	( )	( )	( )
Football . . .	( )	( )	( )	( )
Soccer . . .	( )	( )	( )	( )
Badminton . . .	( )	( )	( )	( )
Skateboarding . . .	( )	( )	( )	( )
Grass hockey . . .	( )	( )	( )	( )
Volleyball . . .	( )	( )	( )	( )
Netball . . .	( )	( )	( )	( )
Floor hockey . . .	( )	( )	( )	( )
Basketball . . .	( )	( )	( )	( )
Table tennis . . .	( )	( )	( )	( )
Lacrosse . . .	( )	( )	( )	( )
Cricket . . .	( )	( )	( )	( )
Tennis . . .	( )	( )	( )	( )

Activity	None	1-2	3-4	5 or more
Martial arts . . .	( )	( )	( )	( )
Judo . . .	( )	( )	( )	( )
Karate . . .	( )	( )	( )	( )
Wrestling . . .	( )	( )	( )	( )
Other				
______________________________.	( )	( )	( )	( )
______________________________.	( )	( )	( )	( )
______________________________.	( )	( )	( )	( )
______________________________.	( )	( )	( )	( )

2. In the last 7 days, during YOUR PHYSICAL EDUCATION classes, how often were you very active (playing hard, running, jumping, throwing)?

Tick one X only

- I didn't do PE . . . . . . ( )
- Hardly ever . . . . . . ( )
- Sometimes . . . . . . ( )
- Quite often . . . . . . ( )
- Always . . . . . . ( )

3. **In the last 7 days, what did you do most of the time at <u>RECESS</u>?**

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

4. **In the last 7 days, on how many days <u>RIGHT AFTER SCHOOL</u>, did you do sports, danced, or played games?**

Tick one X only

- None . . . . ( )
- 1 time last week . . . . ( )
- 2 - 3 time last week . . . . ( )
- 4 time last week . . . . ( )
- 5 time last week . . . . ( )

5. **<u>On WEEKENDS</u>, how often did you do sports, danced, played games or other activities (for example: excursion, picnic...) in which you were active?**

Tick one X only

- Never . . . . . . ( )
- Hardly ever . . . . . . ( )
- Sometimes . . . . . . ( )
- Quite often . . . . . . ( )
- Always . . . . . . ( )

If on weekends, you never or hardly ever do sports, what **did you usually do?**

____

6. **What is your parents' education?**

	Father	Mother
Did not go to school	( )	( )
Complete primary school	( )	( )
Complete secondary school	( )	( )
College/TAFE	( )	( )
University/Master, PhD	( )	( )

Coment: ----------------------------- -------------------------

7. **What is your parents' occupation?**

Father: ____

Mother: ____

Thank you for helping us to find out your physical activity level

CÂU HỎI PHỎNG VẤN VỀ HOẠT ĐỘNG THỂ CHẤT

(những câu hỏi này chỉ phục vụ cho nghiêu cứu khoa học)

Họ và tên: ______________________ Giới tính: nam/nữ Tuổi: ______

Lớp: ________ Trường: ____________________________ Ngày: / /

Chúng tôi đang cố gắng xác định mức độ hoạt động thể chất của bạn. Bao gồm các môn thể thao hoặc khiêu vũ làm cho bạn cảm thấy mệt hoặc các trò chơi mà làm cho bạn thở gấp như nhẩy dây, chạy, leo chèo và vân vân.

Bạn nên biết:

- Đây là nghiên cứu kh chứ không phải cuộc kiểm tra.
- Xin hãy trả lời một cách trung thực và đầy đủ - đây là điều rất cần thiết.

---

8. **Trong bẩy ngày tuần trước em có tham các hoạt động thể chất và thể thao dưới đây (mỗi lần từ 15 phút trở lên) bao gồm ở trường, ngoài giờ học, ở nhà và ngay nghỉ không? Nếu có thì bao nhiêu lần.**

Tên hoạt động	không	1-2	3-4	5 lần hoặc hơn
Đi bộ . . .	( )	( )	( )	( )
Đạp xe . . .	( )	( )	( )	( )
Nhẩy dây . . .	( )	( )	( )	( )
Bơi lội . . .	( )	( )	( )	( )
Bóng bàn . . .	( )	( )	( )	( )
Thể dục dụng cụ . . .	( )	( )	( )	( )
Bóng chuyền . . .	( )	( )	( )	( )
Cầu lông . . .	( )	( )	( )	( )
Chạy . . .	( )	( )	( )	( )
Cầu chinh . . .	( )	( )	( )	( )
Trượt ba-tanh . . .	( )	( )	( )	( )
Đánh gôn . . .	( )	( )	( )	( )
Chơi trò chơi . . .	( )	( )	( )	( )
Quần vợt . . .	( )	( )	( )	( )
Khiêu vũ . . .	( )	( )	( )	( )
Chạy việt dã . . .	( )	( )	( )	( )
Cầu mây . . .	( )	( )	( )	( )
Tập võ . . .	( )	( )	( )	( )
Tập vật . . .	( )	( )	( )	( )
Ju-đô . . .	( )	( )	( )	( )
Ka-ra-te . . .	( )	( )	( )	( )
Tây-côn-đô . . .	( )	( )	( )	( )
Thể dục nhiệp điệu . . .	( )	( )	( )	( )
Chơi cờ . . .	( )	( )	( )	( )
Đua xe đạp . . .	( )	( )	( )	( )
Bóng đá . . .	( )	( )	( )	( )
Bóng rổ . . .	( )	( )	( )	( )
Quyền anh . . .	( )	( )	( )	( )
Bóng ném . . .	( )	( )	( )	( )
Thể dục thể hình . . .	( )	( )	( )	( )
Chơi chuyền . . .	( )	( )	( )	( )

<u>Tên hoạt động</u>	Không	1-2	3-4	5 lần hoặc hơn
Các hoạt động khác:				
______________________.	( )	( )	( )	( )
______________________.	( )	( )	( )	( )
______________________.	( )	( )	( )	( )
______________________.	( )	( )	( )	( )

9. Trong những GIỜ HỌC THỂ DỤC tuần trước em đã tham gia tập luyện như thế nào (tập rất mệt, chạy, nhẩy, và ném)?

Chỉ đánh dấu một lần

Em không tham gia . . . . . . ( )
Rất it tập . . . . . . ( )
Thỉng thoảng . . . . . . ( )
Thường xuyên . . . . . . ( )
Luôn tập mệt . . . . . . ( )

10. Trong bẩy ngày tuần trước, em thường làm gì <u>TRONG LÚC RA CHƠI</u>?

Ngồi chơi (nói chuyện, đọc sách, làm baig tập) . . ( )
Đứng hoặc đi bộ loanh quanh . . . . ( )
Chạy hoặc chơi trò chơi một chút . . . . ( )
Chạy hoặc chơi trò chơi nhiều . . . . ( )
Chạy nhẩy hoặc chơi trò chơi phần lớn thời gian. . . ( )

11. Trong bẩy ngày tuần trước, <u>SAU KHI TAN HOC VỀ</u> em thường chơi thể thao, khiêu vũ, hoặc trò chơi bao nhiêu ngày?

Chỉ đánh dấu một lần

Không lần nào . . . . . . ( )
Một lần trong tuần . . . . . . ( )
2 — 3 lần trong tuần . . . . . . ( )
4 lần trong tuần . . . . . . ( )
5 lần trong tuần . . . . . . ( )

12. <u>VÀO NGÀY NGHỈ CUỐI TUẦN</u>, em có tham các hoạt động thể thao, khiêu vũ, chơi trò chơi hoặc đi tham quan mà làm cho em thấm mệt không?

Chỉ đánh dấu một lần

Không bao giờ . . . . . . ( )
Rất hiếm khi . . . . . . ( )
Thỉng thoảng . . . . . . ( )
Thường xuyên . . . . . . ( )
Tuần nào cũng có . . . . . . ( )

Nếu không bao giờ hoặc hiếm khi tham gia hoạt động thể thao, thì em thường làm gì ?

____

13. **Trình độ văn hóa của bố mẹ em như thế nào?**

	Bố	Mẹ
Không đi học	( )	( )
Học hết cấp một	( )	( )
Học hết cấp hai	( )	( )
Học hết cấp ba	( )	( )
Cao đẳng/Đại học, trên đại học	( )	( )
Giải thích:	----------------------------	--------------------------

14. **Ngề nghiệp của bố mẹ em là gì?**

Của bố: ____

Của mẹ: ____

Xin cảm ơn bạn đã giúp đỡ chúng tôi tìm hiểu mức độ hoạt động thể chất của bạn

APPENDIX C

STUDIES 2 & 3

- Raw data

WEEKDAY I							CATEGORY								Total 15-min		HOURS				
VN-GROUP	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
1	F	12	25.0	43	2	23	10	11	4	3					96	10.75	5.75	2.50	0.00	36.0	900.8
2	F	12	35.0	36	6	31	12	5	0	6					96	9.00	7.75	3.00	0.00	35.9	1255.5
3	F	12	26.0	32	6	28	4	17	3	6					96	8.00	7.00	1.00	0.00	39.6	1028.6
4	F	12	32.0	29	3	32	9	11	6	6					96	7.25	8.00	2.25	0.00	39.7	1270.7
5	F	12	41.0	33	6	30	7	14	1	5					96	8.25	7.50	1.75	0.00	37.8	1549.4
6	F	12	35.0	40	4	22	10	10	3	7					96	10.00	5.50	2.50	0.00	37.7	1320.6
7	F	12	51.0	35	7	32	9	5	1	7					96	8.75	8.00	2.25	0.00	36.8	1874.8
8	F	12	27.5	40	3	29	7	12	1	4					96	10.00	7.25	1.75	0.00	36.1	993.0
9	F	12	26.0	35	3	32	6	10	3	7					96	8.75	8.00	1.50	0.00	38.3	996.6
10	F	12	32.0	36	3	32	4	12	4	5					96	9.00	8.00	1.00	0.00	38.0	1215.4
11	F	12	32.0	35	7	34	4	11		5					96	8.75	8.50	1.00	0.00	36.7	1173.4
12	F	12	24.0	33	5	37	2	12	1	6					96	8.25	9.25	0.50	0.00	37.9	908.9
13	F	12	28.0	34	6	36	2	9	1	8					96	8.50	9.00	0.50	0.00	38.1	1066.8
14	F	12	35.0	34	6	37	1	7	3	8					96	8.50	9.25	0.25	0.00	38.3	1341.9
15	F	12	31.0	28	4	28	19	11		6					96	7.00	7.00	4.75	0.00	38.0	1177.1
16	F	12	32.0	32	7	34	4	14	3	2					96	8.00	8.50	1.00	0.00	37.2	1188.8
17	F	12	35.0	35	3	29	16	9		4					96	8.75	7.25	4.00	0.00	35.8	1254.1
18	F	12	35.0	39	8	26	11	3	2	7					96	9.75	6.50	2.75	0.00	36.2	1267.4
19	F	12	34.0	25	5	25	9	5	9	11	4		3		96	6.25	6.25	2.25	1.75	48.9	1663.3
20	F	12	25.5	32	3	38	8	6		6	3				96	8.00	9.50	2.00	0.75	39.0	994.5
21	F	12	36.0	33	4	40	4	4	3	5	2		1		96	8.25	10.00	1.00	0.75	39.3	1413.7
22	F	12	35.0	28	9	38	1	3	6	10			1		96	7.00	9.50	0.25	0.25	41.3	1444.5
23	F	12	41.0	32	2	26	11	6	9	7	3				96	8.00	6.50	2.75	0.75	42.3	1732.3
24	F	12	25.0	40	4	27	7	5	2	5	4		2		96	10.00	6.75	1.75	1.50	41.1	1026.8
25	F	12	32.0	30	6	30	17	4		8	1				96	7.50	7.50	4.25	0.25	38.1	1220.5
26	F	12	31.0	24	5	26	14	6	1	11	9				96	6.00	6.50	3.50	2.25	47.5	1472.2
27	F	12	21.5	34	7	31	3	8	1	11			1		96	8.50	7.75	0.75	0.25	40.4	868.8
28	F	12	39.0	36	3	31	15	2	1	6	2				96	9.00	7.75	3.75	0.50	37.3	1452.8
29	F	12	38.0	29	8	26	15	7	2	8	1				96	7.25	6.50	3.75	0.25	39.5	1499.1
30	F	12	37.0	40	4	18	4	7	11	12					96	10.00	4.50	1.00	0.00	41.9	1551.8
31	F	12	42.5	27	7	42	4	8	2	4	2				96	6.75	10.50	1.00	0.50	38.9	1651.6
32	F	12	30.0	35	3	28	10	8	4	2	6				96	8.75	7.00	2.50	1.50	40.9	1226.4
33	F	12	35.0	33	7	36	9	4	1	6					96	8.25	9.00	2.25	0.00	36.4	1272.3
34	F	13	28.0	33	6	36	2	8	2	9					96	8.25	9.00	0.50	0.00	38.8	1086.4
35	F	13	33.0	35	3	28	11	12	1	6					96	8.75	7.00	2.75	0.00	37.6	1241.8
36	F	13	34.0	34	6	37	1	7	3	8					96	8.50	9.25	0.25	0.00	38.3	1303.6
37	F	13	32.0	29	5	25	21	8	4	4					96	7.25	6.25	5.25	0.00	37.6	1203.2
38	F	13	31.0	34	3	36	6	7		8	2				96	8.50	9.00	1.50	0.50	39.1	1210.6
39	F	13	35.0	30	4	23	13	13	4	9					96	7.50	5.75	3.25	0.00	40.7	1425.6
40	F	13	33.0	29	3	36	12	1	5	10					96	7.25	9.00	3.00	0.00	39.3	1298.2
41	F	13	27.0	36	2	30	4	12	3	5			4		96	9.00	7.50	1.00	1.00	42.2	1138.1
42	F	13	36.0	34	4	28	5	5	13	7					96	8.50	7.00	1.25	0.00	40.6	1461.6
43	F	13	29.0	37	3	32	8	9		5	2				96	9.25	8.00	2.00	0.50	37.7	1093.0
44	F	13	34.0	38	2	27	9	8	1	11					96	9.50	6.75	2.25	0.00	38.8	1319.5
45	F	13	41.0	39	1	26	9	9	1	11					96	9.75	6.50	2.25	0.00	38.9	1594.1
46	F	13	27.0	31	5	41	7	5	1	6					96	7.75	10.25	1.75	0.00	36.8	993.1
47	F	13	46.0	34	5	24	12	9	3	7	2				96	8.50	6.00	3.00	0.50	39.9	1835.4
48	F	13	37.0	32	2	37	11	4	1	5	4				96	8.00	9.25	2.75	1.00	39.3	1453.7

WEEKDAY I				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	$kcal\,kg^{-1}d^{-1}$	Total $kcal\,d^{-1}$
49	F	13	35.0	31	6	31	7	8		8	5				96	7.75	7.75	1.75	1.25	42.1	1472.1
50	F	13	26.0	31	6	31	6	8		9	5				96	7.75	7.75	1.50	1.25	42.5	1105.5
51	F	13	37.0	34	3	29	13	9	4	4					96	8.50	7.25	3.25	0.00	37.2	1376.0
52	F	13	30.0	34	5	24	10	11	4	7			1		96	8.50	6.00	2.50	0.25	40.1	1202.1
53	F	13	36.5	32	3	32	8	7	2	12					96	8.00	8.00	2.00	0.00	40.1	1464.0
54	F	13	29.0	31	4	31	12	4	3	9	2				96	7.75	7.75	3.00	0.50	40.2	1166.7
55	F	13	42.0	35	4	26	11	5	4	7	4				96	8.75	6.50	2.75	1.00	41.0	1720.7
56	F	13	36.0	26	4	43	4	10	3	5	1				96	6.50	10.75	1.00	0.25	39.3	1415.2
57	F	13	26.0	35	4	40	4	7		6					96	8.75	10.00	1.00	0.00	36.4	945.6
58	F	13	27.0	36	3	38		4	3	12					96	9.00	9.50	0.00	0.00	39.4	1063.0
59	F	13	30.0	28	5	35	10	9	1	8					96	7.00	8.75	2.50	0.00	38.8	1164.6
60	F	13	24.5	24	2	43	4	12	3	5			3		96	6.00	10.75	1.00	0.75	42.5	1040.5
61	F	13	43.0	31	5	30	7	6	6	8	3				96	7.75	7.50	1.75	0.75	41.9	1801.7
62	F	13	35.0	29	4	32	6	9	1	11	4				96	7.25	8.00	1.50	1.00	43.4	1517.6
63	F	13	41.0	28	6	38	4	6	4	4	3		3		96	7.00	9.50	1.00	1.50	43.2	1769.6
64	F	13	36.0	26	8	31	4	14	8	5					96	6.50	7.75	1.00	0.00	40.8	1468.8
65	F	13	37.0	31	2	32	10	5	3	9	4				96	7.75	8.00	2.50	1.00	42.1	1556.2
66	F	13	36.0	26	15	32	3	4	8	4			4		96	6.50	8.00	0.75	1.00	42.9	1545.1
67	F	13	41.0	29	4	29	5	14	9	6					96	7.25	7.25	1.25	0.00	41.2	1689.6
68	F	13	33.0	34	16	28	4	4	7	3					96	8.50	7.00	1.00	0.00	36.7	1211.4
69	F	13	42.0	31	6	33	6	13	2	5					96	7.75	8.25	1.50	0.00	38.2	1602.3
70	F	13	44.0	35	12	29	10	6	1	3					96	8.75	7.25	2.50	0.00	35.1	1544.8
71	F	13	36.0	32	8	26	11	4	4	9	2				96	8.00	6.50	2.75	0.50	40.4	1455.1
72	F	13	44.5	31	17	26	8	10	1	3					96	7.75	6.50	2.00	0.00	36.4	1613.9
73	F	13	34.0	28	8	32	1	9	7	11					96	7.00	8.00	0.25	0.00	42.1	1430.0
74	F	13	44.0	32	9	31	10	10	1	3					96	8.00	7.75	2.50	0.00	36.2	1594.1
75	F	13	35.0	35	14	27	8	3	4	3	2				96	8.75	6.75	2.00	0.50	37.1	1298.9
76	F	13	42.0	29	8	30	11	7	5	6					96	7.25	7.50	2.75	0.00	38.6	1622.9
77	F	13	36.0	33	8	22	9	12	4	6	2				96	8.25	5.50	2.25	0.50	40.4	1455.8
78	F	13	26.0	27	12	28	4	10	4	6	3		2		96	6.75	7.00	1.00	1.25	43.8	1139.8
79	F	13	32.0	31	6	32	7	8	6	6					96	7.75	8.00	1.75	0.00	38.9	1244.8
80	F	13	36.0	35	20	25	6	5	2	3					96	8.75	6.25	1.50	0.00	35.2	1268.3
81	F	13	37.0	30	5	40	7	7	1	6					96	7.50	10.00	1.75	0.00	37.3	1379.4
82	F	14	30.5	30	7	33	4	12	3	6	1				96	7.50	8.25	1.00	0.25	39.7	1209.9
83	F	14	43.0	32	3	36	5	8	2	10					96	8.00	9.00	1.25	0.00	39.4	1693.3
84	F	14	42.0	30	6	23	8	6	6	17					96	7.50	5.75	2.00	0.00	43.7	1835.4
85	F	14	39.5	34	5	40	6	4	1	6					96	8.50	10.00	1.50	0.00	36.2	1431.1
86	F	14	43.5	32	9	46		4	1	4					96	8.00	11.50	0.00	0.00	35.6	1546.4
87	F	14	41.5	36	5	37	4	8	1	5					96	9.00	9.25	1.00	0.00	36.3	1506.0
88	F	14	43.0	37	5	40	4	3	1	6					96	9.25	10.00	1.00	0.00	35.7	1534.2
89	F	14	40.5	30	3	21	4	11	11	3	5		8		96	7.50	5.25	1.00	3.25	52.8	2139.2
90	F	14	39.0	40	12	28	5	8		3					96	10.00	7.00	1.25	0.00	34.6	1338.2
91	F	14	35.0	36	5	22	4	6	5	18					96	9.00	5.50	1.00	0.00	43.1	1509.6
92	F	14	38.5	35	5	29	5	9	5	8					96	8.75	7.25	1.25	0.00	39.2	1510.0
93	F	14	40.0	31	5	30	9	6	4	7	4				96	7.75	7.50	2.25	1.00	41.6	1665.6
94	F	14	43.5	39	14	23	5	9	2	4					96	9.75	5.75	1.25	0.00	36.0	1564.7
95	F	14	52.0	37	8	31	6	5	5	2	2				96	9.25	7.75	1.50	0.50	37.1	1929.2
96	F	14	38.0	31	6	23	13	14	1	7	1				96	7.75	5.75	3.25	0.25	39.8	1511.3
97	F	14	37.0	36	7	23	4	10	3	13					96	9.00	5.75	1.00	0.00	41.0	1515.9

WEEKDAY 1				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
98	M	12	24.5	40	11	27	1	6	1	2	4		4		96	10.00	6.75	0.25	2.00	41.8	1024.3
99	M	12	28.5	36	8	23	9	6	0	3	7		4		96	9.00	5.75	2.25	2.75	44.9	1279.7
100	M	12	29.0	37	3	30	7	9	4	6					96	9.25	7.50	1.75	0.00	37.8	1094.8
101	M	12	39.0	39	2	28	2	14	9	2					96	9.75	7.00	0.50	0.00	38.2	1488.6
102	M	12	24.0	33	2	36	7	6	1	4	3		4		96	8.25	9.00	1.75	1.75	42.8	1026.0
103	M	12	27.0	34	4	38	5	3	4	8					96	8.50	9.50	1.25	0.00	37.9	1023.0
104	M	12	37.5	36	3	21	9	17	4	6					96	9.00	5.25	2.25	0.00	39.4	1477.1
105	M	12	36.0	34	7	35	5	8	5	2					96	8.50	8.75	1.25	0.00	36.4	1310.0
106	M	12	43.0	38	3	34	12	5	1	3					96	9.50	8.50	3.00	0.00	34.6	1486.1
107	M	12	31.0	35	3	26	7	7	2	10			6		96	8.75	6.50	1.75	1.50	45.6	1412.1
108	M	12	30.5	31	5	46	4	3	6	1					96	7.75	11.50	1.00	0.00	35.7	1087.3
109	M	12	26.0	38	7	32	3	5		7			4		96	9.50	8.00	0.75	1.00	40.6	1054.8
110	M	12	29.5	41	5	34	5	4	6	1					96	10.25	8.50	1.25	0.00	34.6	1022.2
111	M	12	35.0	37	4	25	15	2	1	8			4		96	9.25	6.25	3.75	1.00	40.9	1431.2
112	M	12	28.0	36	2	42	7	3		6					96	9.00	10.50	1.75	0.00	35.5	993.7
113	M	12	42.0	33	11	38		6		5			3		96	8.25	9.50	0.00	0.75	39.3	1651.4
114	M	12	38.0	32	10	26	17	3	1	7					96	8.00	6.50	4.25	0.00	36.7	1396.1
115	M	12	30.5	36	4	25	14	3	1	9			4		96	9.00	6.25	3.50	1.00	41.7	1270.6
116	M	12	28.0	35	6	22	4	15	2	10	2				96	8.75	5.50	1.00	0.50	42.0	1175.7
117	M	12	30.0	27	3	36	12	1	1	11			5		96	6.75	9.00	3.00	1.25	44.4	1332.0
118	M	12	38.0	29	5	25	12	4	1	20					96	7.25	6.25	3.00	0.00	43.3	1644.3
119	M	12	30.0	38	3	33	11	5		6					96	9.50	8.25	2.75	0.00	35.6	1068.9
120	M	12	23.0	34	4	21	15	3	2	8	2		7		96	8.50	5.25	3.75	2.25	46.8	1075.3
121	M	12	35.0	31	6	30	15	2	1	8			3		96	7.75	7.50	3.75	0.75	40.5	1417.2
122	M	12	32.0	31	5	32	16	3	4	5					96	7.75	8.00	4.00	0.00	36.9	1179.8
123	M	12	28.0	30	8	31	17	4	1	5					96	7.50	7.75	4.25	0.00	36.3	1015.0
124	M	12	41.0	34	3	31	6	7		7			8		96	8.50	7.75	1.50	2.00	45.9	1882.3
125	M	12	25.0	31	5	45	4	4		7					96	7.75	11.25	1.00	0.00	45.9	1147.8
126	M	12	31.0	26	4	31	4	5	5	9			12		96	6.50	7.75	1.00	3.00	53.4	1656.6
127	M	12	24.5	27	1	32	23	3		5	2		3		96	6.75	8.00	5.75	1.25	41.1	1007.2
128	M	12	43.0	36	3	30	10	3	3	5	2		4		96	9.00	7.50	2.50	1.50	43.0	1847.3
129	M	12	42.5	36	8	25	12	4	1	7	3				96	9.00	6.25	3.00	0.75	38.9	1653.7
130	M	13	30.0	32	3	46	4	3	4	4					96	8.00	11.50	1.00	0.00	36.3	1088.7
131	M	13	29.0	23	4	31	25	3	3	7					96	5.75	7.75	6.25	0.00	38.4	1114.8
132	M	13	29.0	31	2	37	12	2	3	8	1				96	7.75	9.25	3.00	0.25	38.6	1118.5
133	M	13	41.0	37	2	37	8	2	1	7				2	96	9.25	9.25	2.00	0.50	39.2	1606.8
134	M	13	32.0	35	2	38	5	5	3	8					96	8.75	9.50	1.25	0.00	37.8	1210.9
135	M	13	25.0	28	6	20	7	10	11	14					96	7.00	5.00	1.75	0.00	44.9	1121.8
136	M	13	40.0	35	2	38	5	5	3	7			1		96	8.75	9.50	1.25	0.25	38.5	1540.0
137	M	13	35.0	35	4	29	4	9		13	2				96	8.75	7.25	1.00	0.50	41.6	1456.4
138	M	13	29.5	32	4	34	11	5	1	8	1				96	8.00	8.50	2.75	0.25	38.4	1132.8
139	M	13	31.0	37	5	19	11	17	4	3					96	9.25	4.75	2.75	0.00	37.9	1174.6
140	M	13	32.0	32	4	39	8	3		7	1		2		96	8.00	9.75	2.00	0.75	39.5	1263.7
141	M	13	33.0	34	3	34	9	7	2	6	1				96	8.50	8.50	2.25	0.25	37.9	1251.7
142	M	13	26.0	32	2	23	12	5	2	6			1	13	96	8.00	5.75	3.00	3.50	59.2	1537.9
143	M	13	34.0	28	2	36	6	3	1	17			3		96	7.00	9.00	1.50	0.75	45.2	1536.1
144	M	13	31.5	31	2	32	4	3	1	4	4		15		96	7.75	8.00	1.00	4.75	55.6	1750.1

WEEKDAY I							CATEGORY								Total 15-min		HOURS				
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
145	M	13	25.0	42	3	13	9	5	7	17					96	10.50	3.25	2.25	0.00	42.4	1059.5
146	M	13	31.0	36	6	30	6	2	4	4			8		96	9.00	7.50	1.50	2.00	44.6	1382.0
147	M	13	30.0	30	6	39	8	5	2	3	3				96	7.50	9.75	2.00	0.75	38.3	1148.7
148	M	13	25.0	43	8	25	10	4	2	4					96	10.75	6.25	2.50	0.00	34.5	863.5
149	M	13	44.0	36	3	28	7	9	5	4	1		3		96	9.00	7.00	1.75	1.00	41.4	1823.4
150	M	13	31.0	34	7	26	16	7	2	4					96	8.50	6.50	4.00	0.00	36.2	1121.9
151	M	13	42.0	26	7	40	9	7	2	3			2		96	6.50	10.00	2.25	0.50	38.9	1635.1
152	M	13	32.5	25	4	36	8	12	4	5	2				96	6.25	9.00	2.00	0.50	40.9	1330.6
153	M	13	35.0	17	15	31	8	10	4	8	3				96	4.25	7.75	2.00	0.75	43.7	1530.2
154	M	13	32.0	31	16	32	3	7	4	3					96	7.75	8.00	0.75	0.00	36.7	1174.7
155	M	13	33.0	30	11	34	3	5	5	5			3		96	7.50	8.50	0.75	0.75	41.0	1354.3
156	M	13	32.5	26	6	37	6	7	5	4	2		3		96	6.50	9.25	1.50	1.25	43.1	1400.1
157	M	13	36.0	28	8	32	7	7	2	7	5				96	7.00	8.00	1.75	1.25	42.4	1526.0
158	M	13	33.0	35	15	23	6	5	4	7	1				96	8.75	5.75	1.50	0.25	38.5	1270.8
159	M	13	26.5	35	3	38	4	2	3	6			5		96	8.75	9.50	1.00	1.25	42.0	1111.7
160	M	13	34.0	37	9	35	3	6	1	4	1				96	9.25	8.75	0.75	0.25	36.2	1229.1
161	M	13	33.0	36	5	31	9	9	3	3					96	9.00	7.75	2.25	0.00	36.2	1193.9
162	M	13	40.0	33	8	33	2	4	4	4	5		3		96	8.25	8.25	0.50	2.00	43.8	1752.8
163	M	13	31.0	36	4	37	4	7	2	2	4				96	9.00	9.25	1.00	1.00	38.3	1187.6
164	M	13	38.0	34	9	33	2	7	3	6	2				96	8.50	8.25	0.50	0.50	39.1	1484.3
165	M	14	39.0	32	11	34	12	2	1	4					96	8.00	8.50	3.00	0.00	35.2	1371.6
166	M	14	46.0	33	5	22	14	3	1	18					96	8.25	5.50	3.50	0.00	41.7	1917.3
167	M	14	50.0	26	6	37	6	7	5	4	2		3		96	6.50	9.25	1.50	1.25	43.1	2154.0
168	M	14	54.0	29	9	34	2	10	4	3			5		96	7.25	8.50	0.50	1.25	43.1	2328.5
169	M	14	51.5	32	4	32	11	6	3	5	2		1		96	8.00	8.00	2.75	0.75	39.8	2048.2
170	M	14	34.0	42	8	24	4	6	3	2	2		5		96	10.50	6.00	1.00	1.75	41.7	1416.8
171	M	14	35.0	32	13	15	11	3	8	8	1		5		96	8.00	3.75	2.75	1.50	45.8	1602.7
172	M	14	47.0	40	5	36		3	2	2	8				96	10.00	9.00	0.00	2.00	40.4	1896.5
173	M	14	44.5	41	7	35	1	5	5				2		96	10.25	8.75	0.25	0.50	36.3	1615.4
174	M	14	56.0	35	14	22	12	4		7	2				96	8.75	5.50	3.00	0.50	37.9	2122.4
175	M	14	33.0	33	5	23	21	4	4	6					96	8.25	5.75	5.25	0.00	37.3	1230.2
176	M	14	40.0	28	10	22	10	5	1	16	4				96	7.00	5.50	2.50	1.00	45.0	1800.8
177	M	14	41.5	30	9	25	14	8	5	2	3				96	7.50	6.25	3.50	0.75	39.3	1632.2
178	M	14	37.5	37	6	23	6	10	4	6	4				96	9.25	5.75	1.50	1.00	41.2	1545.8
179	M	14	36.0	30	7	35	5	7	5	3	2		2		96	7.50	8.75	1.25	1.00	41.0	1476.7

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
VN	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
1	F	12	25.0	43	2	27	6	10	5	3					96	10.8	6.8	1.5	0.0	36.2	903.8
2	F	12	35.0	35	4	33	11	7		4	2				96	8.8	8.3	2.8	0.5	37.1	1298.2
3	F	12	26.0	34	4	29	6	13	4	6					96	8.5	7.3	1.5	0.0	38.9	1010.6
4	F	12	32.0	28	5	30	9	11	6	7					96	7.0	7.5	2.3	0.0	40.3	1289.3
5	F	12	41.0	35	5	32	5	9	3	5	2				96	8.8	8.0	1.3	0.5	38.9	1593.3
6	F	12	35.0	37	6	26	6	11	4	4			2		96	9.3	6.5	1.5	0.5	39.5	1380.8
7	F	12	51.0	35	8	30	11	3		9					96	8.8	7.5	2.8	0.0	37.0	1886.5
8	F	12	27.5	38	4	31	3	13	3	4					96	9.5	7.8	0.8	0.0	37.2	1021.9
9	F	12	26.0	39	5	31	4	7	7	3					96	9.8	7.8	1.0	0.0	36.7	953.7
10	F	12	32.0	37	5	34	6	7	3	4					96	9.3	8.5	1.5	0.0	36.1	1156.5
11	F	12	32.0	35	5	35	5	10	2	4					96	8.8	8.8	1.3	0.0	36.6	1172.5
12	F	12	24.0	35	3	36	3	8	3	5	3				96	8.8	9.0	0.8	0.8	39.5	947.8
13	F	12	28.0	36	3	33	2	9	3	7	3				96	9.0	8.3	0.5	0.8	40.5	1133.4
14	F	12	35.0	38	6	33	3	9	3	4					96	9.5	8.3	0.8	0.0	36.4	1274.0
15	F	12	31.0	32	4	29	14	8		9					96	8.0	7.3	3.5	0.0	38.3	1187.3
16	F	12	32.0	37	7	31	4	10	3	4					96	9.3	7.8	1.0	0.0	36.7	1174.7
17	F	12	35.0	37	4	29	12	9		5					96	9.3	7.3	3.0	0.0	36.1	1261.8
18	F	12	35.0	36	9	27	4	6	7	7					96	9.0	6.8	1.0	0.0	38.7	1354.2
19	F	12	34.0	32	6	19		9	6	4	13		7		96	8.0	4.8	0.0	5.0	56.6	1922.7
20	F	12	25.5	36	5	27	4	8		7	7		2		96	9.0	6.8	1.0	2.3	44.9	1144.4
21	F	12	36.0	31	3	45	5	2	2	5	3				96	7.8	11.3	1.3	0.8	38.5	1386.7
22	F	12	35.0	31	6	25	7	7	5	12	3				96	7.8	6.3	1.8	0.8	43.6	1526.7
23	F	12	41.0	30	3	28	8	7	8	8	4				96	7.5	7.0	2.0	1.0	43.7	1789.7
24	F	12	25.0	39	11	21	7	3	2	4	7		2		96	9.8	5.3	1.8	2.3	42.8	1070.3
25	F	12	32.0	40	8	24	5	8		6	5				96	10.0	6.0	1.3	1.3	40.1	1281.9
26	F	12	31.0	32	4	29	11	8	1	4	7				96	8.0	7.3	2.8	1.8	42.1	1303.6
27	F	12	21.5	36	7	36	4	6		5	2				96	9.0	9.0	1.0	0.5	37.2	800.7
28	F	12	39.0	36	2	37	6	5	1	7	2				96	9.0	9.3	1.5	0.5	38.3	1492.9
29	F	12	38.0	38	4	31	6	6		4	7				96	9.5	7.8	1.5	1.8	40.6	1544.3
30	F	12	37.0	35	6	24	4	6	9	11	1				96	8.8	6.0	1.0	0.3	42.1	1557.3
31	F	12	42.5	27	7	41	5	9		3	4				96	6.8	10.3	1.3	1.0	39.6	1683.4
32	F	12	30.0	37	3	23	12	9	3	3	6				96	9.3	5.8	3.0	1.5	41.0	1229.4
33	F	12	35.0	35	5	23	9	2	11	5	6				96	8.8	5.8	2.3	1.5	43.3	1515.2
34	F	13	28.0	32	6	35	4	9	4	6					96	8.0	8.8	1.0	0.0	38.4	1073.8
35	F	13	33.0	36	5	28	8	11	2	6					96	9.0	7.0	2.0	0.0	37.6	1241.8
36	F	13	34.0	32	4	36	4	7	3	10					96	8.0	9.0	1.0	0.0	39.5	1343.0
37	F	13	32.0	32	7	16	14	9	9	9					96	8.0	4.0	3.5	0.0	41.3	1321.0
38	F	13	31.0	39	3	22	5	9	5	13					96	9.8	5.5	1.3	0.0	41.0	1272.2
39	F	13	35.0	24	2	24	11	13	5	17					96	6.0	6.0	2.8	0.0	45.4	1590.4
40	F	13	33.0	30	3	34	12	3	5	9					96	7.5	8.5	3.0	0.0	39.1	1291.6
41	F	13	27.0	29	6	24	3	13	3	13	4		1		96	7.3	6.0	0.8	1.3	46.8	1263.1
42	F	13	36.0	27	6	21	7	19	4	10	2				96	6.8	5.3	1.8	0.5	44.3	1595.9
43	F	13	29.0	43	7	20	6	10	2	8					96	10.8	5.0	1.5	0.0	37.5	1088.1
44	F	13	34.0	39	4	21	9	7	1	15					96	9.8	5.3	2.3	0.0	40.3	1371.6
45	F	13	41.0	36	2	26	5	9	1	17					96	9.0	6.5	1.3	0.0	42.0	1722.0
46	F	13	27.0	27	5	20	12	10	3	15	4				96	6.8	5.0	3.0	1.0	46.3	1248.8
47	F	13	46.0	36	3	22	12	9	1	9	4				96	9.0	5.5	3.0	1.0	41.6	1913.6
48	F	13	37.0	25	4	22	17	12	2	14					96	6.3	5.5	4.3	0.0	42.8	1584.3

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	$kcal\,kg\,d^{-1}$	Total $kcal\,d^{-1}$
49	F	13	35.0	29	6	32	6	10		7	6				96	7.3	8.0	1.5	1.5	43.0	1506.4
50	F	13	26.0	29	5	15	2	11	12	18	4				96	7.3	3.8	0.5	1.0	50.4	1309.6
51	F	13	37.0	26	3	20	14	18	1	14					96	6.5	5.0	3.5	0.0	43.5	1610.6
52	F	13	30.0	33	10	17		14	4	18					96	8.3	4.3	0.0	0.0	44.7	1341.0
53	F	13	36.5	32	3	27	9	10	1	14					96	8.0	6.8	2.3	0.0	41.3	1507.1
54	F	13	29.0	29	4	18	18	15	4	8					96	7.3	4.5	4.5	0.0	40.8	1182.3
55	F	13	42.0	30	4	15	13	12	1	18			3		96	7.5	3.8	3.3	0.8	47.1	1978.6
56	F	13	36.0	26	2	32	5	12		19					96	6.5	8.0	1.3	0.0	44.4	1597.7
57	F	13	26.0	29	6	32	7	9	1	12					96	7.3	8.0	1.8	0.0	40.5	1054.0
58	F	13	27.0	32	2	26		16	4	15	1				96	8.0	6.5	0.0	0.3	44.6	1205.3
59	F	13	30.0	27	6	27	4	16	1	12	3				96	6.8	6.8	1.0	0.8	44.6	1337.1
60	F	13	24.5	32	2	30	4	6	3	19					96	8.0	7.5	1.0	0.0	43.5	1064.5
61	F	13	43.0	32	4	28	6	7	4	13	2				96	8.0	7.0	1.5	0.5	42.8	1841.7
62	F	13	35.0	30	12	17	9	14	9	5					96	7.5	4.3	2.3	0.0	40.6	1422.1
63	F	13	41.0	28	9	34	9	5	1	6	3		1		96	7.0	8.5	2.3	1.0	40.7	1669.5
64	F	13	36.0	35	2	38	4	13	1	3					96	8.8	9.5	1.0	0.0	36.4	1311.8
65	F	13	37.0	29	5	33	10	7	2	7	3				96	7.3	8.3	2.5	0.8	40.6	1503.3
66	F	13	36.0	34	9	37		2	6	8					96	8.5	9.3	0.0	0.0	38.3	1379.5
67	F	13	41.0	27	6	32	13	6	8	4					96	6.8	8.0	3.3	0.0	38.7	1586.7
68	F	13	33.0	31	13	33		3		16					96	7.8	8.3	0.0	0.0	40.7	1342.8
69	F	13	42.0	34	6	30	6	7	5	6	2				96	8.5	7.5	1.5	0.5	39.7	1666.6
70	F	13	44.0	33	13	27	9	6	6	2					96	8.3	6.8	2.3	0.0	36.4	1603.4
71	F	13	36.0	35	9	31	5	5	1	7	3				96	8.8	7.8	1.3	0.8	39.2	1411.9
72	F	13	44.5	40	15	15	10	11		5					96	10.0	3.8	2.5	0.0	36.1	1601.5
73	F	13	34.0	29	10	26	2	17	1	11					96	7.3	6.5	0.5	0.0	41.6	1414.4
74	F	13	44.0	31	8	30	12	8	6	1					96	7.8	7.5	3.0	0.0	36.6	1610.4
75	F	13	35.0	32	11	25	9	3	2	6	8				96	8.0	6.3	2.3	2.0	43.2	1510.3
76	F	13	42.0	34	9	21	13	5	2	9	3				96	8.5	5.3	3.3	0.8	40.6	1703.9
77	F	13	36.0	31	6	31	7	7	3	7	4				96	7.8	7.8	1.8	1.0	41.5	1494.7
78	F	13	26.0	32	8	27	7	4	3	12	3				96	8.0	6.8	1.8	0.8	42.3	1100.1
79	F	13	32.0	33	7	29	6	2	3	11	5				96	8.3	7.3	1.5	1.3	43.0	1375.7
80	F	13	36.0	32	18	34	4	1		6	1				96	8.0	8.5	1.0	0.3	36.4	1310.8
81	F	13	37.0	28	12	31	8	6	1	9	1				96	7.0	7.8	2.0	0.3	39.5	1462.6
82	F	14	30.5	35	6	24	10	10		10	1				96	8.8	6.0	2.5	0.3	39.6	1207.8
83	F	14	43.0	32	4	34	6	8	5	7					96	8.0	8.5	1.5	0.0	38.9	1674.0
84	F	14	42.0	31	7	26	4	7	6	15					96	7.8	6.5	1.0	0.0	42.9	1799.7
85	F	14	39.5	35	8	38	5	4	2	4					96	8.8	9.5	1.3	0.0	35.5	1402.3
86	F	14	43.5	34	9	41	4	3	1	4					96	8.5	10.3	1.0	0.0	35.1	1527.7
87	F	14	41.5	33	6	37	4	7	3	6					96	8.3	9.3	1.0	0.0	37.5	1557.9
88	F	14	43.0	36	3	41	5	5	2	4					96	9.0	10.3	1.3	0.0	35.6	1529.5
89	F	14	40.5	32	5	24	2	9	12	3	4		5		96	8.0	6.0	0.5	2.3	48.3	1957.4
90	F	14	39.0	38	10	29	5	8		6					96	9.5	7.3	1.3	0.0	36.2	1411.8
91	F	14	35.0	33	6	26	2	8	5	16					96	8.3	6.5	0.5	0.0	43.0	1503.3
92	F	14	38.5	31	7	29	4	9	7	6	3				96	7.8	7.3	1.0	0.8	41.9	1611.6
93	F	14	40.0	35	7	28	9	4	3	8	2				96	8.8	7.0	2.3	0.5	39.3	1571.6
94	F	14	43.5	36	10	31	6	6	3	4					96	9.0	7.8	1.5	0.0	36.1	1569.0
95	F	14	52.0	38	9	32	6	4	4	3					96	9.5	8.0	1.5	0.0	35.3	1835.6
96	F	14	38.0	33	6	27	11	10	2	7					96	8.3	6.8	2.8	0.0	38.3	1453.9
97	F	14	37.0	31	8	29	5	9	3	11					96	7.8	7.3	1.3	0.0	40.5	1497.0

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d⁻¹	Total kcal d⁻¹
98	M	12	24.5	40	10	26	3	7		2	6		2		96	10.00	6.50	0.75	2.00	41.1	1006.7
99	M	12	28.5	37	6	25	9	4		5	6		4		96	9.25	6.25	2.25	2.50	44.5	1268.3
100	M	12	29.0	38	5	29	7	6	5	6					96	9.50	7.25	1.75	0.00	37.4	1083.7
101	M	12	39.0	38	4	27	4	10	9	4					96	9.50	6.75	1.00	0.00	38.5	1499.6
102	M	12	24.0	31	4	34	6	6	4	4	3		4		96	7.75	8.50	1.50	1.75	43.9	1054.1
103	M	12	27.0	32	6	36	5	2	4	9	2				96	8.00	9.00	1.25	0.50	40.0	1081.1
104	M	12	37.5	37	4	23	6	14	4	8					96	9.25	5.75	1.50	0.00	39.6	1485.8
105	M	12	36.0	32	8	34	7	8	2	5					96	8.00	8.50	1.75	0.00	37.1	1334.9
106	M	12	43.0	37	5	32	11	5	4	2					96	9.25	8.00	2.75	0.00	35.2	1511.5
107	M	12	31.0	40	2	27	5	8		5	3		6		96	10.00	6.75	1.25	2.25	44.7	1385.1
108	M	12	30.5	31	3	50	4	3		4	1				96	7.75	12.50	1.00	0.25	36.0	1097.7
109	M	12	26.0	36	3	27	4	1	16	9					96	9.00	6.75	1.00	0.00	41.5	1077.7
110	M	12	29.5	36	10	23	13	8		5	1				96	9.00	5.75	3.25	0.25	36.8	1086.0
111	M	12	35.0	36	5	23	14	3	2	9			4		96	9.00	5.75	3.50	1.00	42.0	1469.0
112	M	12	28.0	37	3	47	4	1		4					96	9.25	11.75	1.00	0.00	34.1	954.0
113	M	12	42.0	39	10	29		12		2			4		96	9.75	7.25	0.00	1.00	39.5	1658.2
114	M	12	38.0	33	10	18	17	1	6	11					96	8.25	4.50	4.25	0.00	39.6	1505.9
115	M	12	30.5	37	8	18	15	4		12			2		96	9.25	4.50	3.75	0.50	40.6	1237.1
116	M	12	28.0	35	5	24	3	17		12					96	8.75	6.00	0.75	0.00	41.0	1148.8
117	M	12	30.0	25	9	30	12	3	1	9	3		4		96	6.25	7.50	3.00	1.75	45.4	1363.2
118	M	12	38.0	31	7	24	15	5	6	8					96	7.75	6.00	3.75	0.00	39.3	1491.5
119	M	12	30.0	45	11	30	5	2		3					96	11.25	7.50	1.25	0.00	32.8	985.2
120	M	12	23.0	37	8	20	12	3	5	8	3				96	9.25	5.00	3.00	0.75	40.3	926.9
121	M	12	35.0	31	4	19	13	4	10	15					96	7.75	4.75	3.25	0.00	43.5	1523.2
122	M	12	32.0	32	6	28	14	6	5	3	2				96	8.00	7.00	3.50	0.50	38.4	1227.2
123	M	12	28.0	34	6	25	12	3		13			3		96	8.50	6.25	3.00	0.75	42.3	1184.7
124	M	12	41.0	28	15	35	2	6	1	5			4		96	7.00	8.75	0.50	1.00	41.4	1695.4
125	M	12	25.0	38	6	22	5	5	5	4	11				96	9.50	5.50	1.25	2.75	41.4	1033.8
126	M	12	31.0	23	5	20	6	3	6	29			4		96	5.75	5.00	1.50	1.00	54.0	1673.1
127	M	12	24.5	36	3	21	8	1	2	25					96	9.00	5.25	2.00	0.00	44.5	1089.5
128	M	12	43.0	34	4	31	9	4	2	6	1		5		96	8.50	7.75	2.25	1.50	43.0	1847.3
129	M	12	42.5	38	6	26	12	3		7	4				96	9.50	6.50	3.00	1.00	39.0	1657.1
130	M	13	30.0	33	5	42	4	3	4	5					96	8.25	10.50	1.00	0.00	36.6	1098.9
131	M	13	29.0	28	6	29	17	5	3	8					96	7.00	7.25	4.25	0.00	38.7	1121.7
132	M	13	29.0	28	4	26	15	6	3	14					96	7.00	6.50	3.75	0.00	41.6	1207.3
133	M	13	41.0	28	2	30	6	8	1	14	4			3	96	7.00	7.50	1.50	1.75	49.5	2030.7
134	M	13	32.0	29	5	23	5	11	8	11				4	96	7.25	5.75	1.25	1.00	49.1	1571.5
135	M	13	25.0	29	6	17	9	8	14	13					96	7.25	4.25	2.25	0.00	44.8	1121.0
136	M	13	40.0	36	5	26	1	5	7	15			1		96	9.00	6.50	0.25	0.25	43.3	1732.0
137	M	13	35.0	31	3	26	5	14	1	16					96	7.75	6.50	1.25	0.00	43.1	1508.2
138	M	13	29.5	28	2	22	16	12	1	15					96	7.00	5.50	4.00	0.00	42.6	1257.0
139	M	13	31.0	33	8	25	5	8	1	16					96	8.25	6.25	1.25	0.00	41.7	1293.0
140	M	13	32.0	28	2	16	31	4	1	10	4				96	7.00	4.00	7.75	1.00	42.1	1346.2
141	M	13	33.0	32	2	27	9	9	1	13			3		96	8.00	6.75	2.25	0.75	44.0	1452.0
142	M	13	26.0	36	3	22	6	10	2	15			2		96	9.00	5.50	1.50	0.50	43.8	1139.3
143	M	13	34.0	32	8	20	5	9	4	13	5				96	8.00	5.00	1.25	1.25	45.7	1552.8
144	M	13	31.5	35	3	25	3	9	2	13			6		96	8.75	6.25	0.75	1.50	47.3	1490.3

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
145	M	13	25.0	36	6	21	6	6	6	15					96	9.00	5.25	1.50	0.00	42.1	1051.5
146	M	13	31.0	34	10	24	4	6	1	12			5		96	8.50	6.00	1.00	1.25	45.0	1394.1
147	M	13	30.0	34	4	20	4	12	9	13					96	8.50	5.00	1.00	0.00	43.5	1303.5
148	M	13	25.0	25	3	19	20	13	4	12					96	6.25	4.75	5.00	0.00	42.7	1067.8
149	M	13	44.0	36	2	22	13	6	2	13			2		96	9.00	5.50	3.25	0.50	42.1	1854.2
150	M	13	31.0	34	3	17	14	13	1	8	6				96	8.50	4.25	3.50	1.50	43.8	1357.2
151	M	13	42.0	30	7	36	9	7	2	3			2		96	7.50	9.00	2.25	0.50	38.5	1614.9
152	M	13	32.5	36	5	34	7	7	1	4	1	1			96	9.00	8.50	1.75	0.50	37.5	1218.1
153	M	13	35.0	31	7	33	4	4	7	10					96	7.75	8.25	1.00	0.00	40.3	1410.2
154	M	13	32.0	32	5	36		14		9					96	8.00	9.00	0.00	0.00	39.4	1262.1
155	M	13	33.0	31	9	32	6	6	3	6	1		2		96	7.75	8.00	1.50	0.75	40.7	1341.5
156	M	13	32.5	40	7	25	8	4	4	6			2		96	10.00	6.25	2.00	0.50	38.7	1257.1
157	M	13	36.0	29	7	33	13	4	2	7	1				96	7.25	8.25	3.25	0.25	38.4	1383.1
158	M	13	33.0	32	13	15	10	3	11	10	2				96	8.00	3.75	2.50	0.50	42.9	1414.4
159	M	13	26.5	37	3	40		2	3	6			5		96	9.25	10.00	0.00	1.25	41.7	1105.3
160	M	13	34.0	40	8	35	1	3	1	6	2				96	10.00	8.75	0.25	0.50	37.0	1256.6
161	M	13	33.0	35	2	35	7	7	2	8					96	8.75	8.75	1.75	0.00	37.9	1251.0
162	M	13	40.0	35	7	38		1	5	1	4		5		96	8.75	9.50	0.00	2.25	43.4	1734.4
163	M	13	31.0	35	9	30	6	5		10	1				96	8.75	7.50	1.50	0.25	38.7	1198.2
164	M	13	38.0	36	6	31		11	2	9	1				96	9.00	7.75	0.00	0.25	39.8	1513.5
165	M	14	39.0	34	8	25	5	6	2	16					96	8.50	6.25	1.25	0.00	41.5	1619.3
166	M	14	46.0	25	3	25	7	15	6	13			2		96	6.25	6.25	1.75	0.50	46.4	2134.9
167	M	14	50.0	27	4	40	10	4	1	6			4		96	6.75	10.00	2.50	1.00	41.6	2077.5
168	M	14	54.0	26	12	29	3	12	4	4			6		96	6.50	7.25	0.75	1.50	45.4	2453.8
169	M	14	51.5	33	4	29	12	4	3	6	2		3		96	8.25	7.25	3.00	1.25	42.0	2161.5
170	M	14	34.0	39	7	25	5	6	5	4	2		3		96	9.75	6.25	1.25	1.25	41.3	1405.2
171	M	14	35.0	35	11	21	8	4	5	4	5		3		96	8.75	5.25	2.00	2.00	43.9	1536.2
172	M	14	47.0	38	5	33	3	3	2	5	7				96	9.50	8.25	0.75	1.75	41.2	1934.1
173	M	14	44.5	40	6	36	4	5	2				3		96	10.00	9.00	1.00	0.75	36.6	1629.1
174	M	14	56.0	38	7	31	7	4	2	4	3				96	9.50	7.75	1.75	0.75	35.3	1978.5
175	M	14	33.0	36	5	25	16	3	2	6			3		96	9.00	6.25	4.00	0.75	39.5	1302.5
176	M	14	40.0	30	7	25	6	8	4	12	4				96	7.50	6.25	1.50	1.00	44.4	1777.6
177	M	14	41.5	31	8	26	12	8	5	3	3				96	7.75	6.50	3.00	0.75	39.7	1646.3
178	M	14	37.5	36	7	24	5	8	4	7	5				96	9.00	6.00	1.25	1.25	42.2	1584.0
179	M	14	36.0	32	6	33	5	7	4	5	2		2		96	8.00	8.25	1.25	1.00	41.4	1490.0

WEEKEND DAY 3				CATEGORY											Total 15-min	HOURS					
VN	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
1	F	12	25.0	43	5	19	11	9	6	2	1				96	10.75	4.75	2.75	0.25	36.6	915.8
2	F	12	35.0	40	6	20	13	6	2	7	2				96	10.00	5.00	3.25	0.50	38.3	1340.5
3	F	12	26.0	39	6	22	5	9	2	7	6				96	9.75	5.50	1.25	1.50	42.3	1099.0
4	F	12	32.0	34	5	21	14	12	2	5	3				96	8.50	5.25	3.50	0.75	40.1	1281.9
5	F	12	41.0	37	6	18	6	19	2	5	3				96	9.25	4.50	1.50	0.75	41.0	1682.2
6	F	12	35.0	42	5	14	12	10	3	8	2				96	10.50	3.50	3.00	0.50	39.6	1385.7
7	F	12	51.0	42	6	10	23	8	2	2	3				96	10.50	2.50	5.75	0.75	37.0	1885.0
8	F	12	27.5	40	7	9	4	14	19	3					96	10.00	2.25	1.00	0.00	41.6	1144.3
9	F	12	26.0	29	8	15	14	20	5	3	2				96	7.25	3.75	3.50	0.50	41.4	1075.6
10	F	12	32.0	39	5	16	4	16	5	8	3				96	9.75	4.00	1.00	0.75	42.5	1361.0
11	F	12	32.0	36	4	12	24	9	2	7	2				96	9.00	3.00	6.00	0.50	39.4	1259.2
12	F	12	24.0	29	8	17	6	14	16	5	1				96	7.25	4.25	1.50	0.25	43.7	1049.8
13	F	12	28.0	35	6	20	16	12	1	4	2				96	8.75	5.00	4.00	0.50	38.4	1073.8
14	F	12	35.0	32	5	20	6	12	7	10	4				96	8.00	5.00	1.50	1.00	45.0	1574.0
15	F	12	31.0	36	7	12	10	3	1	23	4				96	9.00	3.00	2.50	1.00	46.9	1453.9
16	F	12	32.0	43	4	18	5	14	1	8	3				96	10.75	4.50	1.25	0.75	40.4	1293.8
17	F	12	35.0	39	5	14	13	7	0	16	2				96	9.75	3.50	3.25	0.50	42.1	1474.6
18	F	12	35.0	34	5	19	25	7	3	3					96	8.50	4.75	6.25	0.00	36.0	1261.4
19	F	12	34.0	30	12	19	13	8	1	4	1		8		96	7.50	4.75	3.25	2.25	46.3	1575.2
20	F	12	25.5	37	7	31	5	5	6	2	3				96	9.25	7.75	1.25	0.75	38.2	974.9
21	F	12	36.0	33	6	19	15	11	2	10					96	8.25	4.75	3.75	0.00	39.8	1433.9
22	F	12	35.0	45	4	15	18	8	2	4					96	11.25	3.75	4.50	0.00	35.1	1227.1
23	F	12	41.0	36	7	23	7	14	6	3					96	9.00	5.75	1.75	0.00	38.1	1560.5
24	F	12	25.0	36	7	22	12	9	5	4	1				96	9.00	5.50	3.00	0.25	38.1	952.0
25	F	12	32.0	35	13	18	18	7	2	3					96	8.75	4.50	4.50	0.00	35.6	1139.5
26	F	12	31.0	34	5	28	5	9	5	10					96	8.50	7.00	1.25	0.00	40.3	1248.1
27	F	12	21.5	41	10	10	8	17	2	7	1				96	10.25	2.50	2.00	0.25	39.5	848.2
28	F	12	39.0	40	4	23	17	5	2	3	2				96	10.00	5.75	4.25	0.50	36.3	1414.5
29	F	12	38.0	36	8	18	15	7	5	3	4				96	9.00	4.50	3.75	1.00	39.7	1508.6
30	F	12	37.0	36	8	18	14	8	5	6	1				96	9.00	4.50	3.50	0.25	38.8	1436.0
31	F	12	42.5	39	7	17	16	7	5	4	1				96	9.75	4.25	4.00	0.25	37.3	1587.0
32	F	12	30.0	48	4	20	7	6	1	7	2		1		96	12.00	5.00	1.75	0.75	38.2	1144.5
33	F	12	35.0	39	5	24	12	5	9	2					96	9.75	6.00	3.00	0.00	36.5	1276.1
34	F	13	28.0	41	5	8	9	17	2	12	2				96	10.25	2.00	2.25	0.50	42.6	1192.0
35	F	13	33.0	40	4	12	13	5	2	19	1				96	10.00	3.00	3.25	0.25	42.8	1412.7
36	F	13	34.0	44	3	19	11	11	3	3	2				96	11.00	4.75	2.75	0.50	37.2	1266.2
37	F	13	32.0	41	23	3	9	12	2	6					96	10.25	0.75	2.25	0.00	37.2	1191.0
38	F	13	31.0	42	2	8	19	25	0	0					96	10.50	2.00	4.75	0.00	36.2	1121.9
39	F	13	35.0	40	5	0	16	29	2	4					96	10.00	0.00	4.00	0.00	39.7	1387.8
40	F	13	33.0	37	10	4	22	22	1	0					96	9.25	1.00	5.50	0.00	36.5	1205.5
41	F	13	27.0	32	6	4	9	25	5	7	8				96	8.00	1.00	2.25	2.00	48.7	1315.4
42	F	13	36.0	35	17	3	6	8	2	5	8		12		96	8.75	0.75	1.50	5.00	56.7	2041.9
43	F	13	29.0	34	15	6	3	27	6	1	3		1		96	8.50	1.50	0.75	1.00	43.4	1259.5
44	F	13	34.0	48	6	0	19	2	9	1	8		3		96	12.00	0.00	4.75	2.75	44.3	1505.2
45	F	13	41.0	42	8	6	18	11	1	10					96	10.50	1.50	4.50	0.00	38.4	1576.0
46	F	13	27.0	41	7	2	10	16	7	13					96	10.25	0.50	2.50	0.00	42.8	1154.3
47	F	13	46.0	42	2	7	14	16	3	12					96	10.50	1.75	3.50	0.00	40.9	1882.8
48	F	13	37.0	41	7	4	10	30	2	2					96	10.25	1.00	2.50	0.00	38.8	1435.6

WEEKEND DAY 3								CATEGORY							Total 15-min		HOURS				
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d⁻¹	Total kcal d⁻¹
49	F	13	35.0	39	6	8	16	15	0	6	3		3		96	9.75	2.00	4.00	1.50	43.2	1513.1
50	F	13	26.0	36	19	0	4	13	4	11	9				96	9.00	0.00	1.00	2.25	48.3	1256.1
51	F	13	37.0	44	4	10	9	22	2	4	1				96	11.00	2.50	2.25	0.25	38.7	1430.4
52	F	13	30.0	42	20	2	8	22	2	0					96	10.50	0.50	2.00	0.00	36.2	1087.2
53	F	13	36.5	46	16	3	9	11	6	3			2		96	11.50	0.75	2.25	0.50	38.5	1406.3
54	F	13	29.0	45	2	5	14	19	1	10					96	11.25	1.25	3.50	0.00	39.6	1148.4
55	F	13	42.0	30	4	0	32	10	5	1	7		7		96	7.50	0.00	8.00	3.50	50.4	2115.5
56	F	13	36.0	36	8	27	10	10	2	2	1				96	9.00	6.75	2.50	0.25	36.4	1311.1
57	F	13	26.0	32	5	37	9	10	1	2					96	8.00	9.25	2.25	0.00	35.8	930.0
58	F	13	27.0	51	2	10	1	13	1	18					96	12.75	2.50	0.25	0.00	41.4	1118.3
59	F	13	30.0	29	11	0	18	30	2	6					96	7.25	0.00	4.50	0.00	42.1	1262.4
60	F	13	24.5	36	4	15	9	26	2	0	4				96	9.00	3.75	2.25	1.00	41.0	1004.5
61	F	13	43.0	35	6	0	0	13	34	0	8				96	8.75	0.00	0.00	2.00	51.9	2229.6
62	F	13	35.0	35	7	8	17	15	1	13					96	8.75	2.00	4.25	0.00	41.4	1449.7
63	F	13	41.0	40	10	18	15	4	0	6	3				96	10.00	4.50	3.75	0.75	37.9	1553.9
64	F	13	36.0	38	11	13	14	4	6	6	4				96	9.50	3.25	3.50	1.00	40.8	1469.5
65	F	13	37.0	39	9	12	13	8	2	5	6		2		96	9.75	3.00	3.25	2.00	43.6	1614.7
66	F	13	36.0	39	13	10	13	5	8	4	2		2		96	9.75	2.50	3.25	1.00	41.0	1474.2
67	F	13	41.0	39	9	8	11	10	7	5	5		2		96	9.75	2.00	2.75	1.75	44.5	1824.9
68	F	13	33.0	41	10	14	8	8	6	5	4				96	10.25	3.50	2.00	1.00	40.5	1337.2
69	F	13	42.0	39	8	21	7	7	4	10					96	9.75	5.25	1.75	0.00	39.0	1636.7
70	F	13	44.0	38	10	17	12	6	5	3			5		96	9.50	4.25	3.00	1.25	39.4	1731.4
71	F	13	36.0	40	7	14	12	9	2	6	6				96	10.00	3.50	3.00	1.50	40.1	1441.8
72	F	13	44.5	37	12	16	9	7	4	5	6				96	9.25	4.00	2.25	1.50	40.2	1788.5
73	F	13	34.0	42	10	15	8	7	3	5	6				96	10.50	3.75	2.00	1.50	38.5	1307.6
74	F	13	44.0	40	9	18	9	7	3	5	5				96	10.00	4.50	2.25	1.25	38.7	1702.8
75	F	13	35.0	39	10	18	10	6	4	5	2		2		96	9.75	4.50	2.50	1.00	40.4	1412.6
76	F	13	42.0	38	8	20	8	7	4	8	3				96	9.50	5.00	2.00	0.75	39.7	1667.8
77	F	13	36.0	41	13	10	11	4	3	6	5		3		96	10.25	2.50	2.75	2.00	38.5	1384.9
78	F	13	26.0	37	10	4	14	10	7	6	4		4		96	9.25	1.00	3.50	2.00	44.9	1166.9
79	F	13	32.0	36	12	14	10	8	4	7	5				96	9.00	3.50	2.50	1.25	41.4	1325.4
80	F	13	36.0	35	9	19	11	9	3	3	4		3		96	8.75	4.75	2.75	1.75	37.6	1354.7
81	F	13	37.0	44	10	4	14	9	4	5	6				96	11.00	1.00	3.50	1.50	41.4	1530.7
82	F	14	30.5	40	10	11	13	8	4	7			3		96	10.00	2.75	3.25	0.75	40.6	1239.5
83	F	14	43.0	36	5	16	10	10	6	11	2				96	9.00	4.00	2.50	0.50	42.62	1832.7
84	F	14	42.0	30	9	0	8	23	6	20					96	7.50	0.00	2.00	0.00	48.31	2029.0
85	F	14	39.5	33	10	18	12	6	4	10	3				96	8.25	4.50	3.00	0.75	41.96	1657.4
86	F	14	43.5	40	4	25	10	7	0	5	5				96	10.00	6.25	2.50	1.25	39.41	1714.3
87	F	14	41.5	40	5	20	14	6	4	7					96	10.00	5.00	3.50	0.00	37.28	1547.1
88	F	14	43.0	39	11	12	13	3	6	6	6				96	9.75	3.00	3.25	1.50	41.91	1802.13
89	F	14	40.5	30	7	9	10	11	11	3	7		8		96	7.50	2.25	2.50	3.75	54.46	2205.6
90	F	14	39.0	40	12	16	15	8	0	5					96	10.00	4.00	3.75	0.00	35.5	1373.9
91	F	14	35.0	36	7	0	6	20	16	11					96	9.00	0.00	1.50	0.00	45.98	1609.3
92	F	14	38.5	35	7	21	4	11	3	14	1				96	8.75	5.25	1.00	0.25	42.56	1638.6
93	F	14	40.0	41	7	13	12	9	2	4	6		2		96	10.25	3.25	3.00	2.00	42.89	1715.6
94	F	14	43.5	40	5	15	14	9	4	9					96	10.00	3.75	3.50	0.00	38.77	1686.5
95	F	14	52.0	36	7	18	8	13	3	7	4				96	9.00	4.50	2.00	1.00	42.06	2187.1
96	F	14	38.0	39	8	16	13	5	4	5	3		3		96	9.75	4.00	3.25	1.50	42.11	1600.2
97	F	14	37.0	38	5	25	9	7	2	6	4				96	9.50	6.25	2.25	1.00	39.91	1476.7

WEEKEND DAY 3				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
98	M	12	24.5	30	19	4	8	9	6	8	8		4		96	7.50	1.00	2.00	3.00	51.2	1253.7
99	M	12	28.5	40	9	4	15	4	1	10	8		5		96	10.00	1.00	3.75	3.25	49.5	1411.0
100	M	12	29.0	39	5	16	16	13	2	2	3				96	9.75	4.00	4.00	0.75	38.3	1109.8
101	M	12	39.0	37	5	6	27	2	5	14	0				96	9.25	1.50	6.75	0.00	40.4	1576.0
102	M	12	24.0	36	3	11	24	4	0	2	8		8		96	9.00	2.75	6.00	4.00	49.4	1184.6
103	M	12	27.0	49	7	18	4	12	0	6	0				96	12.25	4.50	1.00	0.00	35.6	962.3
104	M	12	37.5	30	10	12	21	4	0	13	2		4		96	7.50	3.00	5.25	1.50	45.7	1715.3
105	M	12	36.0	47	7	14	12	5	2	3	4		2		96	11.75	3.50	3.00	1.50	39.3	1415.2
106	M	12	43.0	29	3	2	19	5	9	26	3				96	7.25	0.50	4.75	0.75	51.2	2199.9
107	M	12	31.0	46	3	20	5	10	6	5	1				96	11.50	5.00	1.25	0.25	37.8	1173.0
108	M	12	30.5	40	4	30	7	6	0	4			5		96	10.00	7.50	1.75	1.25	40.3	1227.9
109	M	12	26.0	33	9	33	4	5	6	6					96	8.25	8.25	1.00	0.00	38.1	990.3
110	M	12	29.5	47	14	10	4	7	2	4	4	4			96	11.75	2.50	1.00	2.00	42.0	1239.1
111	M	12	35.0	40	5	18	15	3	2	7			6		96	10.00	4.50	3.75	1.50	42.8	1498.4
112	M	12	28.0	39	3	28	16	2	0	4	4				96	9.75	7.00	4.00	1.00	37.3	1044.4
113	M	12	42.0	44	9	9	8	13	9	4					96	11.00	2.25	2.00	0.00	38.3	1608.6
114	M	12	38.0	33	12	22	19	8	0	2					96	8.25	5.50	4.75	0.00	35.0	1328.5
115	M	12	30.5	41	5	24	12	7	1	2			4		96	10.25	6.00	3.00	1.00	38.6	1177.3
116	M	12	28.0	37	5	23	4	18	6	3					96	9.25	5.75	1.00	0.00	38.7	1083.6
117	M	12	30.0	36	12	32	6	4	2	4					96	9.00	8.00	1.50	0.00	35.4	1061.4
118	M	12	38.0	30	8	24	4	8	0	22					96	7.50	6.00	1.00	0.00	44.5	1691.8
119	M	12	30.0	38	3	16	21	13	4	1					96	9.50	4.00	5.25	0.00	36.1	1082.7
120	M	12	23.0	39	4	18	15	3	2	5	2		8		96	9.75	4.50	3.75	2.50	45.9	1055.5
121	M	12	35.0	29	15	27	15	2	6	2					96	7.25	6.75	3.75	0.00	36.2	1265.6
122	M	12	32.0	47	5	26	9	3	2	4					96	11.75	6.50	2.25	0.00	33.9	1083.8
123	M	12	28.0	46	5	29	10	3	1	2					96	11.50	7.25	2.50	0.00	32.8	917.3
124	M	12	41.0	42	9	25	6	6	1	2	1		4		96	10.50	6.25	1.50	1.25	39.1	1603.5
125	M	12	25.0	41	9	22	10	6	2	2	1		3		96	10.25	5.50	2.50	1.00	38.4	960.5
126	M	12	31.0	30	9	32	6	5	5	3	1		5		96	7.50	8.00	1.50	1.50	43.2	1338.6
127	M	12	24.5	46	6	12	7	3	5	4	3		10		96	11.50	3.00	1.75	3.25	48.6	1190.2
128	M	12	43.0	40	7	10	13	6	4	7	5		4		96	10.00	2.50	3.25	2.25	45.9	1972.0
129	M	12	42.5	38	5	9	20	7	7	6	4				96	9.50	2.25	5.00	1.00	41.5	1762.1
130	M	13	30.0	37	3	3	27	6	5	15					96	9.25	0.75	6.75	0.00	41.6	1248.9
131	M	13	29.0	34	4	20	18	5	6	0	4		5		96	8.50	5.00	4.50	2.25	44.1	1278.6
132	M	13	29.0	26	9	9	8	25	12	0	7				96	6.50	2.25	2.00	1.75	47.6	1379.5
133	M	13	41.0	32	2	20	9	8	2	6	2		15		96	8.00	5.00	2.25	4.25	56.0	2295.2
134	M	13	32.0	37	2	22	11	9	3	12					96	9.25	5.50	2.75	0.00	40.2	1286.4
135	M	13	25.0	33	6	4	16	5	27	0	5				96	8.25	1.00	4.00	1.25	45.9	1148.5
136	M	13	40.0	38	8	6	6	22	2	8		6			96	9.50	1.50	1.50	1.50	46.5	1860.8
137	M	13	35.0	48	3	11	4	21	1	1			7		96	12.00	2.75	1.00	1.75	43.3	1516.2
138	M	13	29.5	43	13	0	7	5	18	2	8				96	10.75	0.00	1.75	2.00	45.3	1337.2
139	M	13	31.0	36	9	5	13	17	14	2					96	9.00	1.25	3.25	0.00	40.7	1260.2
140	M	13	32.0	44	9	0	19	2	13	1			8		96	11.00	0.00	4.75	2.00	45.0	1441.0
141	M	13	33.0	46	4	12	4	9	12	2			7		96	11.50	3.00	1.00	1.75	45.2	1490.0
142	M	13	26.0	32	2	23	12	5	2	6			1	13	96	8.00	5.75	3.00	3.50	59.2	1537.9
143	M	13	34.0	44	9	7	18	8	3	0	7				96	11.00	1.75	4.50	1.75	39.4	1339.3
144	M	13	31.5	36	3	7	4	14	17	0			15		96	9.00	1.75	1.00	3.75	56.9	1792.0

WEEKEND DAY 3							CATEGORY								Total 15-min		HOURS				
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
145	M	13	25.0	35	8	3	3	22	14	0	11				96	8.75	0.75	0.75	2.75	49.8	1245.5
146	M	13	31.0	40	9	8	11	10	4	0	4		10		96	10.00	2.00	2.75	3.50	49.3	1528.3
147	M	13	30.0	40	11	8	11	10	12	0	4				96	10.00	2.00	2.75	1.00	40.6	1217.4
148	M	13	25.0	37	6	8	18	21	6	0					96	9.25	2.00	4.50	0.00	37.9	947.3
149	M	13	44.0	27	6	14	13	8	14	6			8		96	6.75	3.50	3.25	2.00	50.8	2236.1
150	M	13	31.0	33	9	7	24	16	2	0	5				96	8.25	1.75	6.00	1.25	40.3	1248.7
151	M	13	42.0	41	8	20	9	7	2	3	2		4		96	10.25	5.00	2.25	1.50	41.0	1722.4
152	M	13	32.5	44	4	6	9	16	2	8	6		1		96	11.00	1.50	2.25	1.75	44.6	1448.9
153	M	13	35.0	37	6	4	14	10	6	8	7		4		96	9.25	1.00	3.50	2.75	49.7	1739.5
154	M	13	32.0	42	6	4	12	11	7	9	5				96	10.50	1.00	3.00	1.25	43.9	1406.1
155	M	13	33.0	42	7	12	12	5	5	5	4		4		96	10.50	3.00	3.00	2.00	44.0	1452.0
156	M	13	32.5	43	6	7	16	7	5	4	2		6		96	10.75	1.75	4.00	2.00	44.4	1443.0
157	M	13	36.0	39	4	24	7	6	2	6	4		4		96	9.75	6.00	1.75	2.00	44.1	1586.9
158	M	13	33.0	38	7	17	11	4	6	6	5		2		96	9.50	4.25	2.75	1.75	43.6	1440.1
159	M	13	26.5	42	5	14	13	4	4	5	4		5		96	10.50	3.50	3.25	2.25	44.6	1182.4
160	M	13	34.0	40	12	4	17	6	4	7	4		2		96	10.00	1.00	4.25	1.50	42.8	1455.2
161	M	13	33.0	43	8	6	10	9	3	4	9		4		96	10.75	1.50	2.50	3.25	47.5	1568.8
162	M	13	40.0	41	7	16	4	3	4	7	10		4		96	10.25	4.00	1.00	3.50	49.3	1970.8
163	M	13	31.0	40	6	9	13	8	3	6	3		8		96	10.00	2.25	3.25	2.75	48.3	1497.6
164	M	13	38.0	39	7	8	10	17	2	7	4		2		96	9.75	2.00	2.50	1.50	44.4	1686.8
165	M	14	39.0	40	10	0	13	10	10	5			8		96	10.00	0.00	3.25	2.00	47.9	1869.7
166	M	14	46.0	26	13	26	13	9	3	2			4		96	6.50	6.50	3.25	1.00	41.4	1904.4
167	M	14	50.0	44	4	16	15	3	1	9			4		96	11.00	4.00	3.75	1.00	40.7	2035.0
168	M	14	54.0	37	8	5	13	9	5	9	4		6		96	9.25	1.25	3.25	2.50	49.4	2669.8
169	M	14	51.5	33	8	11	21	7	0	9	2		5		96	8.25	2.75	5.25	1.75	45.2	2329.3
170	M	14	34.0	43	6	15	13	6	2	3	2		6		96	10.75	3.75	3.25	2.00	42.8	1455.9
171	M	14	35.0	40	5	16	14	4	2	7	3		5		96	10.00	4.00	3.50	2.00	44.3	1551.9
172	M	14	47.0	39	7	12	7	9	4	8	6		4		96	9.75	3.00	1.75	2.50	47.8	2248.0
173	M	14	44.5	38	9	11	12	8	1	9	4		4		96	9.50	2.75	3.00	2.00	45.7	2031.4
174	M	14	56.0	41	12	16	8	7	3	3	2		4		96	10.25	4.00	2.00	1.50	40.7	2280.3
175	M	14	33.0	39	5	14	17	4	6	11					96	9.75	3.50	4.25	0.00	39.5	1302.8
176	M	14	40.0	37	9	10	14	7	2	2	5		10		96	9.25	2.50	3.50	3.75	50.2	2008.4
177	M	14	41.5	30	14	18	20	7	0	0			7		96	7.50	4.50	5.00	1.75	42.1	1745.1
178	M	14	37.5	36	7	21	9	4	3	11	5				96	9.00	5.25	2.25	1.25	43.0	1612.9
179	M	14	36.0	37	6	19	10	8	5	4	3		4		96	9.25	4.75	2.50	1.75	43.9	1580.0

VN - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	TRICEPS	SUBSCAP	SUM_SKIN	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
1	F	12	134.0	25.0	13.9	90	45	6.8	6.5	13.3	11	23	160	32	7.1	low
2	F	12	138.0	35.0	18.4	85	30	9.2	7.0	16.2	8	20	170	34	6.3	low
3	F	12	134.0	26.0	14.5	90	35	8.4	6.0	14.4	16	17	140	29	5.4	low
4	F	12	139.0	32.0	16.6	100	60	13.0	8.0	21.0	14	19	160	28	9.5	low
5	F	12	145.0	41.0	19.5	90	40	13.0	8.5	21.5	23	23	150	31	5.3	low
6	F	12	140.0	35.0	17.9	85	45	18.5	16.0	34.5	5	9	150	27	5.6	high
7	F	12	150.0	51.0	22.7	130	70	28.0	15.8	43.8	11	15	130	28	5.1	low
8	F	12	128.0	27.5	16.8	90	45	9.0	6.8	15.8	10	20	150	18	5.2	low
9	F	12	139.0	26.0	13.5	105	50	6.0	5.6	11.6	12	23	170	35	6.2	low
10	F	12	138.0	32.0	16.8	120	50	8.6	8.8	17.4	18	9	165	35	6.4	low
11	F	12	139.0	32.0	16.6	95	55	6.6	5.2	11.8	5	16	190	37	4.7	low
12	F	12	130.0	24.0	14.2	85	45	8.4	5.8	14.2	14	10	150	25	5.9	low
13	F	12	134.0	28.0	15.6	85	30	7.6	4.6	12.2	12	17	170	35	7.1	low
14	F	12	139.0	35.0	18.1	90	50	7.8	9.0	16.8	11	25	160	36	6.3	high
15	F	12	144.0	31.0	14.9	110	60	7.0	7.0	14.0	11	31	170	33	6.3	low
16	F	12	145.0	32.0	15.2	85	45	6.2	6.0	12.2	11	22	170	32	5.6	low
17	F	12	146.0	35.0	16.4	110	60	8.0	6.0	14.0	9	33	160	34	6.1	low
18	F	12	149.0	35.0	15.8	85	45	7.4	6.0	13.4	22.5	16	178	36	5.4	high
19	F	12	145.0	34.0	16.2	120	80	8.4	7.0	15.4	6.5	24	177	25	7.7	low
20	F	12	133.0	25.5	14.4	90	50	8.0	7.0	15.0	4	4	155	35	6.4	high
21	F	12	150.0	36.0	16.0	80	40	7.8	7.0	14.8	15	16	162	27	4.5	low
22	F	12	142.0	35.0	17.4	105	55	7.8	7.2	15.0	14	36	198	38	7.4	low
23	F	12	159.0	41.0	16.2	90	50	9.5	8.4	17.9	4	15	180	31	3.7	high
24	F	12	133.0	25.0	14.1	90	50	7.2	5.6	12.8	8	17	167	27	9.3	high
25	F	12	139.0	32.0	16.6	95	55	9.4	7.0	16.4	15	10	160	30	5.8	low
26	F	12	141.0	31.0	15.6	90	50	5.0	6.8	11.8	18.5	15	192	35	5.4	low
27	F	12	127.0	21.5	13.3	90	60	6.0	5.0	11.0	6	17	150	27	5.2	low
28	F	12	152.0	39.0	16.9	110	70	10.4	8.0	18.4	9	8	177	30	5.8	low
29	F	12	150.0	38.0	16.9	120	80	7.6	7.0	14.6	1	18	177	33	7.9	high
30	F	12	148.0	37.0	16.9	95	55	8.2	8.0	16.2	10	12	170	30	5.9	high
31	F	12	145.0	42.5	20.2	130	90	14.8	12.0	26.8	12	20	168	32	4.9	high
32	F	12	143.0	30.0	14.7	95	55	7.0	5.4	12.4	4	8	182	31	7.2	high
33	F	12	146.0	35.0	16.4	110	70	8.0	8.0	16.0	18	8	145	26	5.5	low
34	F	13	142.0	28.0	13.9	100	50	7.6	5.0	12.6	3	27	140	30	5.9	low
35	F	13	145.0	33.0	15.7	100	60	8.6	9.0	17.6	11	32	190	38	7.1	low
36	F	13	142.0	34.0	16.9	120	50	9.0	7.4	16.4	16	23	155	33	8.4	low
37	F	13	141.0	32.0	16.1	90	50	9.4	8.0	17.4	23	26	175	40	6.7	high
38	F	13	153.0	31.0	13.2	80	50	6.8	5.8	12.6	8	20	155	35	7.6	low
39	F	13	145.0	35.0	16.6	80	50	7.0	8.0	15.0	14	41	175	39	7.1	low
40	F	13	150.0	33.0	14.7	80	50	6.4	5.8	12.2	20	18	180	35	7.2	low
41	F	13	141.0	27.0	13.6	90	50	7.0	5.2	12.2	18	20	160	34	5.5	low
42	F	13	145.0	36.0	17.1	90	50	9.8	10.2	20.0	18	30	160	29	4.9	low
43	F	13	152.0	29.0	12.6	90	60	7.0	5.6	12.6	11	17	172	40	7.2	low
44	F	13	149.0	34.0	15.3	100	60	4.6	4.8	9.4	11	14	200	43	6.7	low
45	F	13	152.0	41.0	17.7	110	70	12.0	10.6	22.6	17	18	170	35	6.7	low
46	F	13	146.0	27.0	12.7	80	60	7.8	5.0	12.8	11	30	172	29	7.4	low
47	F	13	156.0	46.0	18.9	100	65	9.4	11.0	20.4	24	23	180	38	5.9	low
48	F	13	148.0	37.0	16.9	90	60	7.3	6.1	13.4	17	30	178	30	8.7	low

VN - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	TRICEPS	SUBSCAP	SUM_SKIN	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
49	F	13	147.0	35.0	16.2	120	80	8.4	6.0	14.4	19	30	180	35	8.4	high
50	F	13	137.0	26.0	13.9	80	50	9.2	5.0	14.2	15	25	155	31	7.4	low
51	F	13	148.0	37.0	16.9	110	70	7.2	7.0	14.2	16	20	170	29	7.6	low
52	F	13	147.0	30.0	13.9	80	50	9.2	7.6	16.8	8	28	155	36	4.8	low
53	F	13	152.0	36.5	15.8	100	70	10.4	7.0	17.4	6	10	170	36	6.2	low
54	F	13	142.0	29.0	14.4	80	50	6.4	6.0	12.4	14	30	190	40	8.8	low
55	F	13	148.0	42.0	19.2	100	80	26.0	10.6	36.6	17	28	185	32	16.2	low
56	F	13	148.0	36.0	16.4	110	80	8.8	9.0	17.8	7	25	165	36	6.1	low
57	F	13	134.0	26.0	14.5	80	50	8.2	5.6	13.8	16	30	172	35	7.2	low
58	F	13	141.0	27.0	13.6	90	50	6.6	5.0	11.6	11	17	175	35	5.9	low
59	F	13	142.0	30.0	14.9	70	30	7.0	6.6	13.6	10	20	192	38	6.2	low
60	F	13	136.0	24.5	13.2	90	50	6.0	6.4	12.4	13	40	180	33	7.2	low
61	F	13	146.0	43.0	20.2	80	50	14.2	11.0	25.2	7	23	165	32	5.9	high
62	F	13	147.0	35.0	16.2	80	50	7.0	6.6	13.6	14	28	172	33	6.1	low
63	F	13	155.0	41.0	17.1	90	50	10.2	8.0	18.2	6	13	162	35	6.8	high
64	F	13	148.0	36.0	16.4	95	60	8.8	9.0	17.8	20	6	162	31	6.2	low
65	F	13	145.0	37.0	17.6	100	55	8.4	8.2	16.6	10	21	199	45	6.3	low
66	F	13	149.0	36.0	16.2	95	45	8.0	9.0	17.0	23	26	158	29	6.7	low
67	F	13	152.0	41.0	17.7	100	60	8.0	7.8	15.8	9	25	175	39	6.4	high
68	F	13	154.0	33.0	13.9	95	45	7.2	6.4	13.6	1	23	187	36	6.5	high
69	F	13	156.0	42.0	17.3	100	60	10.2	9.0	19.2	1	21	158	29	5.9	high
70	F	13	156.0	44.0	18.1	100	55	10.6	13.0	23.6	12	6	137	23	5.7	low
71	F	13	153.0	36.0	15.4	90	50	6.2	6.4	12.6	5	2	170	35	6.7	high
72	F	13	149.0	44.5	20.0	100	55	13.5	11.1	24.6	19	19	158	31	7.1	high
73	F	13	143.0	34.0	16.6	80	40	12.0	9.0	21.0	10	14	140	26	5.5	high
74	F	13	156.0	44.0	18.1	100	50	10.4	9.6	20.0	14	6	155	26	4.3	low
75	F	13	142.0	35.0	17.4	105	45	8.2	6.0	14.2	16	6	177	43	7.5	high
76	F	13	155.0	42.0	17.5	100	60	8.0	8.4	16.4	19	19	188	29	8.5	low
77	F	13	149.0	36.0	16.2	95	60	10.0	6.2	16.2	17	8	173	28	10.7	low
78	F	13	129.0	26.0	15.6	80	40	6.6	6.0	12.6	18	6	156	34	6.5	low
79	F	13	141.0	32.0	16.1	95	55	7.0	6.8	13.8	7	18	180	33	8.7	low
80	F	13	146.0	36.0	16.9	100	60	5.7	3.8	9.5	12	13	169	33	7.8	high
81	F	13	147.0	37.0	17.1	95	60	6.3	5.9	12.2	11	14	171	36	7.6	high
82	F	14	137.0	30.5	16.3	95	50	7.2	5.6	12.8	5	4	145	23	6.3	high
83	F	14	151.0	43.0	18.9	100	65	9.1	10.8	19.9	9	21	170	35	6.3	high
84	F	14	153.0	42.0	17.9	100	60	8.3	8.6	16.9	20	23	186	29	8.7	low
85	F	14	153.0	39.5	16.9	90	60	7.2	6.8	14.0	5	4	169	33	6.5	low
86	F	14	157.0	43.5	17.6	100	65	10.2	10.5	20.7	3	23	160	31	6.1	high
87	F	14	152.0	41.5	18.0	100	55	9.6	12.8	22.4	14	7	151	25	5.9	high
88	F	14	149.0	43.0	19.4	100	65	12.5	11.3	23.8	19	20	165	32	7.6	high
89	F	14	154.0	40.5	17.1	95	55	6.3	7.3	13.6	9	25	185	39	7.7	high
90	F	14	150.0	39.0	17.3	105	45	7.2	7.1	14.3	16	8	180	38	7.9	high
91	F	14	149.0	35.0	15.8	80	45	5.7	6.7	12.4	10	12	145	30	5.7	low
92	F	14	151.0	38.5	16.9	100	55	8.4	7.6	16.0	14	9	165	30	5.8	high
93	F	14	154.0	40.0	16.9	110	50	8.4	10.0	18.4	14.5	19	195	36	6.5	high
94	F	14	149.0	43.5	19.6	90	55	15.2	3.4	18.6	9	17	170	32	6.8	high
95	F	14	154.0	52.0	21.9	115	75	20.5	21.0	41.5	19	15	170	41	5.8	high
96	F	14	147.0	38.0	17.6	95	60	8.0	7.6	15.6	14.5	25	170	39	7.1	low
97	F	14	156.0	37.0	15.2	100	65	10.0	7.6	17.6	11	19	150	30	4.9	low

VN - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	TRICEPS	SUBSCAP	SUM_SKIN	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
98	M	12	134.0	24.5	13.6	75	40	3.8	3.6	7.4	8	13	135	41	10.1	low
99	M	12	136.0	28.5	15.4	90	50	8.2	5.2	13.4	4	30	170	34	8.6	low
100	M	12	146.0	29.0	13.6	80	50	6.0	4.8	10.8	1	17	155	29	8.5	high
101	M	12	151.0	39.0	17.1	85	40	8.2	6.2	14.4	5	20	180	35	6.4	low
102	M	12	130.0	24.0	14.2	85	35	7.0	4.8	11.8	8	35	180	40	10.1	high
103	M	12	138.0	27.0	14.2	85	40	8.8	4.8	13.6	6	32	150	34	6.8	high
104	M	12	146.0	37.5	17.6	110	55	10.4	10.0	20.4	12	28	160	27	5.1	low
105	M	12	139.0	36.0	18.6	90	45	10.0	6.6	16.6	3	30	170	41	6.6	low
106	M	12	149.0	43.0	19.4	110	90	8.4	6.5	14.9	1	12	160	29	4.7	low
107	M	12	140.0	31.0	15.8	90	60	6.2	5.0	11.2	17	23	195	48	8.9	low
108	M	12	140.0	30.5	15.6	90	60	10.0	7.2	17.2	7	7	168	33	8.3	high
109	M	12	131.0	26.0	15.2	95	50	5.6	4.4	10.0	3	4	161	31	9.1	low
110	M	12	137.0	29.5	15.7	90	55	7.8	4.8	12.6	10	15	172	33	7.8	low
111	M	12	148.0	35.0	16.0	80	50	8.4	5.4	13.8	10	7	170	32	7.7	low
112	M	12	135.0	28.0	15.4	95	50	5.2	5.4	10.6	3	8	160	40	8.9	low
113	M	12	158.0	42.0	16.8	120	80	7.4	7.8	15.2	1	28	158	28	7.3	low
114	M	12	145.0	38.0	18.1	120	70	10.0	7.0	17.0	4	17	170	34	7.6	low
115	M	12	134.0	30.5	17.0	95	50	10.2	7.6	17.8	13.5	6	154	29	5.7	high
116	M	12	143.0	28.0	13.7	95	50	5.6	5.0	10.6	3.2	15	148	30	7	low
117	M	12	142.0	30.0	14.9	100	60	5.2	4.0	9.2	5.7	33	197	40	9.1	high
118	M	12	154.0	38.0	16.0	95	55	9.0	6.4	15.4	7	17	188	38	7.4	low
119	M	12	138.0	30.0	15.8	95	55	12.0	6.4	18.4	5	19	148	34	8.2	low
120	M	12	129.0	23.0	13.8	90	50	6.0	3.8	9.8	2	8	175	30	6.6	low
121	M	12	150.0	35.0	15.6	95	50	7.0	5.6	12.6	9	29	169	34	8.3	low
122	M	12	143.0	32.0	15.6	120	80	8.2	5.0	13.2	1	17	186	38	6.4	low
123	M	12	130.0	28.0	16.6	90	50	7.0	4.2	11.2	6.5	5	175	36	7.6	high
124	M	12	138.0	41.0	21.5	100	60	18.2	13.2	31.4	10	13	152	27	6.4	high
125	M	12	132.0	25.0	14.3	95	55	6.8	5.2	12.0	5.5	6	155	27	6.4	low
126	M	12	143.0	31.0	15.2	75	35	12.2	6.2	18.4	7	17	145	33	8.4	low
127	M	12	136.0	24.5	13.2	120	90	5.0	4.4	9.4	4.1	13	171	24	6.8	low
128	M	12	162.0	43.0	16.4	100	70	6.2	6.0	12.2	16	20	202	50	8.2	low
129	M	12	141.0	42.5	21.4	95	60	17.9	14.5	32.4	9	8	185	26	6.2	high
130	M	13	136.0	30.0	16.2	95	45	9.4	6.4	15.8	14	10	155	23	4.4	low
131	M	13	143.0	29.0	14.2	105	50	5.8	4.4	10.2	8	21	170	36	7.9	low
132	M	13	140.0	29.0	14.8	80	40	8.4	6.0	14.4	10	30	185	38	12.4	low
133	M	13	155.0	41.0	17.1	110	70	4.0	4.6	8.6	12	62	202	46	7.8	high
134	M	13	141.0	32.0	16.1	80	40	9.0	5.8	14.8	10	40	190	35	13.6	low
135	M	13	136.0	25.0	13.5	110	70	6.0	5.0	11.0	11	25	200	44	10.9	high
136	M	13	151.0	40.0	17.5	110	60	6.4	6.4	12.8	11	24	210	42	10	low
137	M	13	150.0	35.0	15.6	90	60	5.8	4.2	10.0	10	35	170	40	10.1	low
138	M	13	143.0	29.5	14.4	70	40	6.2	4.6	10.8	2	21	180	34	7.5	low
139	M	13	145.0	31.0	14.7	120	80	4.6	4.4	9.0	14	30	200	47	7.4	low
140	M	13	143.0	32.0	15.6	90	50	5.2	5.0	10.2	8	26	175	39	13.13	low
141	M	13	145.0	33.0	15.7	80	40	4.2	4.4	8.6	11	60	182	32	8.1	low
142	M	13	140.0	26.0	13.3	100	60	5.2	4.0	9.2	10	34	175	30	9.5	low
143	M	13	148.0	34.0	15.5	80	40	5.0	4.8	9.8	11	50	200	36	9.1	low
144	M	13	140.0	31.5	16.1	100	50	8.0	5.8	13.8	8	30	175	29	9.9	low

VN - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	TRICEPS	SUBSCAP	SUM_SKIN	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
145	M	13	137.0	25.0	13.3	90	45	6.4	4.4	10.8	9	20	170	34	8.4	low
146	M	13	137.0	31.0	16.5	90	60	7.6	5.2	12.8	12	20	180	34	8.1	low
147	M	13	142.0	30.0	14.9	80	50	7.2	5.8	13.0	6	40	195	40	9.11	low
148	M	13	132.0	25.0	14.3	80	60	7.6	5.4	13.0	8	15	160	37	8	high
149	M	13	148.0	44.0	20.1	110	80	11.2	8.0	19.2	13	32	190	33	8.1	low
150	M	13	146.0	31.0	14.5	90	55	5.4	5.0	10.4	11	15	195	45	7.1	low
151	M	13	148.0	42.0	19.2	95	65	7.2	6.2	13.4	11	32	206	43	7.5	high
152	M	13	133.0	32.5	18.4	100	60	12.8	7.4	20.2	14	25	169	21	7.6	low
153	M	13	149.0	35.0	15.8	90	60	4.6	4.2	8.8	6	12	208	37	7.2	low
154	M	13	144.0	32.0	15.4	85	45	5.2	5.0	10.2	6	22	196	41	6.9	high
155	M	13	140.0	33.0	16.8	85	50	6.4	5.0	11.4	3	14	157	28	11.4	low
156	M	13	143.0	32.5	15.9	100	60	7.0	5.2	12.2	8	16	177	33	8.11	high
157	M	13	151.0	36.0	15.8	110	50	4.2	5.0	9.2	11	26	200	28	11.1	high
158	M	13	150.0	33.0	14.7	100	60	6.8	5.2	12.0	5	2	179	33	8.8	high
159	M	13	137.0	26.5	14.1	90	60	7.2	5.0	12.2	8	21	172	38	8.1	low
160	M	13	141.0	34.0	17.1	115	65	7.6	6.0	13.6	6	57	190	34	10.4	high
161	M	13	148.0	33.0	15.1	90	45	6.0	4.0	10.0	9	5	198	36	8.3	high
162	M	13	159.0	40.0	15.8	95	60	7.0	6.4	13.4	3	45	193	33	7.5	high
163	M	13	141.0	31.0	15.6	95	50	7.2	5.4	12.6	7	15	181	31	10.6	low
164	M	13	148.0	38.0	17.3	90	60	4.7	4.1	8.8	6	12	208	41	7.4	high
165	M	14	156.0	39.0	16.0	80	30	6.2	5.4	11.6	11	15	165	37	7.2	low
166	M	14	157.0	46.0	18.7	90	50	5.4	5.6	11.0	8	30	220	55	8.1	low
167	M	14	157.0	50.0	20.3	100	65	7.4	6.6	14.0	13	29	229	42	10.2	high
168	M	14	156.0	54.0	22.2	100	55	6.5	10.0	16.5	19	23	195	31	9.3	high
169	M	14	150.0	51.5	22.9	110	60	10.6	8.9	19.5	13	30	180	46	8.7	low
170	M	14	151.0	34.0	14.9	110	60	6.0	6.0	12.0	11	31	200	33	8.4	low
171	M	14	145.0	35.0	16.6	100	60	5.4	4.8	10.2	3	25	170	38	9.1	low
172	M	14	152.0	47.0	20.3	105	50	5.4	5.2	10.6	6.5	19	160	38	8.4	high
173	M	14	151.5	44.5	19.4	110	45	5.1	4.9	10.0	8	22	170	38	7.8	low
174	M	14	169.0	56.0	19.6	115	60	6.0	7.2	13.2	5	21	210	57	9.6	high
175	M	14	144.0	33.0	15.9	110	55	4.0	4.6	8.6	6.5	20	165	29	9.7	low
176	M	14	156.0	40.0	16.4	100	65	5.7	4.6	10.3	14	22	210	42	8	high
177	M	14	154.0	41.5	17.5	110	70	6.8	6.2	13.4	12	49	195	35	7.5	high
178	M	14	152.0	37.5	16.2	100	65	6.2	5.8	12.0	11	30	205	40	7.8	low
179	M	14	147.0	36.0	16.7	120	50	8.0	7.2	15.2	17	30	190	37	8.7	low

WEEKDAY I							CATEGORY								Total 15-min		HOURS				
AV-GROUP	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
1	F	12	40.0	34	12	25	10	5	2	5	2		1		96	8.50	6.25	2.50	0.75	39.0	1561.2
2	F	12	37.0	39	8	30	3	2		4	5		5		96	9.75	7.50	0.75	2.50	43.7	1617.6
3	F	12	38.0	48	5	8	21	5			5		4		96	12.00	2.00	5.25	2.25	40.3	1529.5
4	F	12	32.0	36	10	28	14	3	3	2					96	9.00	7.00	3.50	0.00	34.6	1106.6
5	F	12	38.5	36	12	26	6	4	3	6			3		96	9.00	6.50	1.50	0.75	40.0	1538.8
6	F	12	46.5	35	9	23	7	6	7	5			4		96	8.75	5.75	1.75	1.00	42.4	1970.2
7	F	12	36.0	31	12	23	10	7	11		2				96	7.75	5.75	2.50	0.50	39.1	1409.0
8	F	12	37.0	37	11	25	12	4	5	2					96	9.25	6.25	3.00	0.00	35.3	1305.0
9	F	12	39.0	38	2	19	15	8	4	6	2		2		96	9.50	4.75	3.75	1.00	41.3	1611.5
10	F	12	40.0	40	3	7	20	9	5	8	4				96	10.00	1.75	5.00	1.00	41.9	1676.0
11	F	12	40.0	37	6	20	11	5	3	6	6		2		96	9.25	5.00	2.75	2.00	43.8	1753.6
12	F	12	40.0	38	4	24	13	3	4	5	5				96	9.50	6.00	3.25	1.25	40.1	1605.2
13	F	12	37.0	35	5	23	10	6	5	8	4				96	8.75	5.75	2.50	1.00	41.9	1551.4
14	F	12	53.0	37	10	15	10	5	7	2	2		8		96	9.25	3.75	2.50	2.50	46.7	2474.0
15	F	12	42.0	38	10	16	10	2	4	2	7		7		96	9.50	4.00	2.50	3.50	48.0	2017.7
16	F	12	46.0	38	10	19	5	8	10		6				96	9.50	4.75	1.25	1.50	41.5	1907.2
17	F	13	47.0	38	3	19	15	7	4	6	2		2		96	9.50	4.75	3.75	1.00	41.1	1933.1
18	F	13	48.0	32	10	18	15	9	8	4					96	8.00	4.50	3.75	0.00	38.7	1856.2
19	F	13	38.0	39	5	30	8	3	3	3			5		96	9.75	7.50	2.00	1.25	40.3	1530.6
20	F	13	43.0	30	4	32	3	5	3	6	9		4		96	7.50	8.00	0.75	3.25	49.4	2123.3
21	F	13	43.0	43	11	26	8	1	2	1	2		2		96	10.75	6.50	2.00	1.00	36.5	1568.2
22	F	13	50.5	35	9	24	12	3	4	2	4		3		96	8.75	6.00	3.00	1.75	41.7	2103.3
23	F	13	45.0	36	14	20	7	4	4	5	2		4		96	9.00	5.00	1.75	1.50	42.6	1916.1
24	F	13	39.0	36	10	20	8	5	6	3	2		6		96	9.00	5.00	2.00	2.00	44.7	1743.7
25	F	13	38.0	39	15	14	8	6	4	8			2		96	9.75	3.50	2.00	0.50	40.1	1523.8
26	F	14	46.0	37	7	14	10	8	5	4	5		6		96	9.25	3.50	2.50	2.75	47.8	2197.4
27	F	14	45.0	38	4	18	10	5	6	9	4		2		96	9.50	4.50	2.50	1.50	44.4	1997.6
28	F	14	45.0	37	6	20	12	5	7	6			3		96	9.25	5.00	3.00	0.75	41.3	1857.6
29	F	14	38.0	34	9	21	7	6	11	4	4				96	8.50	5.25	1.75	1.00	42.1	1598.7
30	F	14	55.0	39		14	12	10	5	12				4	96	9.75	3.50	3.00	1.00	47.3	2598.8
31	F	14	46.0	40	9	18	8	6	5	6	4				96	10.00	4.50	2.00	1.00	40.4	1858.9
32	F	14	46.0	34	10	30		6	2	5	5		4		96	8.50	7.50	0.00	2.25	45.0	2071.8
33	F	14	43.0	42		7	18	12	5	5	3			4	96	10.50	1.75	4.50	1.75	46.5	1999.9
34	F	14	53.0	36	14	17	8	2	8	7			4		96	9.00	4.25	2.00	1.00	42.7	2264.2
35	F	14	48.0	40	8	24	9	6	1	2	6				96	10.00	6.00	2.25	1.50	39.0	1870.6
36	F	14	35.0	33	12	22	8	9	8		4				96	8.25	5.50	2.00	1.00	40.0	1399.7
37	F	14	47.0	42	12	23	8	5	2	4	0		0		96	10.50	5.75	2.00	0.00	34.9	1638.0

WEEKDAY 1							CATEGORY								Total 15-min		HOURS				
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
38	M	12	38.0	40	19	16	6	3	3	2	7				96	10.00	4.00	1.50	1.75	39.8	1513.9
39	M	12	41.5	39	12	12	15	4	1	7		6			96	9.75	3.00	3.75	1.50	42.2	1751.7
40	M	12	40.0	39	10	21	12	8	1	3	2				96	9.75	5.25	3.00	0.50	36.7	1466.0
41	M	12	44.0	36	8	22	8	6	3	5	8				96	9.00	5.50	2.00	2.00	43.1	1896.0
42	M	12	38.5	39	14	18	10	4	2	3	6				96	9.75	4.50	2.50	1.50	39.5	1520.0
43	M	12	39.0	40	9	21	12	4	2	8					96	10.00	5.25	3.00	0.00	36.7	1432.9
44	M	12	43.0	39	4	24	9	5	10	1	4				96	9.75	6.00	2.25	1.00	39.6	1702.4
45	M	12	51.0	38	11	20	9	2	9	3	4				96	9.50	5.00	2.25	1.00	39.8	2027.3
46	M	13	43.0	40	17	20	9	2	2	2			4		96	10.00	5.00	2.25	1.00	38.1	1637.4
47	M	13	46.0	36	7	12	20	3	5	5	4		4		96	9.00	3.00	5.00	2.00	44.3	2039.6
48	M	13	42.0	36	18	19	4	6	4	9					96	9.00	4.75	1.00	0.00	38.7	1624.6
49	M	13	50.0	52	7		16	9	5	7					96	13.00	0.00	4.00	0.00	36.7	1836.0
50	M	13	39.0	42	8	21	1	8	1	4		11			96	10.50	5.25	0.25	2.75	46.3	1806.9
51	M	13	46.0	40	8	22	10	1	2	5	8				96	10.00	5.50	2.50	2.00	41.4	1902.1
52	M	13	48.0	42	4	21	9	7	6	3			4		96	10.50	5.25	2.25	1.00	40.5	1943.5
53	M	13	27.0	39	12	19	15	6	5						96	9.75	4.75	3.75	0.00	34.5	931.2
54	M	13	48.0	40	6	14	28	4	2	2					96	10.00	3.50	7.00	0.00	34.0	1631.0
55	M	13	47.0	32	6	30	21	2	1	4					96	8.00	7.50	5.25	0.00	35.2	1653.0
56	M	13	47.0	37	18	18	10	4	2	3			4		96	9.25	4.50	2.50	1.00	39.3	1846.2
57	M	13	49.0	39	11	23	6	6	1	4	6				96	9.75	5.75	1.50	1.50	40.0	1960.5
58	M	14	49.0	37	11	24	17	2		5					96	9.25	6.00	4.25	0.00	34.7	1701.3
59	M	14	53.0	43	3	3	10	7	2	11			8	9	96	10.75	0.75	2.50	4.25	61.9	3279.1
60	M	14	62.0	42	5	28	12	2	2	5					96	10.50	7.00	3.00	0.00	34.7	2153.9
61	M	14	52.0	37	11	17	19	3	1	2			6		96	9.25	4.25	4.75	1.50	40.6	2109.1
62	M	14	59.0	34	6	19	18	6	4	5	4				96	8.50	4.75	4.50	1.00	40.4	2381.2
63	M	14	38.0	39	6	22	11	4		6	6		2		96	9.75	5.50	2.75	2.00	42.5	1614.2
64	M	14	45.0	38	12	25	11	5		5					96	9.50	6.25	2.75	0.00	35.2	1582.7
65	M	14	46.0	36	15	23		4	9	1	4		4		96	9.00	5.75	0.00	2.00	43.9	2020.8
66	M	14	42.0	34	12	16	16	3	6	3	6				96	8.50	4.00	4.00	1.50	41.1	1727.5

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
AV	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal·kg·d^{-1}	Total kcal·d^{-1}
1	F	12	40.0	37	10	26	6	5		12					96	9.25	6.50	1.50	0.00	38.5	1540.4
2	F	12	37.0	39	11	26	10	3	4	3					96	9.75	6.50	2.50	0.00	35.0	1294.6
3	F	12	38.0	46	5	10	17	4	2	5	3		4		96	11.50	2.50	4.25	1.75	41.6	1580.0
4	F	12	32.0	36	10	28	8	5		3	4		2		96	9.00	7.00	2.00	1.50	40.0	1280.3
5	F	12	38.5	40	11	14	11	6	3	4	4		3		96	10.00	3.50	2.75	1.75	42.2	1625.9
6	F	12	46.5	37	9	17	8	6	9	5			5		96	9.25	4.25	2.00	1.25	43.9	2040.0
7	F	12	36.0	32	8	27	12	5	8		4				96	8.00	6.75	3.00	1.00	39.4	1416.6
8	F	12	37.0	37	11	18	15	8	7						96	9.25	4.50	3.75	0.00	35.7	1322.0
9	F	12	39.0	39	3	15	16	5	4	8	4		2		96	9.75	3.75	4.00	1.50	43.2	1684.4
10	F	12	40.0	37	5	12	16	9	7	6	4				96	9.25	3.00	4.00	1.00	42.0	1678.4
11	F	12	40.0	38	6	19	11	7	5	3	4		3		96	9.50	4.75	2.75	1.75	42.8	1712.8
12	F	12	40.0	36	9	21	12	5	2	7	4				96	9.00	5.25	3.00	1.00	40.2	1609.2
13	F	12	37.0	34	8	24	8	4	7	6	3		2		96	8.50	6.00	2.00	1.25	42.8	1583.2
14	F	12	53.0	38	13	21	12	7	5						96	9.50	5.25	3.00	0.00	34.8	1844.4
15	F	12	42.0	36	7	18	18	2	7	2	6				96	9.00	4.50	4.50	1.50	40.6	1703.1
16	F	12	46.0	38	10	17	5	7	11		6		2		96	9.50	4.25	1.25	2.00	43.8	2015.7
17	F	13	47.0	38	9	23	2	14	2	4	2		2		96	9.50	5.75	0.50	1.00	40.9	1923.2
18	F	13	48.0	34	9	20	16	3	6	4	4				96	8.50	5.00	4.00	1.00	40.0	1917.6
19	F	13	38.0	39	5	26	9	4	3	5			5		96	9.75	6.50	2.25	1.25	41.4	1572.8
20	F	13	43.0	34	6	28	5	3	4	6	6		4		96	8.50	7.00	1.25	2.50	46.4	1993.9
21	F	13	43.0	40	13	16	8	7	3	4	3		2		96	10.00	4.00	2.00	1.25	40.5	1740.6
22	F	13	50.5	39	11	18	9	4	5	6			4		96	9.75	4.50	2.25	1.00	41.4	2088.2
23	F	13	45.0	34	15	18	6	7	8	4			4		96	8.50	4.50	1.50	1.00	42.5	1913.9
24	F	13	39.0	37	9	21	8	5	4	6	4		2		96	9.25	5.25	2.00	1.50	42.5	1657.9
25	F	13	38.0	38	5	18	10	8	6	7			4		96	9.50	4.50	2.50	1.00	43.0	1634.0
26	F	14	46.0	39	8	20	12	3	5	4	3		2		96	9.75	5.00	3.00	1.25	40.5	1861.2
27	F	14	45.0	37	9	23	5	7	4	5	6				96	9.25	5.75	1.25	1.50	41.8	1882.4
28	F	14	45.0	35	8	19	10	6	8	6			4		96	8.75	4.75	2.50	1.00	43.1	1941.3
29	F	14	38.0	32	10	31	4	6	3	4	4		2		96	8.00	7.75	1.00	1.50	42.1	1598.7
30	F	14	55.0	37	3	18	14	4	5	1	14				96	9.25	4.50	3.50	3.50	46,3	2546.0
31	F	14	46.0	38	7	20	7	6	7	5	6				96	9.50	5.00	1.75	1.50	42.5	1952.7
32	F	14	46.0	36	8	24	4	4	6	3	6		5		96	9.00	6.00	1.00	2.75	46.7	2147.3
33	F	14	43.0	39	4	10	14	10	7	5	5		2		96	9.75	2.50	3.50	1.75	44.5	1913.9
34	F	14	53.0	32	20	18	7	2	5	2	10				96	8.00	4.50	1.75	2.50	43.7	2315.6
35	F	14	48.0	37	7	18	19	11	1	3					96	9.25	4.50	4.75	0.00	35.8	1719.4
36	F	14	35.0	38	9	26	2	8	6	3	1		3		96	9.50	6.50	0.50	1.00	40.9	1430.1
37	F	14	47.0	42	11	20	5	7		4	3		4		96	10.50	5.00	1.25	1.75	41.6	1952.9

WEEKDAY 2				CATEGORY											Total 15-min	HOURS					
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
38	M	12	38.0	42	19	23	5	3	3	1					96	10.50	5.75	1.25	0.00	33.4	1269.2
39	M	12	41.5	41	6	4	13	3	4	6			19		96	10.25	1.00	3.25	4.75	57.4	2382.5
40	M	12	40.0	42	8	17	11	8	3	3	4				96	10.50	4.25	2.75	1.00	38.6	1542.0
41	M	12	44.0	36	6	26	7	7	2	3	9				96	9.00	6.50	1.75	2.25	42.9	1886.3
42	M	12	38.5	40	15	24	8	2	2	5					96	10.00	6.00	2.00	0.00	35.0	1346.7
43	M	12	39.0	39	11	20	6	3	4	5	5		3		96	9.75	5.00	1.50	2.00	43.4	1691.4
44	M	12	43.0	49	7	23	10	3	1	3					96	12.25	5.75	2.50	0.00	32.9	1413.0
45	M	12	51.0	38	15	19	4	2	3	5	3		7		96	9.50	4.75	1.00	2.50	45.8	2337.3
46	M	13	43.0	40	14	15	10	2	1	2	6		6		96	10.00	3.75	2.50	3.00	44.9	1932.0
47	M	13	46.0	38	7	18	24		5	4					96	9.50	4.50	6.00	0.00	35.3	1624.3
48	M	13	42.0	37	17	15	3	3	5	6		10			96	9.25	3.75	0.75	2.50	47.1	1979.0
49	M	13	50.0	45	17	15	8		1	2	4		4		96	11.25	3.75	2.00	2.00	40.1	2003.5
50	M	13	39.0	35	8	22	9	3	8	1	10				96	8.75	5.50	2.25	2.50	44.0	1715.6
51	M	13	46.0	43	8	20	12	1	2	4	6				96	10.75	5.00	3.00	1.50	38.9	1788.9
52	M	13	48.0	43	7	1	4	7	7	1	7		19		96	10.75	0.25	1.00	6.50	62.3	2990.4
53	M	13	27.0	36	26		4	7	5	10	4		4		96	9.00	0.00	1.00	2.00	47.4	1279.8
54	M	13	48.0	40	7	15	21	3	1	3	6				96	10.00	3.75	5.25	1.50	38.9	1865.3
55	M	13	47.0	32	6	20	23	1	1	3	6		4		96	8.00	5.00	5.75	2.50	43.9	2064.2
56	M	13	47.0	50	14	18	4	2		8					96	12.50	4.50	1.00	0.00	34.5	1623.4
57	M	13	49.0	40	12	23		4	1	16					96	10.00	5.75	0.00	0.00	40.1	1965.4
58	M	14	49.0	36	9	23	12	3	5		8				96	9.00	5.75	3.00	2.00	40.8	2001.2
59	M	14	53.0	41	7	21	3	8	4	3			9		96	10.25	5.25	0.75	2.25	45.8	2426.3
60	M	14	62.0	42	8	26	8		8	4					96	10.50	6.50	2.00	0.00	35.8	2217.1
61	M	14	52.0	37	15	21	8	6	5	4					96	9.25	5.25	2.00	0.00	36.6	1901.6
62	M	14	59.0	35	8	21	16	4	6	4	2				96	8.75	5.25	4.00	0.50	38.4	2264.4
63	M	14	38.0	36	7	24	11	3	4	5	4		2		96	9.00	6.00	2.75	1.50	41.8	1588.0
64	M	14	45.0	38	8	20	9	4	5	6	6				96	9.50	5.00	2.25	1.50	41.9	1886.0
65	M	14	46.0	36	5	18	6	5	10	16					96	9.00	4.50	1.50	0.00	43.6	2004.2
66	M	14	42.0	35	11	16	14	5	6	4	5				96	8.75	4.00	3.50	1.25	41.0	1723.3

WEEKEND DAY 3							CATEGORY								Total 15-min		HOURS				
AV	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
1	F	12	40.0	41	9	6	13	3	10	14					96	10.25	1.50	3.25	0.00	41.7	1666.8
2	F	12	37.0	54	8	14	8	6	4	1	1				96	13.50	3.50	2.00	0.25	33.7	1245.4
3	F	12	38.0	48	4	8	16	4	3	5	2		6		96	12.00	2.00	4.00	2.00	43.1	1636.7
4	F	12	32.0	42	7	12	15	5	4	6	5				96	10.50	3.00	3.75	1.25	40.5	1295.7
5	F	12	38.5	50	10		8	10	2	4	6		6		96	12.50	0.00	2.00	3.00	46.5	1789.5
6	F	12	46.5	48	7	10	12	7	6				6		96	12.00	2.50	3.00	1.50	40.6	1889.3
7	F	12	36.0	38	6	6	18	7	6	5	6			4	96	9.50	1.50	4.50	2.50	48.8	1757.2
8	F	12	37.0	37	8	8	15	3	10	7			4	4	96	9.25	2.00	3.75	2.00	49.9	1845.9
9	F	12	39.0	42	3	12	16	4	5	6	4		4		96	10.50	3.00	4.00	2.00	44.3	1726.5
10	F	12	40.0	47	5	9	15	3	4	5	6		2		96	11.75	2.25	3.75	2.00	42.1	1684.4
11	F	12	40.0	48	4	10	12	5	2	6			5	4	96	12.00	2.50	3.00	2.25	47.1	1885.2
12	F	12	40.0	48	9		18	4	3	3	5		6		96	12.00	0.00	4.50	2.75	44.6	1784.4
13	F	12	37.0	45	5	9	14	7	5	7	4				96	11.25	2.25	3.50	1.00	40.5	1497.0
14	F	12	53.0	42	5	16	11	10	12						96	10.50	4.00	2.75	0.00	37.1	1964.2
15	F	12	42.0	52	7		15	4	7	8	3				96	13.00	0.00	3.75	0.75	39.3	1651.0
16	F	12	46.0	47	11		9	6	18	2	3				96	11.75	0.00	2.25	0.75	40.9	1883.2
17	F	13	47.0	52	11	7	18	4	3		1				96	13.00	1.75	4.50	0.25	32.8	1539.3
18	F	13	48.0	40	6	10	17	4	4	5	5		5		96	10.00	2.50	4.25	2.50	45.7	2192.6
19	F	13	38.0	47	5	6	14	5	4	2	7		6		96	11.75	1.50	3.50	3.25	46.4	1763.6
20	F	13	43.0	34	8	12	7	8		6	13		8		96	8.50	3.00	1.75	5.25	56.3	2420.9
21	F	13	43.0	50	9	4	16	4	2	5	4		2		96	12.50	1.00	4.00	1.50	39.7	1706.2
22	F	13	50.5	38	7	8	18	6	3	5	6		5		96	9.50	2.00	4.50	2.75	46.8	2363.9
23	F	13	45.0	45	9	11	14	3	7	2	5				96	11.25	2.75	3.50	1.25	38.8	1747.8
24	F	13	39.0	51	14		5	5	6	10	2		3		96	12.75	0.00	1.25	1.25	42.8	1668.0
25	F	13	38.0	50	13	4	5	15	7		2				96	12.50	1.00	1.25	0.50	37.1	1411.3
26	F	14	46.0	46	8		14	7	8	4	3		6		96	11.50	0.00	3.50	2.25	45.8	2106.3
27	F	14	45.0	38	6	10	11	12	6	5	6			2	96	9.50	2.50	2.75	2.00	46.5	2093.4
28	F	14	45.0	52	5	12	8	4	6	2	4		3		96	13.00	3.00	2.00	1.75	40.4	1818.9
29	F	14	38.0	46	5	7	16	3	4	5	4		6		96	11.50	1.75	4.00	2.50	45.1	1712.7
30	F	14	55.0	40	14	12	4	3	21	2					96	10.00	3.00	1.00	0.00	39.7	2182.4
31	F	14	46.0	52	5	8	16	4	3	2			6		96	13.00	2.00	4.00	1.50	39.6	1820.2
32	F	14	46.0	42	7	18	15	5	3		6				96	10.50	4.50	3.75	1.50	38.2	1759.0
33	F	14	43.0	46	12	8	16	2	3		4		5		96	11.50	2.00	4.00	2.25	41.2	1769.5
34	F	14	53.0	54	10		14	2	2	10	4				96	13.50	0.00	3.50	1.00	38.9	2060.6
35	F	14	48.0	36	4	10	26	9	1	6	1		3		96	9.00	2.50	6.50	1.00	41.1	1973.8
36	F	14	35.0	33	11	21	20	5	3	3					96	8.25	5.25	5.00	0.00	35.8	1252.3
37	F	14	47.0	42	13	11	8	6	14	2					96	10.50	2.75	2.00	0.00	37.8	1778.5

WEEKEND DAY 3							CATEGORY								Total 15-min		HOURS				
	SEX	AGE	BM	1	2	2-ST	2-TV	3	4	5	6	7	8	9	periods/day	Sleep	2-ST	2-ST	6 to 9	kcal kg d^{-1}	Total kcal d^{-1}
38	M	12	38.0	50	16		17	3	7		3				96	12.5	0.0	4.3	0.8	35.7	1355.8
39	M	12	41.5	46	16		16	9	9						96	11.5	0.0	4.0	0.0	35.5	1471.6
40	M	12	40.0	46	7	4	18	7	3	3	4		4		96	11.5	1.0	4.5	2.0	42.4	1694.4
41	M	12	44.0	33	17	4	12	11	5	6	8				96	8.3	1.0	3.0	2.0	45.5	2001.1
42	M	12	38.5	48	17		15	7		5	4				96	12.0	0.0	3.8	1.0	37.6	1448.8
43	M	12	39.0	47	11	4	14	3	4	5			8		96	11.8	1.0	3.5	2.0	43.9	1712.5
44	M	12	43.0	45	21	5	6	5	6	2			6		96	11.3	1.3	1.5	1.5	41.5	1785.8
45	M	12	51.0	48	9	3	13	3	7	2			11		96	12.0	0.8	3.3	2.8	46.7	2381.7
46	M	13	43.0	42	6	10	16	4	2	4	5		7		96	10.5	2.5	4.0	3.0	46.6	2003.8
47	M	13	46.0	38	5	13	23	3	4	3	6		1		96	9.5	3.3	5.8	1.8	41.2	1892.9
48	M	13	42.0	52	5		27	3	7		2				96	13.0	0.0	6.8	0.5	34.6	1454.0
49	M	13	50.0	48	7		36	1	4						96	12.0	0.0	9.0	0.0	32.2	1607.5
50	M	13	39.0	65	6	4	19	2							96	16.3	1.0	4.8	0.0	29.1	1133.3
51	M	13	46.0	36	5		41	2	1		11				96	9.0	0.0	10.3	2.8	41.9	1926.0
52	M	13	48.0	48	8		9	5	4	10			12		96	12.0	0.0	2.3	3.0	51.0	2445.6
53	M	13	27.0	57	12		13	6	8						96	14.3	0.0	3.3	0.0	33.3	898.0
54	M	13	48.0	33	4		56	3							96	8.3	0.0	14.0	0.0	33.1	1588.3
55	M	13	47.0	32	9	8	43	2	2						96	8.0	2.0	10.8	0.0	33.6	1581.1
56	M	13	47.0	56	14		10	4	2	3	5		2		96	14.0	0.0	2.5	1.8	38.9	1826.4
57	M	13	49.0	45	8		12	3		2	22		4		96	11.3	0.0	3.0	6.5	55.1	2699.4
58	M	14	49.0	40	20		9	9	12	6					96	10.0	0.0	2.3	0.0	39.9	1953.6
59	M	14	53.0	30	8		19	3	4	4	10		18		96	7.5	0.0	4.8	7.0	64.9	3439.2
60	M	14	62.0	37	11	20	17	1	3	7					96	9.3	5.0	4.3	0.0	36.4	2255.6
61	M	14	52.0	46	12		13	2	1	1	21				96	11.5	0.0	3.3	5.3	49.3	2565.2
62	M	14	59.0	40	11	8	13	5	6	5	6		2		96	10.0	2.0	3.3	2.0	44.0	2593.1
63	M	14	38.0	41	18		12	9	7	7	2				96	10.3	0.0	3.0	0.5	40.3	1531.4
64	M	14	45.0	44	14		16	3	3	4	12				96	11.0	0.0	4.0	3.0	44.4	1997.1
65	M	14	46.0	32	11			14	13	21	5				96	8.0	0.0	0.0	1.3	53.1	2442.1
66	M	14	42.0	56	5		18	5	2		6		4		96	14.0	0.0	4.5	2.5	40.7	1710.7

AV - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
1	F	12	158.0	40.0	16.0	110	60	4	14	149	31	8.9	low
2	F	12	151.0	37.0	16.2	95	50	5	3	130	38	9.9	low
3	F	12	151.0	38.0	16.7	105	65	6	18	156	30	8.4	low
4	F	12	150.0	32.0	14.2	100	70	2	24	140	33	4.4	low
5	F	12	151.0	38.5	16.9	95	65	4	21	170	35	6.9	high
6	F	12	156.0	46.5	19.1	105	75	6	18	145	30	7.9	low
7	F	12	151.0	36.0	15.8	105	70	5	19	150	25	8.3	low
8	F	12	153.0	37.0	15.8	90	60	15	31	169	45	6.2	low
9	F	12	156.5	39.0	15.9	110	75	9	31	144	40	6.4	high
10	F	12	150.0	40.0	17.8	120	75	7	12	168	35	5.3	high
11	F	12	150.0	40.0	17.8	90	55	7	12	168	35	7.4	low
12	F	12	148.0	40.0	18.3	115	70	5	23	157	25	5.1	low
13	F	12	146.0	37.0	17.4	105	65	7	15	147	32	4.8	low
14	F	12	161.0	53.0	20.4	85	55	-4	28	155	35	3.8	low
15	F	12	154.0	42.0	17.7	90	60	9	26	158	25	8.5	high
16	F	12	157.0	46.0	18.7	125	70	17	50	204	55	5.8	low
17	F	13	160.5	47.0	18.2	115	70	6	21	151	44	4.9	low
18	F	13	157.5	48.0	19.3	110	65	8	14	149	32	4.6	low
19	F	13	150.0	38.0	16.9	90	65	-6	31	162	25	4.8	high
20	F	13	150.0	43.0	19.1	110	70	6.5	5	120	25	6.8	low
21	F	13	154.0	43.0	18.1	102	75	16	56	147	31	5.2	low
22	F	13	161.0	50.5	19.5	108	78	13	33	146	31	7.8	high
23	F	13	157.0	45.0	18.3	130	82	14	32	149	35	3.8	low
24	F	13	160.0	39.0	15.2	115	70	20	48	165	38	9.8	low
25	F	13	149.0	38.0	17.1	120	75	15	37	146	33	7.5	low
26	F	14	154.5	46.0	19.3	95	65	15	15	172	25	4.5	low
27	F	14	155.0	45.0	18.7	108	75	12	59	155	35	7.6	low
28	F	14	164.5	45.0	16.6	120	80	14	12	161	25	3.5	low
29	F	14	148.5	38.0	17.2	100	60	7	20	142	31	6.3	low
30	F	14	154.0	55.0	23.2	118	60	13	19	165	36	5.3	low
31	F	14	149.0	46.0	20.7	102	68	6	7	145	38	3.7	low
32	F	14	146.0	46.0	21.6	108	60	3	15	161	37	7.8	low
33	F	14	157.0	43.0	17.4	110	80	8.5	19	155	25	3.4	low
34	F	14	153.0	53.0	22.6	108	78	15	50	150	26	5.8	low
35	F	14	155.0	48.0	20.0	125	80	16	30	160	31	7.2	low
36	F	14	149.0	35.0	15.8	90	60	3	26	110	20	6.1	low
37	F	14	155.0	47.0	19.6	118	70	17	41	180	34	6.7	low

AV - FITNESS	SEX	AGE	HEIGHT	BM	BMI	SYSTOLIC	DIASTOLIC	FLEXIBILITY	SIT_UPS	LONG_JUMP	VERT_JUMP	SHUTTLE	SES
38	M	12	155.0	38.0	15.8	125	70	3	35	169	40	8.6	low
39	M	12	149.0	41.5	18.7	105	70	2	79	153	36	7.8	low
40	M	12	160.0	40.0	15.6	95	65	7	56	173	39	5.7	high
41	M	12	148.0	44.0	20.1	90	65	2	35	172	39	9.2	high
42	M	12	146.0	38.5	18.1	90	60	12	37	168	38	6.1	low
43	M	12	144.0	39.0	18.8	95	55	11	39	175	35	6.8	low
44	M	12	155.0	43.0	17.9	115	70	9	50	209	41	6.7	low
45	M	12	167.0	51.0	18.3	110	75	12	46	190	42	6.8	low
46	M	13	143.0	43.0	21.0	110	80	5	50	185	40	8.2	low
47	M	13	150.0	46.0	20.4	90	65	1	39	182	46	9.1	low
48	M	13	157.0	42.0	17.0	130	75	-13	34	210	45	5.1	low
49	M	13	153.0	50.0	21.4	115	65	11	99	176	38	7.9	low
50	M	13	150.0	39.0	17.3	105	70	8	50	186	39	4.8	high
51	M	13	162.0	46.0	17.5	90	65	17.5	100	209	40	9.5	high
52	M	13	161.0	48.0	18.5	100	65	5	57	197	38	11.9	low
53	M	13	128.0	27.0	16.5	95	65	13	90	135	30	8.3	high
54	M	13	162.0	48.0	18.3	115	75	-7	40	192	36	5.6	low
55	M	13	164.0	47.0	17.5	95	69	24	100	236	51	4.7	high
56	M	13	155.0	47.0	19.6	100	65	10	68	192	40	6.1	low
57	M	13	157.0	49.0	19.9	95	60	-8	45	190	38	7.8	low
58	M	14	156.0	49.0	20.1	110	65	7	33	173	32	6.8	high
59	M	14	170.0	53.0	18.3	108	80	-2	40	186	31	10.3	low
60	M	14	168.0	62.0	22.0	90	60	14	56	205	40	11.2	low
61	M	14	165.0	52.0	19.1	88	65	5.5	16	230	55	10.8	low
62	M	14	168.0	59.0	20.9	120	70	-13	62	186	34	6.4	high
63	M	14	147.0	38.0	17.6	115	75	9	37	179	35	7.1	low
64	M	14	153.0	45.0	19.2	105	60	4	39	202	39	6.9	low
65	M	14	164.0	46.0	17.1	120	65	6	100	211	46	9.4	low
66	M	14	156.0	42.0	17.3	115	70	-6	60	196	35	10.2	low