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CHAPTER 2 REVIEW OF LITERATURE

2.1 INTRODUCTION

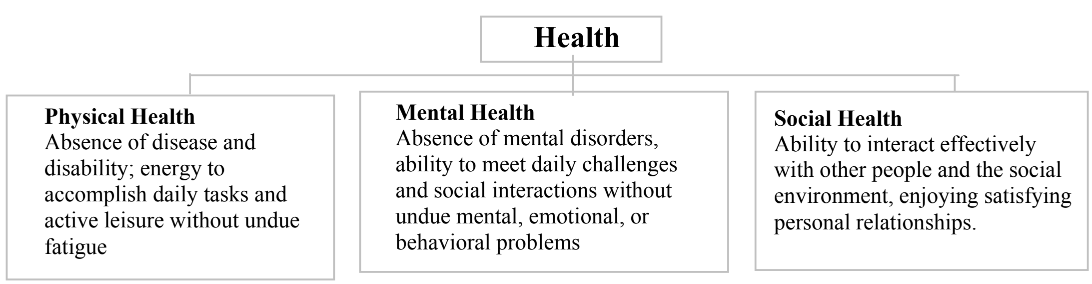
In this chapter, we review the current health problem, physical fitness and activity among children and adolescences; we look into the definitions of health, physical activity, and the relationship between health and physical activity.

World health is in transition. Increasing numbers of people practice a sedentary lifestyle and eat unhealthy diets - two habits that are responsible for the most chronic diseases in our world. Most children must go to school; a school-based intervention is a wise choice; so we also reviewed some school-based interventions.

Since research method is a critical area in our study, we also review a brief history of fitness tests of youth, and the rationale, reliability and validity of FITNESSGRAM, which were used in our study. Finally, we review the research method for its effectiveness in assessing children's physical activity, obesity and the factors that could influence children' physical fitness such as physical activity levels, stage of maturation.

2.2 DEFINITIONS OF HEALTH

Figure 2-01 Definition of health



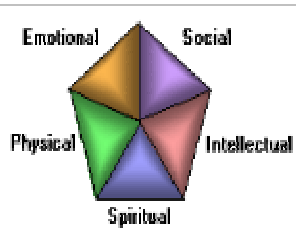
Source: Neiman, 2002, p4

Health has been defined in many different ways throughout history. The ancient Greek physicians believed health to be a condition of perfect body equilibrium. The ancient Chinese believed that health was a reflection of a vital body force called "Qi" (Edelman & Mandle, 1986). In contrast, Western medicine attempted to understand the construct of health by analysing its single components rather than the interconnection of the various parts. The Western approach has been advocated throughout the world for years, which led the international medical community to focus primarily on disease and disability. Only recently has this medical outlook begun to gradually change towards a more holistic view. In 1946, The World Health Organization (WHO) defined **health** (Figure 2-01) as “a state of complete physical, mental, and social well-being and not merely the absence of disease” (WHO, 1946, p.1).

Good health, according to Nieman (1998), might be better defined as the presence of “sufficient energy and vitality to accomplish daily tasks and active recreational pursuits without undue fatigue”. Good health to an individual means that you can lead a full and active life day in-and-out (working, running a household, attending classes, studying, participating in recreational activities, and enjoying an active social life without collapsing into bed each night, exhausted), contract infectious disease less often, and tend to fight off infectious disease better than those who are sedentary. This affects not only one’s health today, but also the quality of life in later years. Generally, good health enjoyed by individuals can be assessed statistically on a national level by average life spans.

Optimal health (Figure 2-02) is defined as a balance of physical, emotion, social, spiritual and intellectual health. Lifestyle change can be facilitated through a combination of efforts to (1) enhance awareness, (2) change behaviour and (3) create environments that support good health practices. Of the three, supportive environments will probably have the greatest impact in producing lasting changes (Michael, 1989).

Figure 2-02 The definition of optimal health



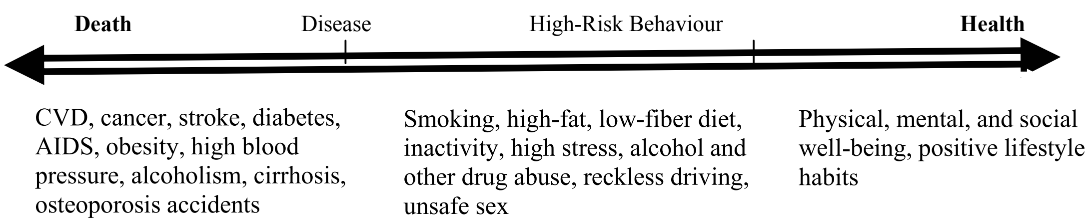
Physical	Fitness. Nutrition. Medical self-care. Control of substance abuse
Emotional	Care for emotional crisis. Stress Management
Social	Communities. Families. Friends
Intellectual	Educational. Achievement. Career development
Spiritual	Love. Hope. Charity.

Source: Michael, 1989

Wellness is an approach to personal health that emphasizes individual responsibility for well-being through the practice of health-promoting lifestyle behaviours. It is an all-inclusive concept that encourages good health behaviours to improve quality of life and reduce the risk of premature disease (Neiman, 2002, p.3).

Health behaviour is defined as the combination of knowledge, practices, and attitudes that together contribute to motivate the actions people take regarding health and wellness (Neiman, 2002, p.3). **Health promotion** is the process of enabling people to increase control over, and to improve, their health (WHO, 1986). Health promotion is also the science and art of helping people change their lifestyle to move toward a state of optimal health. The health continuum (Figure 2-03) shows that between optimal health and death lies disease, which is preceded by a prolonged period of negative lifestyle habits. Individual behaviours and environmental factors are responsible for about 70 percent of all premature deaths in the United States (Neiman, 2002, p.3).

Figure 2-03 The health continuum



Source: Neiman, 2002, p4

Bouchard, Shephard and Stephens (1994) presented a comprehensive model for **physical fitness** (Table 2-01). We can see the difference between health-related physical fitness and skill-related physical fitness.

Table 2-01 Common Physical Fitness and Fitness Related Terms

Physical Fitness			Skills
Physiological Fitness	Health-Related Fitness	Skill-Related Fitness	Sports
Metabolic Body	Body Composition	Agility	Team
Morphological	Cardiovascular Fitness	Balance	Individual
Bone Integrity	Flexibility	Coordination	Lifetime
Other	Muscular Endurance	Power	Other
	Muscle Strength	Speed	
		Reaction Time	

Source: Bouchard, Shephard & Stephens (1994)

Health-related physical fitness consists of those components of physical fitness that have a relationship with good health. The components are commonly defined as body composition, cardiovascular fitness, flexibility, muscular endurance and strength.

Skill-related physical fitness consists of those components of physical fitness that have a relationship with enhanced performance in sports and motor skills. The components are commonly defined as agility, balance, coordination, power, speed and reaction time. Prior to the last 40 years the distinction between health-related and skill-related physical fitness was not typically made.

Body Composition is a health-related component of physical fitness that relates to the relative amounts of muscle, fat, bone and other vital parts of the body (USDHHS, 1996).

Cardiovascular Fitness is a health-related component of physical fitness that relates to ability of the circulatory and respiratory systems to supply oxygen during sustained physical activity (USDHHS, 1996). Cardiovascular fitness is also referred to as cardiovascular endurance, aerobic fitness and cardiorespiratory fitness. A $VO_{2\ max}$ test in the laboratory setting is considered to be the best measure of cardiovascular fitness. Commonly administered field tests include the One mile run/walk, the 12-minute run, the PACER run for children and various bicycle, step, and treadmill tests.

Flexibility is a health-related component of physical fitness that relates to the range of motion available at a joint (USDHHS, 1996). Some experts specify that flexibility requires range of motion without discomfort or pain (Howley & Franks, 1997). Flexibility is specific to each joint of the body, thus there is no general measurement of flexibility as there is for cardiovascular fitness. Flexibility is typically measured in the lab using measurement devices such as a goniometer, flexometer and in the field with test exercises such as the sit and reach, and the zipper.

Muscular Endurance is a health-related component of physical fitness that relates to the muscle's ability to continue to perform without fatigue (USDHHS, 1996). Muscular endurance is specific in nature. For true assessment of muscular endurance it would be necessary to test each major muscle group of the body. Lab and field tests of muscular endurance are similar and are based on the number of repetitions that can be performed by the specific muscle group being tested (example: repetitions of push-ups or abdominal curls). Muscular endurance can be measured isometrically (static contractions) or isotonically (dynamic contractions).

Strength is a health-related component of physical fitness that relates to the ability of the muscle to exert force (USDHHS, 1996). Strength is specific in nature. For true assessment it would be necessary to test each major muscle group of the body. Lab and field tests are similar and involve the assessment of one repetition maximum (the maximum amount of resistance you can overcome one time). 1RM tests are typically conducted on resistance machines. Strength can also be assessed using dynamometers. Strength can be measured isometrically (static contractions) or isotonically (dynamic contractions).

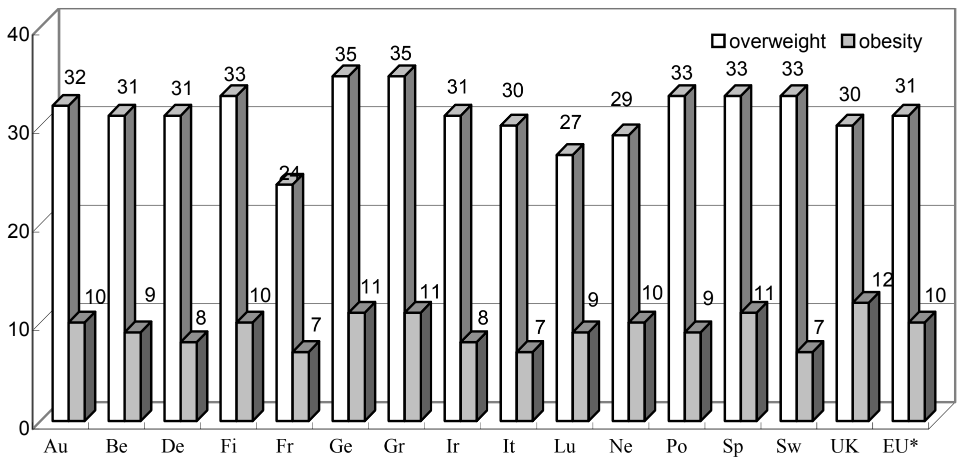
2.3 WORLD HEALTH IN TRANSITION

As a result of the long list of successes in health achieved globally during the 20th century, many health problems that were common a century ago do not exist today. But they have been replaced by conditions associated with hypokinesia and an affluent lifestyle, such as high blood pressure, obesity, and coronary heart disease. Worldwide, rapid changes in diets and lifestyles that have occurred with industrialization, urbanization, economic development and market globalisation have accelerated over the past decade. This combination of unhealthy diets and lifestyle is having a significant impact on the health and nutritional status of populations, particularly in developing countries and in countries in transition (WHO, 2003a, p.1). Already today in the entire world, with the exception of sub-Saharan Africa, chronic diseases are now the leading causes of death. The WHO estimates that in 2001, chronic diseases contributed approximately 60 percent of the 56.5 million total reported deaths in the world and approximately 43 percent of the global burden of disease (WHO, 2003a, p.4). On a global basis 79 percent of all deaths attributable to chronic diseases are already occurring in developing countries (WHO, 2003a, p.5). It has been projected that, by 2020, chronic diseases will account for almost 75 percent of all deaths and 57 percent of the global burden of disease. They are also showing worrying trends, not only because they already affect a large proportion of the population, but also because they have started to appear earlier in life (WHO, 2003a, p.1-3).

One European Union survey of the prevalence of overweight and obesity was conducted by asking people for their weight and height rather than weighing and measuring them

(Institute of European Food Studies, 1999, p.74). The survey showed that 27 to 35 percent of adults in the EU were overweight and 7 to 12 percent were obese (Figure 2-04).

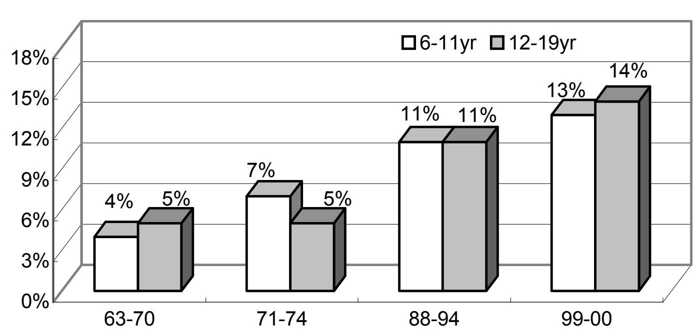
Figure 2-04 Prevalence of overweight and obesity, adults aged 15 and over, 1997, EU countries



Source: Institute of European Food Studies, Trinity College, Dublin (1999, p.74). (According to population size).

In United States, for most of the 1960s and 1970s the prevalence of overweight American adults (25–74 yrs) was nearly constant at about 25 percent. However, by 1988–1994, that rose to approximately 35 percent (NCHS, 1998), and the prevalence continues to increase. Obesity increased from 12 percent in 1991 to almost 18 percent in 1998 (Mokdad et al., 1999) and 19 percent in 1999 (Mokdad et al., 2000a). Recent years have seen an epidemic in obesity in the United States. Appendix 1 and Appendix 2 showed the obesity and diabetes trends of U.S. adults (Mokdad et al., 1999; 2000b).

Figure 2-05 Overweight in children and adolescent in the United States (1963-2000)



Source: CDC, 2000

In the United States (Figure 2-05), physical inactivity has contributed to the 100 percent increase in the prevalence of childhood obesity since 1980 and most of this increase occurred in the last 10 years (CDC, 2000).

A large-scale investigation of total 6903 Portuguese children and adolescents in grades 6, 8 and 10 showed that 36.1% (boys: 25.0% vs. girls: 45.7%) of them were overweight in 1998. This level declined a little in 2002, when 31.9% (boys: 23.9% vs. girls: 39.5%) of the 6131 subjects were overweight (Matos, et al., 2003, p.470-472).

According to the World Health Report, the level of overweight and obesity is rapidly growing worldwide, in developed and developing countries among young people (WHO, 2003a). It is now generally accepted that overweight and obesity increase the risk of chronic diseases, particularly cardiovascular diseases (CVD), cancer and diabetes (WHO, 1998), osteoarthritis, sleep apnea, and respiratory problems (USDHHS, 2000a). The increasing global epidemic of these diseases relates closely to respective changes in lifestyles mainly correlated with tobacco use, physical inactivity and unhealthy diet (WHO, 2003a).

2.4 DEFINITIONS OF PHYSICAL ACTIVITY AND EXERCISE

Physical Activity is defined as bodily movement produced by the contraction of striated muscle that substantially increases energy expenditure (USDHHS, 1996; ACSM, 2000). This definition includes **exercise,** which is planned, structured, and repetitive physical activity aimed at improving maintaining physical fitness, organized sports or games (football, basketball), transport (walking, cycling), occupational physical activity (manual labour, household chores) and non-organized, recreational physical activities (Okely, Patterson & Boothet, 1998; ACSM, 2000).

Exercise can be divided into aerobic exercise and anaerobic exercise. **Aerobic exercise,** which uses oxygen to keep large muscle groups moving continuously at intensity that can be maintained for at least 20 minutes. Aerobic exercise uses several major muscle groups throughout the body, resulting in greater demands on the cardiovascular and respiratory systems to supply oxygen to the working muscles. Aerobic exercise includes walking, jogging, and swimming, and is the form recommended for reducing the risk of heart disease and increasing endurance. Unlike anaerobic exercise, **Anaerobic exercise** involves heavy work by a limited number of muscles, for example during weight lifting. These types of activities are maintained only for short intervals, and the supply of oxygen is insufficient for aerobic metabolism, resulting in a substantial oxygen debt and anaerobic metabolism within those muscles. Another example is sprinting, in which the exercise is high in intensity but short in duration, resulting in substantial oxygen debt. Weight lifting and other types of anaerobic exercise increase strength and muscle mass, but are of limited benefit to cardiovascular health (Microsoft Encarta Encyclopedia Deluxe 2003).

In 1968 American physician Kenneth Cooper coined the term **aerobics** in his exercise book "Aerobics" (Copper, 1968). Cooper explains that aerobics are: ". . . *the foundation exercises on which any exercise program should be built. These exercises demand oxygen without producing an intolerable oxygen debt, so that they can be continued for long periods. They activate the training effect and start producing all those wonderful changes in your body*." Cooper openly admits that his were not the first assertions in this direction. In his book, he describes the Pack Test, developed in the early 1940s for testing military personnel. Similar tests followed, such as the Harvard Step Test and Master's Two-Step Test. All of these tests were applied in an attempt to obtain and compare recovery heart rate values after soldiers performed exertion. But he used the term to describe **aerobic exercises** that "*use oxygen to keep large muscle groups moving continuously for at least 20 minutes*". Based on this definition, the name aerobics came to refer to calisthenics taught to music. Americans Judi Sheppard Missett and Jacki Sorensen were two early aerobics pioneers. They created early forms of dance-based routines that became the basis of group fitness classes. Americans Jane Fonda and Richard Simmons helped popularize aerobics in the United States during the 1980s through instructional videotapes and television programs. The impact of aerobic dance has been enormous: this is an organized activity which did not exist before the early 1970s, and which is embraced by millions of people, especially women, many of whom had never exercised regularly before. It also provides people the opportunity to participate in a group physical activity outside of the narrow realm of high school and college sports (Microsoft Encarta Encyclopedia Deluxe 2003).

Aerobic exercises include walking (at a speed less than 8 minutes per mile), which requires little in the way of equipment and can be performed by people of all ages, jogging/running (speed between 8 to 12 minutes per mile), jumping rope, or some kinds of ball-games (such as football, basketball, handball and etc.). All these forms of aerobic exercise combine running with hand-eye or foot-eye coordination skills. Ball-games add a slight anaerobic benefit to the aerobic benefits of running, since there is some minor muscular resistance in each sport, such as shooting or kicking the ball (Microsoft Encarta Encyclopedia Deluxe, 2003).

2.5 PHYSICAL ACTIVITY AND HEALTH

Physical activity of moderate intensity has been recommended for health and well-being since the time of Hippocrates (460–370 BC). The Greek physician Hippocrates, the `father of medicine`, advised that "Eating alone will not keep a man well; he must also exercise...." Only in the last two decades has consistent epidemiological evidence identified that physical activity is a major modifiable risk factor in the reduction of mortality and morbidity of many chronic diseases (USDHHS, 1996; Armstrong, Bauman & Davies, 2000). Since the 1970´s a number of studies regarding the benefits of physical activity, the health benefits of regular physical activity (aerobic exercise) have been affirmed and summarized in reports from governmental and non-governmental organizations. U.S. Surgeon General (USDHHS, 1996), U.S. National Institutes of Health (NIH Consensus Development Panel on Physical Activity and Cardiovascular Health, 1996), U.S. Centers for Disease Control and Prevention (Pate et al., 1995), American College of Sports Medicine-ACSM (Pate et al., 1995), American Heart Association (Blair & McCloy, 1993) have concluded that regular physical activity is associated with important health benefits.

U.S. Surgeon General Report that summarized the current consensus regarding the health benefits of physical activity concluded the following (USDHHS, 1996):

- ✧ *People of all ages, both male and female, benefit from regular physical activity.*
- ✧ *Significant health benefits can be obtained by including a moderate amount of physical activity (e.g., 30 minutes of brisk walking or raking leaves, 15 minutes of running, or 45 minutes of playing volleyball) on most, if not all, days of the week. Through a modest increase in daily activity, most Americans can improve their health and quality of life.*

- ✧ *Additional health benefits can be gained through greater amounts of physical activity. People who can maintain a regular regimen of activity that is of longer duration or of more vigorous intensity are likely to derive greater health benefits.*
- ✧ *Physical activity reduces the risk of premature mortality in general, and of coronary heart disease, hypertension, colon cancer, and diabetes mellitus in particular. It also improves mental health and is important for the health of muscles, bones and joints.*

The Surgeon General's report on physical activity and health gave physical activity an internationally recognised legitimacy as an important component of public health and wellbeing. Regular moderate physical activity results in many health benefits for adults. For example, it improves cardiorespiratory endurance, flexibility, and muscular strength and endurance (USDHHS, 1996; Bouchard & Shephard, 1994, p.77-88), depression and anxiety (Ross & Hayes, 1988; Stephens, 1988; Camacho et al., 1991; Weyerer, 1992), and builds bone mass density (Lane et al., 1986; Aloia et al., 1988; Dalsky et al., 1988; Michel et al., 1989; Greendale et al., 1995). People who are moderately active on a regular basis have lower mortality rates than sedentary people. Research has found that people who are physically active tend to be healthier than those who are not. The greatest gains in health occur when individuals progress from an inactive lifestyle to being moderately active (USDHHS, 1996).

Current evidence shows that regular physical activity in childhood and adolescence improves aerobic endurance and strength (Dotson & Ross, 1985; Sallis, McKenzie & Alcaraz, 1993), helps build healthy bones and muscles, helps control weight, and may improve blood pressure and cholesterol levels (CDC, 1997). Regular physical activity among children and adolescents with chronic disease risk factors is important (Tomassoni, 1996a,1996b; Nixon, 1996; Bar-Or, 1996; Epstein, Coleman & Myers 1996): it decreases blood pressure in adolescents with borderline hypertension (Alpert & Wilmore 1994), increases physical fitness in obese children (Ignico & Mahon, 1995; Gutin,1996), and decreases the degree of overweight among obese children (Brownell & Kaye, 1982; Sasaski et al., 1987; Epstein, Valoski, Wing & McCurley, 1990; Epstein, Valoski & Vara, 1995). Physical activity among adolescents is consistently related to higher levels of self-esteem and self-concept and lower levels of anxiety and stress (Calfas & Taylor, 1994). Still, more research is needed on the association between physical activity and health among young people (Bar-Or & Baranowski, 1994; Armstrong & Simons-Morton, 1994). The health-related guidelines for youth physical activity recommend the accumulation of at least 60 min of physical activity on most days of the week (Cavill, Biddle & Sallis, 2001). However many adolescents, particularly girls and ethnic minorities, do not meet recommendations, and their activity levels decline with age (CDC, 2000b; Pate et al., 2002; USDHHS, 2000a).

2.6 AEROBIC EXERCISES AND DISEASES PREVENTION

Table 2-02 Effect of physical activity on specific health conditions, disease states and known risk factors for disease

Condition	Reducing Risk	Reduce Symptoms	Improve Outcome	Type of Activity
Alzheimer's Disease	+			A
Anxiety	++	++	+++	A
Asthma	+	+		A
CHD (Coronary Heart Disease)	+++	+++	++	A,E
CORD	+	+	+	A
CVA (stroke)*	+	++	++	S, A*
Cancer (Breast)	++	+	++	A
Cancer (Colon)	+++	++	++	A
Cancer (Endometrium)	+			A
Cancer (Lung)	+			
Cancer (Prostate)	+	+	++	
Depression	++	++	++	A
Diabetes (Type 2)	+++	+++	+++	A,E
Hypertension	++		+++	A,E
Longevity		+++	+++	A
Obesity	++	++	+++	A
Osteoarthritis		+	+	S,A
Osteoporosis	++			S (W),A
Peripheral vascular disease		+		A
Pregnancy		+	++	A
Smoking	+	++	++	A
Stress	++	++	++	A
Ulcer, Duodenal	+			A

+ evidence suggests a small effect; + + moderate effect; + + + large effect A- moderate aerobic activity; E- energy expenditure important; S- strength exercises; W- weight bearing activity; This table comments on the strength of effect of PA in published studies, not on the strength of evidence; * Stroke – moderate activity is important in stroke prevention; strength exercise is important in the rehabilitation post-CVA. (Source: Carr, 2001)

Carr (2001) outlined the effects of moderate physical activity on a range of conditions, risk factors and diseases, based on recent research in these areas (Table 2-02). It shows that aerobic exercises are useful for preventing many kinds of diseases.

2.6.1 Aerobic exercise and aging

Regular physical activity is beneficial for one's health, especially if the aerobic exercise model is selected. ACSM (1995) lists the benefits of the effects of aerobic exercise training against aging (Table 2-02). It shows that most of the physiological changes of aging can be improved with regular aerobic exercise training.

Table 2-03 Effects of aerobic exercise training and aging

Variables	Aging	Exercise Training
Resting heart rate	Little or no change	Decreases
Maximal cardiac output	Decreases	Increases
Resting & exercise blood pressure	Increases	Decreases
Maximal oxygen uptake	Decreases	Increases
HDL	Decreases	Increases
Reaction time	Decreases	Increases
Muscular strength	Decreases	Increases
Muscle endurance	Decreases	Increases
Bone mass	Decreases	Increases
Flexibility	Decreases	Increases
Fat-free body mass	Decreases	Increases
Percent body fat	Increases	Decreases
Glucose tolerance	Decreases	Increases
Recover time	Increases	Decreases

Source: ACSM, 1995

2.6.2 Aerobic exercise and all-cause mortality

Studies show people who participate in moderate to vigorous levels of physical activity and/or have high levels of cardiorespiratory fitness have a lower mortality rate than those with a sedentary lifestyle or low cardiorespiratory fitness. The effects of physical activity on reducing all-cause mortality are strong and consistent across studies and populations (Blair et al., 1996; Lee & Paffenbarger, 1997), even among diverse elderly populations (Bijnen et al., 1999; Stessman, Maaravi, Hammerman-Rozenberg & Cohen, 2000).

Overweight or obese individuals who are physically active and fit are less likely to suffer early death than normal-weight persons who lead a sedentary lifestyle (Blair & Brodney, 1999).

2.6.3 Aerobic exercise and cardiovascular disease (CVD)

Kohl (2001) reviewed the literature on aerobic exercise and cardiovascular disease in MEDLINE through August 2000, which also included the supplemental documents and other published literature. Taken together, physical inactivity has been found to be prominent in the causal constellation for factors predisposing to cardiovascular disease, particularly ischemic heart disease (Kohl, 2001). The strongest evidence for the benefits of physical activity is in the reduction of the risk of mortality and morbidity from CVD (Berlin & Colditz, 1990; USDHHS, 1996). The maximum CVD benefit occurred when people moved from a sedentary lifestyle or low state of cardiorespiratory fitness to a moderately active or moderate fitness level (Blair et al., 1995; Blair et al., 1996; Lakka et al., 1994). Manson et al. (1999) suggested that participating in low-to-moderate aerobic activity, such as walking, had a clear benefit for women, but more vigorous activity produced an even greater reduction in risk. However, the existing data are less definitive for the association between physical activity and both types of strokes (i.e. ischaemic and haemorrhagic) (Kohl & McKenzie, 1994). Generally, for ischaemic stroke, studies show a decrease in the risk of stroke with increasing physical activity (Ellekjaer, Holmen, Ellekjaer & Vatten, 2000; Hu et al., 2000; Wannamethee & Shaper, 1999).

Sturm et al. (1999) found that 12 weeks of moderate aerobic training significantly improved $VO_{2\ max}$ in patients with severe chronic heart failure. Leon et al. (1997) indicated that regular aerobic exercise could reduce the risk of Coronary Heart Disease (CHD). Individuals performing about 20 minutes of light-to-moderate intensity exercise daily have been observed to have about a 30 percent lower risk of death from CHD than do sedentary individuals (Leon et al., 1997). These benefits may be due in part to the blood-pressure-lowering effects of exercise, but other metabolic factors that may be activated by exercise, such as increased High-Density Lipoprotein (HDL) cholesterol, may also be involved (Arakawa, 1996). Physical activity and cardiorespiratory fitness have also be found are both associated with improved total blood cholesterol levels (McMurray et al. 1998) and improved HDL subfraction profiles (Moore 1994). Recent research suggests that there may be a threshold between physical activity and improvements in the HDL subfraction of cholesterol-more prolonged or intensive exercise may be more beneficial for HDL to total cholesterol ratios (Kokkinos & Fernhall, 1999).

2.6.4 Aerobic activity and high blood pressure

Normal blood pressures are lower than 140 mm Hg (systolic) and lower than 90 mm Hg (diastolic). High blood pressure is well recognized as a risk factor for cardiovascular disease. About 25 percent of U.S. adults have high blood pressure (hypertension). If untreated, high blood pressure eventually damages the heart, brain, eyes, and kidneys. The higher the blood pressure, the greater the risk of complications, such as heart attacks and stroke will develop (Whelton, Chin & He, 2001; Whelton, Chin, Xin & He, 2002). Vigorous aerobic activity has been shown to decrease systolic and diastolic blood pressure (Arroll & Beaglehole, 1992; Kelley & McClellan, 1994; McMurray et al., 1998; Mensink, Ziese & Kok, 1999). There is some evidence that participation in more moderate physical activity may achieve similar or even greater effects in lowering blood pressure than vigorous activity (Hagberg, Montain, Martin & Ehsani, 1989; Marceau, Douame, Lacourciere & Cleroux, 1993). Hagberg, Park and Brown (2000) suggested that moderate aerobic activity was an important means of reducing blood pressure in those with hypertension, particularly in middle-aged people. A recent meta-analysis from the United States identified 54 random controlled trials, of a median duration of 12 weeks, conducted among a total of 2419 participants of different ethnic backgrounds and hypertensive status (mean ages, 21 to 79 years). Most trials recruited people with sedentary lifestyles to exercise on a bike, to walk or to jog for up to 150 minutes per week. Aerobic exercise was found to be associated with a significant reduction in mean systolic and diastolic blood pressure (-3.84mmHg and -2.58mmHg, respectively) in both hypertensive and normotensive subjects (Whelton, Chin & He, 2001; Whelton, Chin, Xin & He, 2002). Thus, aerobic activity should be considered as an important component of lifestyle modification for the prevention and treatment of high blood pressure.

2.6.5 Aerobic exercise and overweight and obesity

The World Health Organization's Expert Consultation on Obesity recently recognized that *"overweight and obesity represent a rapidly growing threat to the health of* *populations and an increasing number of countries worldwide"*. It identified obesity as a disease prevalent in both developing and developed countries and affecting children and adults alike (WHO, 1997). Obesity also is associated with numerous metabolic complications such as type 2 diabetes, CVD and psychosocial health (Brownell, 1994, WHO, 1997). Epidemiological studies show that higher relative weights are associated with greater risk of mortality and morbidity from conditions including non-insulin-dependent diabetes mellitus, coronary heart disease, hypertension, hyperlipidemia and certain cancers (Pi-Sunyer, 1991, 1993).

Kriketos et al. (2000) found a strong negative correlation between aerobic fitness ($VO_{2\,max}$) and body fat in both male and female subjects. Physical activity (aerobic exercise) has also been shown to play a role in the prevention, maintenance, and treatment of obesity, although more prolonged activity is required for weight loss (Grundy et al., 1999). Most reviews suggest that at least 2,000 Kcal of energy expenditure per week is required for maintained weight loss (Rippe & Hess 1998), which equates to at least one hour of moderate or half-an-hour of vigorous leisure-time physical activity daily. Nonetheless, more moderate levels of activity can assist with weight maintenance, as well as conferring other health benefits. Wing (1999) recently reviewed the evidence on aerobic exercises in the treatment of adulthood overweight and obesity. He found that in 6 of 10 random trials, the subjects experienced significantly greater weight loss by exercise alone versus no treatment controls. He indicated that regular moderate aerobic activity coupled with a healthy diet could reduce the risk of obesity and improves the health of those who are overweight or obese.

2.6.6 Aerobic exercise and diabetes

Diabetes has long been a significant problem in the western world. In the United States, about 800,000 new cases are diagnosed each year, or 2,200 per day (Clark, 1998). But more recently it has reached epidemic proportions in many developing countries as well (Eriksson, 1999). Patients with type 2 diabetes constitute about 80 to 90 percent of all patients with diabetes (Eriksson, 1999). Exercise has long been considered a cornerstone in the treatment regimen for patients with type 2 diabetes. Aerobic endurance exercise has traditionally been advocated as the most suitable exercise model (Eriksson, 1999). A recent review shows that the benefits of physical activity (aerobic exercise) in the prevention and treatment of type 2 diabetes are strongly supported by current research (Ivy, Zderic & Fogt, 1999). Both moderate and vigorous physical activity (MVPA) reduces the risk of type 2 diabetes in women (Hu et al., 1999; Manson & Spelsberg, 1994). Benefits of MVPA accrue also in diverse populations (Folsom, Kushi & Hong, 2000; Okada et al., 2000). However, the benefits of physical activity for preventing and treating diabetes only occur from regular sustained physical activity patterns. The physiological adaptations that are responsible for the protective effects of physical activity subside within a short period after the cessation of physical activity (Arciero et al., 1999; Dela et al., 1993; Rogers et al., 1990). Recent literature acknowledges that all levels of physical activities, including leisure activities, recreational sports, and competitive professional activities, can be performed by people with type I diabetes. However, it must be stressed that high-intensity endurance exercise (e.g. marathon, triathlon, etc.) is not required to achieve maximal health benefits from exercise (ADA, 1997; Ruderman & Devlin, 1995).

2.6.7 Aerobic activity and musculoskeletal health

Low back pain (LBP), osteoarthritis (OA), and osteoporosis (OP) are prevalent and increasing musculoskeletal disorders that cause a great amount of suffering, loss of productivity and independence, as well as a financial burden on individuals and societies. The prevalence of all these conditions is increasing, partly because of aging of populations and partly because of widespread adverse changes in lifestyle and environments. There is increasing evidence that physical activity is related to the development and course of these conditions, but the relationships of causality, directions, strength, and modifying factors are only partially known. Vuori (2001) reviewed the published literature on the relationships between physical activity and LBP, OA and OP from the computer database from 1990 to 2000. He concluded that physical activity could be effective in preventing LBP but prolonged, heavy loading can lead to LBP. Specific exercises have not been found effective in the treatment of acute LBP, but aerobic exercise can be effective in chronic LBP, especially for diminishing the effects of deconditioning. No evidence indicates that aerobic exercise directly prevents OA. Large amounts of intensive aerobic exercise that involve high impacts or torsional loadings or causing injuries increases risk of OA. Light or moderate aerobic exercise does not increase the risk of OA. Aerobic exercise can be effective in the treatment and rehabilitation of OA (Vuori, 2001). Moderate and vigorous aerobic activity is recommended for children to increase bone mass and strength. It is also recommended for asymptomatic adults to help preserve bone density. Modified physical activity is recommended for those with OP to improve posture and muscle strength and maintain bone mass (Forwood & Larsen, 2000).

2.6.8 Aerobic activity and cancer

Environmental exposure has been accepted as a major causal factor of cancer (80%-90%) (Lichtenstein et al., 2000). Numerous studies have suggested that aerobic exercise, including light to moderate intensities, has many benefits for people with cancer (Courneya & Friedenreich, 1999; Derman, Coleman & Noakes, 1999; Durack & Lilly, 1998; Schultz, Szlovak & Schultz, 1998). Thune et al. (1997, 2001) evaluated the influence of physical activity, both at work and during leisure time, and found that physical activity during leisure time and at work were associated with a reduced risk of overall cancer in both sexes. Following a review of the literature, Batty and Thune (2000) indicated that physical activity reduces the risk of colon cancer by 50 percent and of breast cancer by 30 percent. There is some evidence of vigorous activity providing a protective effect for prostate cancer in men (Giovannucci et al., 1998). There are too few studies to enable clear statements to be made on the associations between physical activity and uterine and ovarian cancer in women, testicular cancer in men, and lung cancer. However, a recent study showed a promising reduction in risk of lung cancer in physically active men (Lee & Paffenbarger, 2000).

2.6.9 Aerobic activity and HIV

Aerobic exercise training (3 times per week for 1 hour of moderate or heavy intensity,) has been found to significantly improve aerobic capacity without detrimental effects on the immune system of HIV^+ individuals. It represents an important non-drug therapy, which can be recommended with confidence. Aerobic exercise training also produced small but significant improvements in immune function and quality of life (Stringer, 1999).

2.6.10 Physical activity, mental health and psychosocial benefits

Aerobic exercise training studies consistently show that participation in physical activity reduces symptoms of stress, anxiety and depression (Glenister, 1996; Hassmén, Koivula & Uutela, 2000; Petruzello et al., 1991), improves self-esteem, coping skills and cognitive functioning among those with depression (Camacho et al., 1991; Ross & Hayes, 1988; Stephens, 1988), and improve quality of life among children and adults (Hassmén et al., 2000; Laforge et al., 1999). Aerobic exercise has been shown to decrease anxiety and increase mental health in normal (Dishman, 1982; Simonsick, 1991; Stephens, 1988), healthy middle-aged adults (Blumenthal, Williams, Needels & Wallace, 1982) and students (Mutrie & Harris, 1984). Aerobic exercise is recognized as an evidence-based treatment for clinical anxiety and depression (Bauman & Owen, 1999). People who are in the poorest physical and psychological state could have the most to gain from regular exercise programs (Long, 1988).

2.6.11 Physical activity on preventing children's diseases both now and later

A sedentary lifestyle in young people can have negative health consequences both now and later.

Physical activity in childhood may have lasting effects on bone development. Exercise may lower osteoporosis risk by increasing bone mineral density. Though most attention has focused on exercise in later years to reduce or restore bone loss, the skeleton appears to be most responsive to the effects of activity during growth (Welten et al., 1994).

Overweight children are at increased risk of many health problems, including hypertension, hyperlipidemia, type 2 diabetes, growth hormone dysregulation, and respiratory and orthopedic problems. Self-esteem and socialization frequently suffer (Bar-Or et al., 1998). And that is just the beginning. Not only does obesity follow children into adulthood (40% of overweight children and 70% of overweight adolescents become obese adults). Obesity in adolescence is independently associated with chronic diseases that develop in adulthood (Must et al., 1992). While cardiovascular disease is primarily manifested in adulthood, risk factors appear much earlier in life and typically persist. The experts in human growth and development note that physical inactivity is a major risk factor (Malina, 1989). Although adolescent obesity certainly has adverse implications for long-term health, it also imposes a harmful psychological burden because of an obesity-related social stigma (Williams, 1986). Although caloric restriction is a key element in the prevention and treatment of obesity and related CHD risk factors, such restriction in children may suppress growth and development (Rowland, 1990).

The relationship between physical activity and adiposity in children is complex, especially at earlier ages, and studies have been inconsistent (Caspersen, Nixon & DuRant, 1998), but increasing physical activity, while restricting calorie intake has been documented as an effective weight loss strategy (Bar-Or & Baranowski, 1994). Accordingly, increasing caloric expenditure by habitual exercise may be even more important for children than for adults in preventing and controlling obesity. In addition, properly designed exercise programs can lower blood pressure and serum lipid levels in obese children (Endo et al., 1992), which are the most important risk factors for stroke and heart attack.

Exercise may also improve the ability of young people to cope with stress. A study of 220 adolescent girls during a high-stress period found that those who adhered to a rigorous exercise program reported less physical and emotional distress than those who exercised less (Brown & Lawton, 1986). Participating in physical activity may also reduce self-destructive and antisocial behavior among young people (Mutrie & Parfitt, 1998).
(more informatin also included in 2.9 of this chapter)

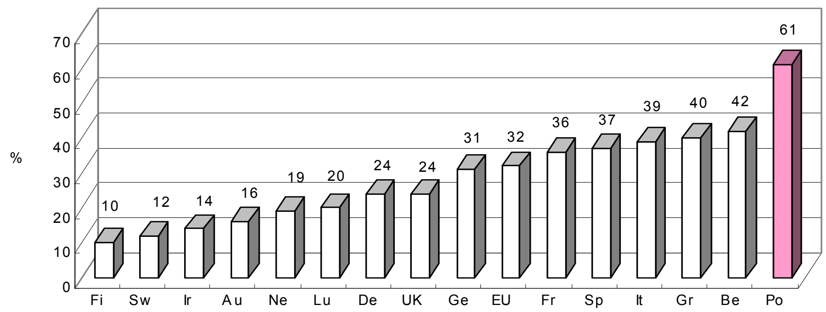
2.7 WORLDWIDE PHYSICAL INACTIVITY

In 1995, a panel discussion organized by the ACSM and CDC concluded *"Every adult should accumulate 30 minutes or more of moderate-intensity physical activity (aerobic exercise) on most, preferably all, days of the week"* (Pate, et al., 1995). The reports also state that the 30 minutes can be accumulated in smaller doses, even as brief as 10 minutes, throughout the day. It is not necessary to do the full 30 minutes of activity at one time if shorter sessions are easier to fit into the daily routine. Regular physical activity at a moderate level, such as a brisk walk or raking the lawn, improves physical and mental health. To achieve these benefits, regularity is more important than the intensity or strenuousness of the physical activity (USDHHS, 1996).

Even though most people know the benefits of regular physical activity, most adults and many children still lead a relative sedentary lifestyle and are not active enough to achieve many health benefits. Worldwide, it is estimated that over 60 percent of adults are simply not active enough to benefit their health (WHO, 2003b). From adolescence onward, physical activity declines significantly with age. Physical activity and physical education programs are declining in schools. Physical inactivity is generally higher among girls and women. The overall inactivity trend is worse in poor urban areas (WHO, 2003b).

Physical inactivity is major public health problem in Portugal with recent evidence suggesting that many Portuguese adults do not participate in sufficient activity to gain the associated health benefits. Approximately 61 percent Portuguese adults do not participate in any leisure time physical activity, which is the highest rate in EU countries (Figure 2-06 & Table 2-04).

Figure 2-06 Percentage of adults aged 15 and over who have no PA in a typical week, 1997, EU



Source: Institute of European Food Studies, Trinity College, Dublin (1999)

Table 2-04 Percentage of adults' aged 15 and over who have no physical activity in a typical week, 1997, EU

	Au	Be	De	Fi	Fr	Ge	Gr	Ir	It	Lu	Ne	Po	Sp	Sw	UK	EU
No	16	42	24	10	36	31	40	14	39	20	19	61	37	12	24	32
<1hour	4	7	6	5	7	6	4	5	7	8	6	7	11	4	7	7
1-3 hours	18	18	16	18	20	19	18	16	20	19	18	15	17	16	17	18
3-5 hours	20	15	22	26	20	19	22	28	19	21	18	11	21	23	25	21
> 5hours	42	14	30	41	16	24	16	37	14	30	38	5	12	45	27	21

Source: Institute of European Food Studies, Trinity College, Dublin (1999)

Children have become less physically active in recent decades, with children today expending approximately 600 kcal per day less than their counterparts 50 years ago (Boreham & Riddoch, 2001). Adolescent habitual physical activity levels also have been found to be declining dramatically both in the United States (USDHHS, 1996) and in Europe (Freedson & Rowland, 1992).

A large-scale investigation comparing Portuguese adolescent leisure time physical activity between 1998 and 2002 (see Figure 2-05) shows that adolescent's physical activity levels and adolescent participation in popular sport is declining. In 2002, only 36.8 percent (boys: 48.9% vs. girls: 25.5%) participated in physical activity 4 to 7 times weekly (Matos et al., 2003).

Table 2-05 Comparing the leisure physical activity among the Portuguese adolescents (1998-2002)

N_{1998} = 6846 ; N_{2002} = 6017	Total	Boy	Girl	11yr	13yr	15yr	16+yr
Number in participating PA (from 1998 to 2002)	↓	↓	↓	↓	↓	↓	↓
Participating popular sports (from 1998 to 2002)							
1. Football	↓	↓	↓	↓	↓	↓	↓
2. Basketball	↓	↓	↓	↓	↓	↓	↓
3. Volleyball	↓	↓	↓	↓	↓	↓	↓
4. Gymnastics	↓	↓	↓	↓	↓	↓	↓
5. Swimming	↓	↓	↓	↓	↓	↓	↓
6. Cycling	↓	↓	↓	↓	↓	↓	↓

↓= decline, Adopt from Matos et al., (2003). A Saúde dos Adolescents Portugueses, p490

2.8 SCHOOL HEALTH PROMOTION

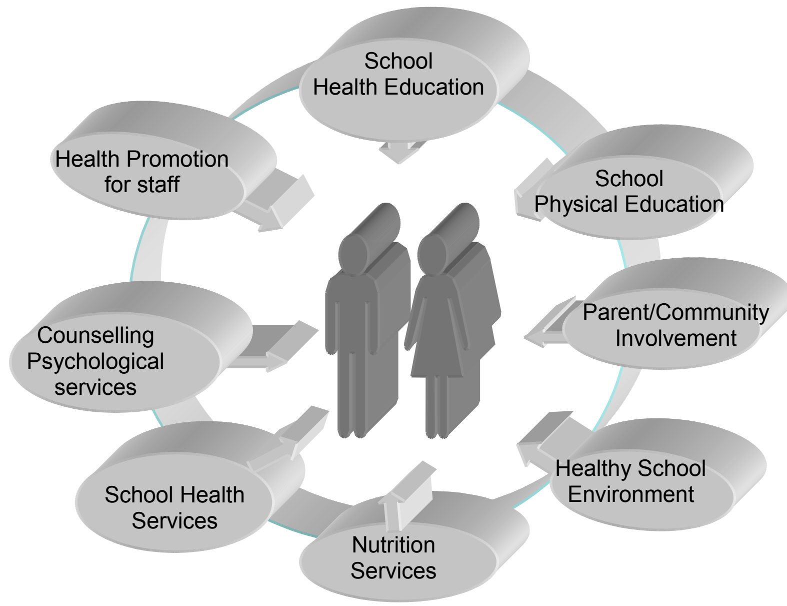
Many of the health challenges facing young people today are different from those plaguing the public's health a century ago. Today, the major health problems are caused, in large part, by behaviors established during youth (Kolbe, 1993). Most of leading causes of death are health-compromising behaviors (CDC, 1999). A lot of people often neglect to maintain their health when they are young. Consequently, many preventable health problems are not prevented. This is especially true with most chronic diseases that have been traced as a result of various unhealthy behaviors. One example of this is the relationship between smoking and lung cancer.

While it is true that children and young adults have very low rates of CHD, cancer, and strokes, it is also true that these diseases develop over time and quite often begin developing in youth (Jackson, Morrow, Hill & Dishman, 1999). Gilliam, Katch, Thorland and Weltman (1977) studied risk factors for CHD in children aged 7 to 12 years, and found that 20 percent had high body fat, 11 percent had high cholesterol and low cardiovascular endurance, 25 percent had a family history of CHD and 60 percent had one or two of the risk factors for CHD. The study had been supported by many large scale investigations (Jackson, Morrow, Hill & Dishman, 1999).

Over the past two decades, extensive attention has been paid to health promotion and diseases prevention among young people, particularly in schools (Best, 1989; Stone & Perry, 1990). Schools are often considered to be ideal vehicles for the delivery of health intervention, as most children are enrolled in school and spend a large amount of their time there. A variety of professionals in schools can implement health interventions, such as dietitians, physical educators, classroom teachers, counselors, and school nurses. Classrooms, gyms, outdoor playing fields, and other facilities are necessary and useful for health promotion. Schools provide a means of intervention early in life before many of the detrimental effects of diseases have developed. It also a good place to develop a health lifestyle early. No other institution provides a more appropriate combination of access to children, professional expertise, and physical resources to affect children's health over period of time needed to achieve long-term behavioral changes. More importantly, schools provide a means of intervening early in life (Sallis, Chen & Castro, 1995). Normally, school-based intervention for children's health can be categorized into two types: **primary prevention intervention,** reducing the risk factor distribution in the entire population, and **secondary prevention intervention,** targeting high-risk children who are already in high risk health levels. The U.S. Preventative Services Task Forces' Guide to Clinical Preventive Services (2nd edition, 1996) defines primary prevention measures as "those provided to individuals to prevent the onset of a targeted condition." It describes secondary prevention measures as those that "identify and treat asymptomatic persons who have already developed risk factors or preclinical disease but in whom the condition is not clinically apparent."

During the late 1880s until the late 1990s, school health programs were conceived as having three components: health education, health services, and school health environment, During the 1980s, more sophisticated concepts of the school health program were proposed. Allensworth and Kolbe (1987) proposed a model, the Comprehensive School Health Program-CSHP (Figure 2-07), which extended the classic triad of health education, health services, and health school environment to include physical education, counseling and psychological services, nutrition services, health promotion for staff and parent/community involvement as interactive components. This model was broadly adopted in United States and internationally.

Figure 2-07 Comprehensive School Health Program

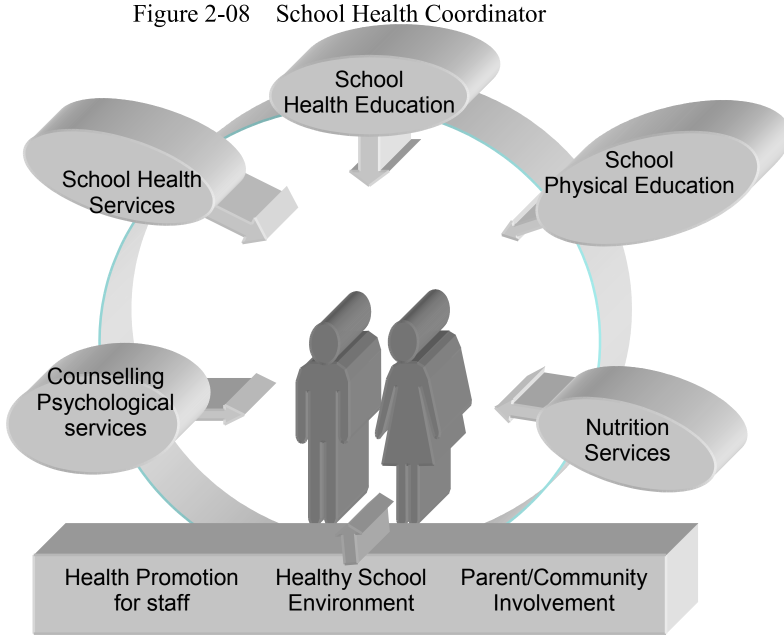


Source: Torabi and Yang (2000).

The CSHP model requires systematic coordination among eight components to magnify the benefits available in each component. In general, schools by themselves cannot, and should not be expected to, address a nation's most serious health and social problems. Collaborative efforts among families, health care workers, the media, religious organizations, and community organizations must be involved to maintain the well-being of young people. The glue that could cement each component is health education, for it is the major source of the one element common to all components - health knowledge.

CSHP transforms several solo performers into an orchestra. Extending this metaphor, CSHP assumes that the aggregate of a synchronized, integrated school health program will produce a product greater than the total of its parts. Therefore, the actual success of CSHP hinges largely on a coordinating mechanism. However, the role of a coordinator within the eight component model has not been articulated adequately. In 1996, Resnicow and Allensworth (1996) proposed a model - the School Health Coordinator-SHC (Figure 2-08), which is a revision of CSHP. The main feature of SHC is that it sets the school health coordinator component, an essential and unifying element, into the model. The major function of the SHC component is coordination. Its principal responsibilities include administration, integration of personnel and programs, evaluation, and direct intervention.

Figure 2-08 School Health Coordinator



Source: Torabi and Yang (2000).

Direct intervention includes coordinating three program elements - health promotion for staff, a healthy school environment, and parent/community involvement. Therefore these three components are considered as second strings, which are assigned to the school health coordinator component to support and enhance the impact of the other five core elements remaining in the CSHP model.

Folding these three elements into the role of the coordinator effectively reduces the number of program elements from eight to five, or six if the coordinator is considered an additional element, and thereby minimizes the number of elements which schools must adopt (Resnicow & Allensworth, 1996).

Today, more than ever before, challenging economic, physical and social conditions put the health of our children at risk. Schools, families and communities have fewer resources. Family and social structures are less stable. Lifestyle choices are more complex. The pressures and hazards of growing up have never been greater. A teacher can not manage it all. No individual can. Teamwork is the key. Studies suggest that CSHP and SHC are the cost-effective approach to health. Studies of school-based programs show that health instruction is effective in changing health attitudes and behaviors. By combining instruction with environmental, social and service support, CSHP and SHC ensure that pro-health attitudes and behaviors endure. It shows students, teachers, parents and the community that, by working together, they can achieve a higher level of health and well-being. They give students the best possible chance to grow up healthy.

2.9 SCHOOL-BASED INTERVENTIONS FOR HEALTH OF YOUNG PEOPLE

School is often considered to be ideal vehicles for the delivery of interventions. For example, in the United States, an estimated 95 percent of all children ages 5 through 18 years are enrolled in school (Walter, Hofman, Vaughn & Wynder, 1988). School can be a powerful influence on children who have daily contact with teachers 10 months a year for many years. A variety of professionals in schools can implement health interventions, such as dietitians, physical educator, classroom teacher, counselors, and school nurses. Classrooms, gyms, outdoor playing fields, and other facilities are necessary and useful in intervention for health promotion. Thus, no other institution provides a more appropriate combination of access to children, professional expertise, and physical resources for affecting children's health over period of time needed to achieve long-term behavioral changes. More importantly, for example, schools provide a means of intervention early in life before many of detrimental effects of obesity have developed (Cheung & Richmond, 1995, p.181).

2.9.1 School-based Obesity Treatment for children adolescents

Sallis, Chen and Castro (1995) reviewed 11 school-based treatment studies for obese youth (Table 2-06 with *), summarizing the design, interventions, and the results. The studies were conducted between 1970 and 1985, criteria for obesity varied considerably among studies, treatment lengths ranged from 9 weeks to 6 months, with session frequencies ranging from once a week to twice daily. Most study consisted of an experimental group and control group. We included the main interventions as below:

(1) Physical Activity Education. Children were provided with structured physical activity (Ruppenthal & Gibbs, 1979), provided with information or brief counselling by teachers and parents (Brownell & Kay, 1982) and older peers (Foster, Wadden & Brownell, 1985), after school activity programs (Jetté, Sidney & Cicutti, 1977).

(2) Modified Physical Education. Children were encouraged to increase class time spent in endurance activity (Seltzer & Mayer, 1970), to substitute non-competitive actives for competitive sports (Brownell & Kay, 1982), and to participate in walking and jogging programs (Moody et al, 1972). While on obese students who encouraged signing up for additional physical education credits for fitness-oriented classes (Zakus et al, 1981) and increasing the general emphasis on endurance activities (Seltzer & Mayer 1970).

(3) Diet and Nutrition Education. It included mainly general concepts on nutrition education (Epstein, Masek & Marshall, 1978; Ruppenthal & Gibbs, 1979), which would not be expected to be highly relevant to changing dietary habits. Others included peer counselling (Foster et al., 1985) and made specific recommendations for change (Seltzer & Mayer, 1970; BrownelI & Kaye, 1982). The programs for adolescents included a course for credit on dietary management (Zakus et aI., 1981), combined classes for adolescents and parents (Seltzer & Mayer, 1970), and behaviourally oriented approaches (Botvin, Cantlon, Carter & Williams, 1979; Lansky & Brownell, 1982; Lansky & Vance, 1983).

(4) Modified Lunch. A special lunch was offered by school to obese children as part of the intervention (Brownell & Kaye, 1982). The goal was to teach children to select low-calorie, high nutritional value foods from the menu.

(5) Parental Involvement. The children's programs had meetings with parents where they were taught behavior modification methods to apply to diet and physical activity (Foster et al., 1985). One study included telephone follow-up (Brownell & Kaye, 1982). The adolescent program also taught parents to reinforce health behaviour (Lansky & Vance, 1983).

(6) Behaviour Modification. Typical behaviour change methods included self-monitoring, stimulus control, self-reinforcement, and practicing new food preparation and physical activity behaviours (Botvin, Cantlon, Carter & Williams, 1979; Lansky & Brownell, 1982; Lansky & Vance, 1983). Three other studies included some mention of behavior modification methods (Foster et al., 1985; Seltzer & Mayer, 1970; Zakus et al., 1981).

Table 2-06 Review of some school-based obesity treatment before

Lead author	Subject	Duration	PAE	MPE	DNE	ML	PL	BML	Results
Botvin	52B/67G (>12yr)	10w classes	Yes	No	Yes	No	No	3	E: < SF in 70%
(1979)*	> 120% OW								C: < SF in 43%
Brownell	37B/40G (<12yr)	18w seasons	A:Yes	A:No	A:Yes	A:No	A:No	A:3	E: -3% OW
(1982)*	Mean 3% OW	A: BM/B:E	B:Yes	B:No	B:Yes	B:No	B:No	B:1	C: -2% OW
Epstein	3B/3G (<12yr)	2 times/w	No	No	Yes	Yes	No	1	E: -5.6% OW
(1978)*	> 25% OW	for 3 months							C: own control
Foster	44B/45G (<12yr)	12w	Yes	No	Yes	No	Yes	2	E: -5% OW
(1985)*	Mean 30%OW								C: +3% OW
Jetté	21B (<12yr)	2*45min/w	After	No	No	No	No	1	E: -6% OW
(1977)*	Mean 33% BF	for 5 months	school						C: +2% OW
Lansky	32B/ 39G (>12yr)	45 min/w	Yes	No	Yes	No	Yes	3	E: -11% OW
(1982)*	Mean 57%OW	for 12w							C: -2% OW
Lansky	51B/ 63G (>12yr)	45 min/w	Yes	No	Yes	No	Yes	3	E: -11% OW
(1983)*	> 10% OW	for 12w							C: -2% OW
Moody	40G (>12yr)	4 time/w	No	Yes	No	No	No	1	E: -2.5% BF
(1972)*	> 30% OW	for 15w							C: -1.0% BF
Ruppenthal	37B/40G (<12yr)	5*45min/w	After	No	Yes	No	No	1	E: -11.4% OW
(1979)*	> 10% OW	for 5 months	school						C: NS
Seltzer	105B/245G	5-6 months	No	Yes	Yes	No	No	2	E: -11% OW
(1970)*	(< & >12yr) SF								C: -2% OW
Zakus *	22G (>12yr)	5*45min/w	No	Yes	Yes	No	No	2	E: -4% OW
(1981)	>10% OW	for 9w							C: unknown
Gutin	E: 12G, C:10G	5 day PA/w	Yes	No	No	No	No	2	SE in BF (-1.4%)
(1995)	(7-11yr) BF>32%	for 10w							Aerobic fitness
Gately	64B/130G (12.6±2.5)	8w summer	Yes	Yes	Yes	Yes	No	3	SE in BC, Aerobic fitness,
(2000)	Obese children	weight loss camp							Psychometric variables

* means the studies included in Sallis, Chen & Castro (1995); B-boy; G-girl; PAE-physical activity education; E-education; MPE-modify physical education; DNE-diet and nutrition education; NS-not significant; ML-modify lunch; PI-parents involved; OW-overweight, BF- body fat; BML-behaviour modification level; BML=1-few behaviour procedures or cannot judge; BML=2-moderate emphasis on behaviour procedures; BML=3-extensive use of behaviour procedures.

Sallis, Chen and Castro (1995) indicated that school-based interventions for the treatment of obesity in childhood were encouraging. In all five studies there were significant intervention effects at posttest, with an average decrease in overweight of about 10 percent. There were essentially no changes in controls. Large effects were seen in the Brownell and Kaye (1982; 15% reduction) and Ruppenthal and Gibbs (1979; 11% reduction). The effects reported in the studies of adolescents were much less impressive. Three of the six studies found a change in the percentage of overweight. For these three studies (Lansky & Brownnell, 1982; Lansky & Vance, 1983; Zakus et al., 1981), the mean decrease in the experimental group was about 4 percent, whereas the controls remained largely unchanged.

Sallis, Chen and Castro (1995) indicated that overall the school-based treatments successfully reduce obesity in children and adolescents and appear to be effective at least for short-term change. All studies showed some degree of reduction in measures of overweight and obesity among experimental subjects. Treatment for children results in more significant obesity reduction than treatment for adolescents. Physical activity education and diet education were the most popular and frequently used components.

We reviewed two recent studies (Table 2-06) on treatment of obese children (Gately, Cooke, Butterly & Carroll, 2000) and obese girls (Gutin, et al., 1996).

Gutin et al. (1996) studied the effects of physical training (PT) and lifestyle education (LSE) on risk factors for coronary artery disease and non-insulin-dependent diabetes mellitus in 22 obese girls aged 7-11 yrs. The subjects were divided into two groups. The PT group (N=12) completed a 5-days/week, 10-week aerobic training program; and the LSE group (N=10) participated in weekly lifestyle discussions to improve exercise and eating habits. The PT group showed a significant increase in aerobic fitness ($p<0.05$) and decrease in percent body fat ($p< 0.05$), while the LSE group declined significantly more in dietary energy and percent of energy from fat ($p<0.05$). The two different interventions were similarly effective in improving some diabetogenic and atherogenic factors, perhaps through different pathways; i.e., the PT improved fitness and fatness, while the LSE improved diet.

Gately, Cooke, Butterly and Carroll (2000) studied the effects of an 8-week diet, exercise, and education camp program on obese 194 children (64 boys and 130 girls aged 12.6±2.5 yrs). During the camp, diet was restricted to 1400 kcal/day, with a daily prescription of structured fun-type, skill-based physical activities and regular behavioral and educational sessions. Significant improvements in body composition, aerobic performance, and psychometric variables were found, suggesting that aerobic camp program was successful in reducing significant risk factor in children's health.

Both recent studies included all the multi-component interventions and show good effects on treatment of obese children for their body composition, body fat, CVD risk and even the psychometric variables.

2.9.2 School-based preventive intervention for children and adolescents health

Table 2-07 Review of some school-based obesity preventive intervention

Lead author	Subject	Duration	PAE	MPE	DE	ML	PI	BML	Results (post-test)
Alexandrov (1988)*	2106B/2107G (<12 yr)	3 year	Yes	No	Yes	No	Yes	L=1	SE in SF, HDL-C; NS on BMI
Angelico (1991)*	75B/75G (<12 yr)	5 years	Some	No	Yes	No	Yes	L=1	NS effect on BMI
Bush (1989)*	531B/532G (<12 yr)	4 years	Yes	No	Yes	No	No	L=2	NS on BMI and SF
Dwyer (1983)*	311B/259G (<12 yr)	1 year daily P.E.	No	Yes	No	No	No	L=1	SE on SF, CV fitness
Killen (1988)*	723B/724G (>12 yr)	20 sessions in 7 weeks	Yes	No	Yes	No	No	L=3	SE on SF and BMI, resting HR
Lionis (1991)*	84B/87G (>12 yr)	10*2 hr in 9 months	Yes	No	Yes	No	Yes	L=1	SE on BMI, TC, BP, NS on SF
Puska (1987)*	499B/460G (>12 yr)	2 years	Some	No	Yes	Yes	Yes	L=2	NS on BMI and SF
Resnicow (1992)*	1278B/1695G (<12 yr)	3 years	No	Yes	Yes	Yes	No	L=1	SE on BMI, TC, systolic BP dietary behaviour
Tamir et al (1990)*	413B/416G (<12 yr)	2 years	Yes	No	Yes	No	No	L=1	SE on BMI, HDL-C, TC,
Tell (1987)*	414B/414G (>12 yr)	17 months	Yes	Yes	Yes	No	Some	L=2	NS on BMI, or SF. SE on fitness(B),BP(G), TC
Walter (1988)*	1694B/1694G (<12 yr)	5 years	Yes	No	Yes	No	No	L=2	NS effect on BMI, S effect on TC, not BP
Harrell, (1998)	422 B & G (9± 0.8 yr)	8 weeks	E1:Yes E2:Yes C: No	E1:Yes E2:No C: No	No	No	No	E1=1 E2=2 C=0	SE in cholesterol, BF and health knowledge,
Caballero (2003)	1704 B & G 3rd-5th grades	3 years	Yes	No	Yes	No	Yes	L=2	NS in BF,SE in energy intake knowledge,attitudes&behaviours
Ewart (1998)	99 G 9th grades	1 semester	E: AE C: no	No	No	No	No	No	SE in cardiorespiratory Fitness and systolic BP

*means the studies included in Sallis, Chen & Castro (1995); B-boy; G-girl; PAE-physical activity education; MPE-modify physical education; DNE—diet & nutrition education; NS-not significant; SE-significant effect; ML-modify lunch; PI-parents involved; BML-behaviour modification levels; BML=1-few behaviour procedures or cannot judge; BML=2-moderate emphasis on behaviour procedures; BML=3-extensive use of behaviour procedures; BF-body fat; TC-total cholesterol; HDL-C- high density lipoprotein cholesterol.

Sallis, Chen and Castro (1995) reviewed 11 school-based preventive interventions that focused on the reduction of CVD risk through multiple risk factor interventions (Table

2-07 with *). Summarizing the design, interventions and results, these studies were conducted between 1981 and 1991; include children (below 12 yr) and adolescents (above 12yr); Treatment length ranged from 7 weeks to 2 years. Most studies were large, and total number of subjects at baseline was 13495 primary students and 3405 secondary students. Intervention components included physical activity education, modified physical education, diet and nutrition education, modified school lunch, parental involvement, and behaviour modification.

The results of these school-based preventive interventions for children and adolescents found only 4 in 11 studies had a significant intervention effect on obesity or overweight (two in primary and two in secondary). Most studies with significant results did not present adequate data to compute effect sizes. It appears that the school-based multiple risk factor intervention programs were most effective in preventing smoking and least effective in reducing body fat or body mass in general population samples.

We reviewed the 3 current school-based preventive intervention studies on children's health (Harrell et al., 1998; Caballero et al., 2003; Ewart, Young & Hagberg, 1998).

Harrell et al. (1998) studied the immediate effects of two types of elementary school-based interventions on children with multiple cardiovascular disease (CVD) risk factors. 422 children, ages 9 ± 0.8 years with at least two risk factors at baseline: low aerobic power and either high serum cholesterol or obesity, were randomly selected from 18 elementary schools across North Carolina. The 8-week intervention included an adaptation of physical education, knowledge and attitude program. The classroom-based intervention was given by regular teachers to all children in the 3rd and 4th grades. The risk-based intervention was given in small groups only to children with identified risk factors. Children in the control group received the usual teaching and physical education. After 8 weeks, both interventions produced large reductions in cholesterol (10.1 mg/dl and 11.7 mg/dl) compared with a small drop (2.3 mg/dl) in the controls. There was a trend for systolic blood pressure to increase less in both intervention groups than in the controls. Both intervention groups had a small reduction in body fat and higher health knowledge than the control group. The study indicated that both brief interventions can improve the CVD risk profile of children with multiple risk factors. The classroom-based approach was easier to implement and used fewer resources. This population approach should be considered as one means of early primary prevention of CVD.

Caballero et al. (2003) study the effectiveness of a school-based, multi-component intervention for reducing percentage body fat in American Indian schoolchildren. This study included 1704 children in 41 schools and was conducted over 3 consecutive years, in 3rd to 5th grades, in schools serving American Indian communities in Arizona, New Mexico, and South Dakota by random and the children indicated to participated in 4 components of the intervention. The intervention included (1) change in dietary intake; (2) increase in physical activity; (3) a course focused on healthy eating and lifestyle; and (4) a family-involvement program. The main outcome was percentage body fat; other outcomes included dietary intake, physical activity, and knowledge, attitudes and behaviors. The results show the intervention resulted in no significant reduction in percentage body fat. However, a significant reduction in the percentage of energy from fat was observed in the intervention schools. Total energy intake (by 24-h dietary recall) was significantly reduced in the intervention schools but energy intake (by direct observation) was not. Motion sensor data showed similar activity levels in both the intervention and control schools. Several components of knowledge, attitudes, and behaviours were also positively and significantly changed by the intervention. The results document the feasibility of implementing a multicomponent program for obesity prevention in elementary schools. The program produced significant positive changes in fat intake, in food and in health-related knowledge and behaviours. More intense or longer interventions may be needed to significantly reduce adiposity in this population.

Ewart, Young and Hagberg (1998) studied the effects of aerobic exercise physical education on blood pressure in 99 high-risk adolescent girls. These 9th grade with blood pressure above the 67th percentile were randomized to one semester of aerobic exercise classes or standard physical education classes; 88 girls completed the study. At post-test, only members of the aerobic exercise group increased their estimated cardiorespiratory fitness. The aerobic exercise group had a greater decrease in systolic blood pressure than the standard physical education group ($p<0.03$). The study suggested that aerobic exercise physical education is a feasible and effective health promotion strategy for high-risk adolescent girls.

Three school-based preventive interventions on children's multiple CVD risk (Harrell, et al., 1998), body fat (Caballero et al., 2003), and blood pressure (Ewart, Young & Hagberg, 1998) showed an effective results in multiple risk factors, reductions in cholesterol and blood pressure, and also on children's knowledge, attitudes, and behaviours. Diet education and aerobic exercise have been found more effective on children, especially adolescent girls.

Sallis, Chen, and Castro (1995) also indicated that many studies, both treatment and prevention studies, failed to use what could be considered the most powerful intervention components available in schools. It is well-documented that school lunches are higher in fat than those recommended by health promotion organizations (USDHHS, 1991) and school physical education classes provide limited physical activity (McKenzie et al., 1993; Simons-Morton, Taylor, Snider & Huang 1993). By changing school lunches and the content of physical education classes, students' caloric intake and expenditure could be directly affected. Additional studies of these school policies and environmental interventions are needed, because educational approaches to diet and physical activity change usually have weak, short-term effects (Sallis, Chen, & Castro, 1995). This suggests to us that education alone is not enough.

2.9.3 School-based physical activity intervention for children's health

We reviewed the nine studies (Table 2-08) by using aerobic exercise intervention for school-based children. Three studies showed that aerobic exercise significantly improve children's either BP or LDL, HDL, and TC total cholesterol which may be beneficial in the long term by preventing atherosclerosis of coronary artery disease in adulthood. Children's $VO_{2\ max}$ levels were significant improved in three studies, but two failed to have the significant results. Rowland (1995) indicated that $VO_{2\ max}$ can be improved with endurance training during the childhood years, but the degree of aerobic trainability is limited in healthy, active children.

Stone, McKenzie, Welk and Booth (1998) reviewed the literature of school-based physical activity intervention research in 1980s and 1990s and found that school-based intervention was based on multiple theoretical approaches and incorporated simultaneous multi-component interventions. In general, the studies found significant intervention effects for student knowledge and for psychosocial factors related to physical activity. Significant positive behavior changes were less common, but they were demonstrated in several studies (Dale, Corbin & Cuddihy, 1998; Homel, Daniels, Reid & Lawson, 1981; Luepker, Perry & McKinlay, 1996; McKenzie et al., 1996; Sallis et al., 1999; Tell &

Vellar, 1987). Three studies conducted long-term follow-up found sustained significant differences up to 12 years after the intervention (Luepker, Perry & McKinlay, 1996; McKenzie et al., 1996; Tell & Vellar, 1987). The more extensive interventions typically had better results (Stone, McKenzie, Welk & Booth, 1998). Most youth intervention programs to enhance physical activity have been conducted in school environments, typically through the physical education programs. The Child and Adolescent Trial of Cardiovascular Health (CATCH), a multicenter randomized trial for grades 3–5 involving 5,100 students in 96 schools, developed an intensive, teacher-based curriculum for enhancing health behaviors, including physical activity. The program demonstrated significant differences in vigorous physical activity between experimental and control schools (Luepker, Perry & McKinlay, 1996); the differences were maintained three years after the intervention (Stone, McKenzie, Welk & Booth, 1998).

Table 2-08 Review of some school-based intervention on children's health

Lead author	Subject	Duration	Intervention	Results (post-test)
Daley (1999)	E: 43G, C: 70G (15-16 yr)	1* 60 min weekly for 5 weeks	E: PE (1h/week) + PAE (1h) C: PE (1h/week)	Significant changes in girls' physical self-perceptions
James (1997)	95B/154G (14-17yr)	4* 40 min weekly for 15 weeks	MPE, Each class last 40 min.	Significant reductions in TC NS in HDL-C
Mandigout (2001)	E:18B/17G;C:28B/22G (10-11yr)	3* 60 min weekly for 13 weeks	E: Running training C: No training	SE on VO_2 max
Mandigout (2002)	E1: 36 B/G, E2: 20 B/G, C: 28 B/G, (10-11yr)	E1:3* 25-35min/w E2:2* 25-35min/w for 13 weeks	PAE 15-20min at 80%MHR E1=3days/w, E2=2days/w C: No train	NS in VO_2 max in E2 SE in VO_2 max but only in E1
Rowland (1995)	13B/24G (10.8-12.8yr)	3 * 30min weekly for 12 weeks	Aerobic activity at a mean HR of 166 bpm.	NS effect on VO_2 max
Stergioulas (1998)	E:18B, C:10B (10-14yr)	2* 60 min weekly for 2 weeks	PA Level at 75%PWC	SE in HDL-C
Tolfrey (1998)	E: 28, C:20 Pre-pubertal children	12 weeks 3 times/week	Stationary cycling 30 min/session	SE in LDL, HDL, TC, LDL/HDL ratios
Volpe (2002)	7B/5G (11.3± 0.5yr) 3B/3G (11.5± 0.6yr)	4-5 times weekly for 12 weeks	Boston Marathon Walk. 10-27miles/w at 50%MHR	SE on SF, E:C=-10.3%/:2.3%, NS on $VO_{2\ max}$
Welsman (1997)	E1:17G, E2:18G C: 16G (9 -10yr)	3 * 25min weekly for 8 weeks	C: No train, E1:AE:25 min E2: Cycle ergometer train	SE on Blood lactate, NS $VO_{2\ max}$, TC,HDL-C

B-boy; G-girl; PAE-physical activity education; MPE-modified physical education; NS-not significant; SE-significant effect; E-experimental group, C-control group; BF- body fat; TC-total cholesterol; HDL-high density lipoprotein; LDL-low high density lipoprotein.

In conclusion, school-based health intervention programs have been found to improve students' physical activity knowledge and attitudes (Prokhorov et al., 1993; Arbeit et al., 1992), increased the intensity and duration of physical activity during physical activity classes (Mckenzie et al., 1996; Sallis et al., 1997) and improved physical fitness (Arbeit et al., 1992; Dywer, Coonan, Leitch & Baghurst, 1983).

Mandigout et al. (2002) indicated that "it appeared only a program with continuous activity, organized on the basis of three sessions per week, with 25-35 minutes at the intensity higher than 80 percent of maximal heart rate at each session, enhanced $VO_{2\ max}$ in pre-pubertal boys and girls." One study showed that aerobic exercise produces significant changes in girls' physical self-perceptions. Daley and Buchanan (1999) suggested that aerobics might be one activity which meets these objectives for girls who are at risk of sedentary lifestyles. This may also facilitate a rise in the physical activity rates for girls-a major aim for educators and researchers into the new millennium.

Several school-based trials also targeted dietary behaviors and found significant differences in knowledge, attitudes, and behavior change between intervention and control schools (Kelder et al., 1994; Luepker, Perry & McKinlay, 1996; Perry, Kelder, Murray & Klepp, 1992). Perry, Story & Lytle (1997) concluded that school-based nutrition education programs have been effective in improving aspects of children's eating behaviors, with positive effects also observed in physiological outcomes such as serum cholesterol.

2.10 SCHOOL PHYSICAL EDUCATION AND PUBLIC HEALTH

The concept and practice of physical education have existed in lives of people in various countries and cultures since ancient times. From the time primitive to the present, either directly or indirectly, physical activity has played a part in the lives of all people. It is interesting to note that for centuries, the Chinese thought certain diseases were caused by inactivity, History records that as a result of the connection made between inactivity and diseases, "Kong Fu" gymnastics were developed in 2698 B.C. and have been practiced since then (Bucher, 1968). Physical education experienced a "golden age" in ancient Greece. The Greeks strove for physical perfection and this objective affected all phases of their life. It had its influence on political and educational systems, on sculpture and painting, and in the thinking and writing of that day. No country in history has held physical education in such high respect as did the ancient Greeks (Bucher, 1968).

Physical education has a long and established tradition in schools, being linked with the Aristotelian concept of harmonious development of both body and mind. The importance of physical education in providing a lot of movement experiences has been connected with intellectual, emotional, aesthetic, social, physical and motor development of children and young people (Keel & Leclaire, 1996). Exposure to regular, quality physical education in childhood shows a significant correlation with increased rates of physical activity and stronger intentions to, and positive attitudes towards, physical activity in adulthood. Establishing a foundation of skills for a lifetime of participation in physical activity is a natural immunising agent against many sedentary lifestyle diseases (USDHHS, 1996). School is an important setting for establishing these skills because virtually all children can be reached through it, and existing infrastructures are devoted to physical and health education (Sallis et al., 1992). Accordingly, physical education is recognised by many global organisations as a powerful and viable means of health promotion. The World Health Organisation is currently advocating and promoting the importance of physical education in the creation of the 'physically educated child' through the global initiative of 'Active Living In and Through Schools' (WHO, 1998). The United Nations Educational, Scientific, Cultural Organisation-UNESCO (1978) holds the position that physical education in schools is an essential condition for the exercise of human rights within its 1978 Charter of Physical Education and Sport.

However, although the values of regular physical activity are universally recognized and most youth experience physical education at some point in their school experience, too few young people are exposed to daily physical education. In the United States, high school student enrolment in daily physical education classes dropped from 42 percent in 1991 to 29 percent in 1999 (USDHHS, 1996, 2000a). A comprehensive survey of 25 European countries has revealed that only three countries, France, Austria and Switzerland, offer at least 2 hours per week of physical education at both the primary and secondary levels. No European country offers daily physical education classes (Armstrong & Åstrand, 1997).

Moreover, school physical education occupies a precarious position in some countries. In Canada, physical education appears to be often considered a 'frill' in the curriculum, fit into school schedules when and where possible, taught increasingly by generalist as opposed to specialist teachers (Alexander, 1997). Alarmingly, two decades on from the 1978 UNESCO Charter for Physical Education and Sport, which espoused the principle of Physical education as a basic human right, some national governments have proposed, and are proposing removing physical education from the curriculum or reducing physical education class time (Hardman & Marshall, 1999).

Physical education has not historically been viewed as a public health program. Historically, physical education has been justified on the basis of broad and diverse goals in physical, social, and moral development. In fact, the major emphasis has been on competitive sports, beginning as early as the third grade and continuing throughout high school. Until recently, the large-scale fitness testing programs assesses sport-related skill rather than health-related fitness (Ross & Gilhert 1985; Ross & Pate, 1987; Sallis & Mckenzie, 1991).

Traditionally, school physical education programs have been heavily influenced by Swedish gymnastics and military drill, which emphasized rhythmic callisthenics. Many students heartily detest such programs and often adopt very sedentary lifestyles immediately after leaving school (Ilmarnen & Rutenfranz, 1980). Some U.S. schools place a heavy emphasis on competitive team sports such as basketball and football. These programs also have a high dropout rate during adolescence and adult life. Defections begin with students who fail to develop an appropriate body build for their chosen sport at adolescence (Shephard et al., 1978). According to the review by Kemper et al. (1976), most of the physical education lessons were devoted to improving motor coordination rather than endurance and resistance training. Motor coordination increased significantly, but not maximal aerobic power or maximal strength. However, physical educators have shifted their emphasis to teaching activities that are likely to improve immediate health and carry over into adult life, such as walking and swimming that can develop cardiorespiratory function and muscular endurance (Shephard et al., 1982). Trudeau et al. (1998) emphasized the importance of getting children accustomed to regular and intense physical activity in the school curriculum. They concluded that intense physical activity has a long-term impact on physical fitness characteristics. Aerobic running in physical education is directly linked to the notion of health but may be considered annoying by many adolescents. It seems worthwhile to explore other running paces and, other practices to make this activity more attractive and, thus, create conditions for progress and enhanced motivation. Recently, physical activity guidelines for promoting fitness and health have suggested a minimum of three 30-min periods of moderate to vigorous physical activity (MVPA i.e., 60% MHRR) per week, for 11-21-year-old adolescents (Sallis & Patrick, 1994). During physical education lessons, children should be encouraged to reach these recommendations. Nevertheless, researchers have frequently noticed that most of the physical education lessons are not of sufficient intensity.

According to the systematic review, Kahn et al. (2002) indicated that school physical education interventions can be done in a variety of ways, including (1) adding new (or additional) PE classes, (2) lengthening existing physical education classes, or (3) increasing moderate to vigorous physical activity (MVPA) of students during physical education class without necessarily lengthening class time. An example of the last approach includes changing the activities taught (e.g., substituting soccer for softball) or modifying the rules of the game so that students are more active. There is strong evidence that school-based physical education is effective in increasing levels of physical activity and improving physical fitness (Briss et al., 2000). Nevertheless, barriers to intervention implementation, the fact that few middle and high schools require daily physical education, and school faces increasing pressure to eliminate physical education to make more time available for academic subjects.

2.11 THE DEVELOPMENT OF FITNESS TEST BATTERY FOR YOUTH

In the early 1950s, physical fitness testing indicated that European children had higher levels of fitness than American children. This led the United .States former President Eisenhower to establish what has become the President's Council on Physical Fitness and Sport. The council, along with the American Association for Health, Physical Education and Recreation-AAHPER established a first national youth fitness program in the United States (Table 2-09 & Table 2-10). AAHPER Youth Fitness Test (1961) was designed to evaluate the fitness levels of the American children (Morrow et al., 2000); it includes performance related tests that measured strength, endurance, running, agility, and jumping ability (Safrit, 1990). During the 1970s physical education professionals and researchers became more interested in health-related fitness (Safrit 1990). Because the AAHPER Youth Fitness test items included a 50-yard dash and a standing long jump that were not considered health-related fitness items, however, the 600-yard run is not a good measure of aerobic capacity. The American Association for Health, Physical Education, and Recreation and Dance (AAHPERD) no longer supported the AAHPER Youth Fitness Test. And corresponding to the change in definition, the Youth Fitness Test was replaced by the Health-Related Physical Fitness Test in 1980 (Morrow, Jackson, Disch & Mood, 2000).

Table 2-09 A brief history of fitness testing in the United States.

Year	Representative event in the history of fitness testing
1861	Edward Hitchcoch M.D. Anthropometrical and Strength Measurement
1880	Dudley Sargent M.D. Strength Measurement and Physiological Function Tests
1885	Association For Advancement of Physical Education (AAPE). Later becomes AAHPERD
1927	David Brace M.D. Tests of motor skill
1930	Shift away from fitness toward social objectives (attitudes, posture, knowledge, social relationships)
1940	Begin to emphasize fitness
1945	Shift back to social objectives.
1954	Kraus-Weber test reveal 91.8% of European children pass flexibility (toe touch) test. Only 43.4% of American children pass.
1956	Eisenhower calls for President's council on fitness.
1957	Russia launches Sputnik.
1961	AAHPERD develops first National Youth Fitness Test
1960s	Primarily Motor Skill Test
1970s	Combination of Skill and Fitness
1980s	Health Related Fitness (norm based)
1990s	Health Related Fitness (criterion based)

Table 2-10 Development of youth fitness test in the United States

Test Battery	Contents of Test
AAHPERD Youth Fitness Test (1961)	Pull-up; Sit up (hands behind head); Shuttle Run (30feet); Softball throw For distance; 600 Yard Run.
AAHPERD Youth Fitness Test (1976)	Pull-up / girl flex arm hang; Sit up (Bent knee, hand behind head); Shuffle run (30 feet); Standing Long Jump; 600 Yard Run.
AAHPERD Youth Fitness Test (1980)	Pull up / Push up / Flex arm Hang; Sit up (arms across chest, elbows to mid thigh); Skinfolds (triceps & Subscapular); Sit & Reach; 1 mile run
Physical Best (1988)	One mile run/walk; skinfolds (triceps & calf) / BMI; Sit and Reach; Sit-ups (1minute); Push-up / Pull-ups.
FITNESSGRAM (1999)	Pacer / One mile run/walk / One mile track walk; triceps & calf skinfolds / BMI; Back-saver sit and reach/Shoulder Stretch; Curl-up (cadence); pull-up/ Push-up (cadence) / Flex arm hang; Trunk Lift. Philosophy: Fitness is for a lifetime, for everyone, for fun and enjoyable.

The AAHPERD Health-Related Physical Fitness Test includes components such as aerobic capacity, flexibility, body composition, and muscular strength and endurance. The Prudential FITNESSGRAM developed by Cooper Institute of Aerobic Research (CIAR, 1999) is the latest physical fitness test battery promoted by AAHPERD. Unlike the previous batteries, the FITNESSGRAM includes criterion-referenced standard for performance rather than norm-referenced standards. These criterion-referenced standards classify individuals as either healthy or unhealthy on a particular test item. A healthy classification is indicative of a child meeting the FITNESSGRAM criterion-reference standard established for a particular test item. An individual who does not meet the standard is classified as unhealthy. The FITNESSGRAM test standards are different across age groups and between genders (CIAR, 1999).

Table 2-11 The difference between health-related and skill-related fitness

Skill-related fitness:	Health-related fitness:
It refers to our ability to perform specific skills required to take part in various activities and sports. Skill-related fitness has little to do with overall health. Its components include: 1. Agility, 2. Balance, 3. Coordination, 4. Speed, 5. Power and Quickness	It focuses on areas that affect our overall health and energy and our ability to perform daily tasks and activities. Its components include 1. Cardiorespiratory fitness, 2. Body composition, 3. Musculoskeletal fitness (Flexibility, Strength & Endurance)

Adopted from Jackson et al. 1999 Physical Activity for Health and Fitness. p9

Table 2-12 Comparing the difference between the Norm-reference standard and Criterion-referenced standard

Norm-reference standard	Criterion-referenced standard
It reports how well a performance compares with that of others. The advantages are that students can learn how they compare with other children and youth in the well-defined group (e.g., their age, gender, school, etc.). The primary disadvantage is that the standards are based on the current level of performance of children and adolescents rather than the level they ought to achieve. Another disadvantage is that percentiles, particularly ones set at a high level, serve to discourage students whose fitness levels are moderate or low, as measured by the test, even though the fitness levels of those students may be adequate when viewed in another context such as health or some specific sports performance.	It suggests that there is a minimum level of performance that must be achieved before a student is said to be fit. One should not be interested in how someone compares with others; the comparison is with the standard, or criterion. The criterion often is initially set based on norm-referenced data and the best judgement of experts in the content area. A disadvantage of both is that the student's health status is not considered in determining the standards. A solution to this problem is to use criterion-referenced standards where health status is used as the criterion. With criterion-referenced evaluations, a standard on a field test is determined which is related to a specific criterion. With fitness tests, the criterion is often some sort of health outcome (e.g., heart disease, body fatness, low back pain, etc.).

Table 2-11 and Table 2-12 show the difference between health-related and skill-related fitness, and the difference between the norm- and criterion- referenced standards. The skill-related fitness test, its components include more skill-related items such as agility, speed, power and etc., which have little to do with overall health. The Health-related fitness test, its components include more health-related items such as cardiorespiratory fitness, body composition, musculoskeletal fitness, which has a strong relationship with overall health. The test use the norm-reference standard, it just compare with other children and youth rather than to tell the level the children ought to achieve for health. The test use Criterion-referenced standard, it tell children must achieve all minimum level of its items to be considered fit. It compares with the standard, or criterion.

The standards of FITNESSGRAM were established by a panel of experts who used a combination of professional judgement, normal data, and empirical data (Cureton & Warren, 1990). It is a timely break-through in the youth fitness field. The program of FITNESSGRAM is much more than just an assessment of physical fitness. Students who participate in the health-related test receive personalized reports on their performance. They are also given valuable feedback on ways to establish positive exercise behaviour geared to improving their level of physical fitness. It helps students learn at a young age that regular exercise can pave the way for a lifetime of good health. To date, over 8 million children have been tested under the Fitnessgram format in North America, and it is rapidly becoming the standardized measure for assessing students in U.S. and Canada (Collis, 2000).

The development of fitness tests in school systems in European countries occurred twenty years after the development of the American model. The Belgium and the Netherlands published their test batteries in the 1960s; other countries followed their lead. A more coordinated effort began in 1978, when upon the initiative of the Council of Europe Committee for the Development of Sport, aims and concepts of a EUROFIT test battery were formulated. Between 1980 and 1982, the evaluation and choice of both motor fitness and endurance fitness tests were carried out, and as a result of their international effect, in 1983 a provisional and in 1988 a final EUROFIT handbook was published in French and English. The test items cover strength, power, speed, flexibility, balance, endurance, as well as body composition measured with height, weight and skinfold thickness (Kemper & Van Mechelen, 1996). EUROFIT tests are aimed at measuring abilities rather than skills, but development of the EUROFIT test battery is an important step in Europe. However, it is only a first step. Although the EUROFIT handbook allows people to use these tests, it still needs to construct norm-referenced or criterion-referenced scales in the future.

2.12 RATIONALE, RELIABILITY AND VALIDITY OF FITNESSGRAM

FITNESSGRAM is the U.S. national fitness test battery for youth. The assessment was developed by The Cooper Institute in response to the needs of physical education programs for a comprehensive assessment protocol. The assessment includes a variety of health-related physical fitness tests designed to assess cardiovascular fitness, muscle strength, muscular endurance, flexibility, and body composition. Criterion-referenced standards associated with good health were established for children and youth for each of the health-related fitness components. The software for the program produces an individualized report card that summarizes the child's performance on each component of health-related fitness and provides suggestions for how to promote and maintain good fitness. The sophisticated database structure within the program produces compiled class reports and allows for long-term tracking of the student's fitness over time (CIAR, 1999).

2.12.1 Rationale, reliability and validity of one mile run for aerobic capacity

Aerobic capacity ($VO_{2\ max}$) reflects the maximum rate that oxygen can be taken up and utilized by the body during exercise. The magnitude of $VO_{2\ max}$ depends on the capacity of the lungs to exchange oxygen between the air and blood in lung capillaries, the capacity of the cardiovascular system to transport oxygen to the muscles, and the muscles' capacity to use oxygen. The highest rate of oxygen uptake and use reflects the upper limit in the ability of the body to supply energy via aerobic metabolism to active muscles during strenuous exercise. Aerobic capacity is most commonly expressed relative to body weight to account for differences in body size and to reflect a person's ability to carry out weight-bearing tasks.

Aerobic capacity is an important component of physical fitness because it reflects the overall capacity of the cardiovascular and respiratory systems (Mitchell, Sproule & Chapman, 1958; Taylor, Buskirk & Henschel, 1955) and the ability to carry out prolonged strenuous exercise (Astrand & Rodahl, 1986; Taylor, Buskirk & Henschel,, 1955). From a health perspective, good cardiorespiratory fitness has been shown to reduce the risk of hypertension, coronary heart disease, obesity, diabetes, some forms of cancer, and other health problems (Blair, Clark, Cureton & Powell, 1989; Blair, Kohl, Gordon & Paffenbarger, 1992).

Direct measurement of aerobic capacity or $VO_{2\ max}$ is primarily obtained using a graded exercise to exhaustion and open-circuit spirometry (Appendix-3). Subjects generally exercise on an appropriate treadmill or ergometer while wearing a noseclip and a mouthpiece equipped with one-way valves. In some cases respiratory masks are used in place of the traditional nose-clip-mouthpiece set-up, although at high ventilation rates they are prone to gas leakage. The low resistance one-way valves allow subjects to breathe ambient air while expired air is either collected into a Douglas bag or meteorological balloon for later analysis, or passed through a gas analyser for on-line measurement of minute ventilation and fraction of expired O_2 (FeO_2) and CO_2 ($FeCO_2$). These measurements along with accurate knowledge of gas temperature, barometric pressure and relative humidity are required for the determination of VO_2. The rate of aerobic metabolism and oxygen uptake increases as the intensity of exercise increases up to the point at which the aerobic capacity is reached. At this point, even though the exercise intensity can be increased, the oxygen uptake no longer increases proportionally, and there is a plateau relative to the rate of oxygen uptake to work rate (exercise intensity). The rate of oxygen uptake at the plateau is aerobic capacity. The measurement of aerobic capacity in the laboratory is technically demanding requiring expensive equipment and highly-trained technicians. It also is time consuming; a test requires about 30 minutes and only one person can be measured at a time. Therefore, the direct measurement of aerobic capacity is not possible or practical for most field settings, such as schools where large numbers of people must be tested.

Three field tests are used in FITNESSGRAM to assess aerobic capacity: the PACER (Progressive Aerobic Cardiovascular Endurance Run), the one-mile run and a walk test (for adolescents 13 years of age or older). In the one-mile run test, the objective is to run a mile as fast as possible. Because the rate of oxygen uptake is related in part to the pace sustained, it is possible to estimate the highest rate of oxygen uptake possible from the average pace sustained. Age, gender and body fatness also affect the prediction of aerobic capacity. Therefore, in the FITNESSGRAM software, aerobic capacity is predicted from running time, age, gender and body mass index using an equation of Cureton et al. (1995) developed on a large sample of children and adolescents.

Aerobic capacity ($VO_{2\ max}$) expressed relative to body weight (ml/kg/min) measured on the treadmill is the criterion against which FITNESSGRAM field tests of aerobic capacity have been validated. Its reliability is important because it affects the magnitude of validity coefficients assessing the accuracy of the field tests for predicting $VO_{2\ max}$. Although a range of reliability coefficients has been reported, the consensus is that the reliability of measuring $VO_{2\ max}$ in young people is high and acceptable for a criterion measure of physical fitness. The table below summarizes the results of studies reporting the test-retest reliability coefficients for $VO_{2\ max}$ (ml/kg/min) determined on the treadmill in young people. The values have generally varied from moderate to high. The validity coefficients ranged from approximately 0.60 to 0.80. Studies on the concurrent validity of the one-mile run are showed in the table below (Table 2-13).

Table 2-13 Reliability of VO_2 max (ml/kg/min) from One mile run/walk in Children and Adolescents

Lead author	Sample	Test Type	Reliability Coefficient[a]
Boileau (1977)	21 M, 11-14y	One mile Walk	r = .87
Cunningham et al. (1977)	66 M, 10 y	One mile Walk/Run	r = .56
Cureton (1976)	27 M&F, 7-12y	One mile Walk	r = .88
Paterson et al. (1981)	8 M, 10-12 y	One mile Walk, Jog, Run	R_{walk} = .47, R_{jog} = .87, R_{run} = .95

Note. [a] r = interclass reliability; R = intraclass reliability, M-male; F-female

Table 2-14 Reliability of the One-Mile Run Test in Children and Adolescents

Lead author	Sample	Reliability Coefficient
Bono et al. (1991)	15 M & 15 F (each), 5^{th} , 8^{th} , 11^{th} grade	r <5^{th}> = .91, r <8^{th}> = .93, r <11^{th}>= .98
Rikli et al. (1992)	53 M & 63 F, 3^{rd} grade	R_M = .84 / R_F = .90
	44 M & 37 F, 4^{th} grade	R_M = .87 / R_F = .85

Notes. r = interclass reliability; R = infraclass reliability for a single trial; M-male; F-female

The reliability of distance run tests in young people was summarized by Safrit (1990). Reliability coefficients for 600-yd, 1600-m, 9-minute, and 12-minute runs ranged from approximately 0.60 to 0.90. Safrit (1990) concluded that the reliability of distance runs in children is for the most part high, but not uniformly so. Results of the relatively few studies that have reported reliability coefficients for the One mile run test in youth are summarized in the table above (Table 2-14). In general, for children 9 years of age (3rd grade) and older, the reliability is high, with reliability coefficients above 0.80. For younger children, reliability coefficients are mixed.

The rationale (content and construct validity) for using the one-mile run to estimate VO_{2max} is based on the fact that for exhaustive exercise lasting longer than two minutes, energy is provided primarily through aerobic metabolism (Astrand & Rodahl, 1986). Therefore, performance in an event such as the One-mile run is determined, distance run performance and $VO_{2\ max}$ are correlated and a distance run performance can be used to estimate $VO_{2\ max}$ Moderately strong correlations between $VO_{2\ max}$ and performances on distance run tests in adults and youth support this rationale (Safrit, et al., 1988).

A study of college students found that distance runs of one mile and longer measure the same underlying factors, whereas the factors underlying shorter runs were different (Disch, Frankiewicz & Jackson, 1975). A study of elementary school children obtained similar results (Jackson & Coleman, 1976). These studies suggest that if $VO_{2\ max}$ is the primary determinant of distance running, runs of one mile and longer should be used to assess $VO_{2\ max}$. Correlations between distance runs of different distances and $VO_{2\ max}$ support this deduction (Baumgartner & Jackson, 1991; Disch, Frankiewicz & Jackson, 1975; Jackson & Coleman, 1976; Krahenbuhl, et al., 1977; Krahenbuhl et al., 1978; Safrit et al., 1988). The validity coefficients ranged from approximately 0.60 to 0.80 (with one exception). Studies on the concurrent validity of the One-mile run are summarized in the Table 2-15.

Table 2-15 Concurrent Validity of the 1-Mile Run in Children and Adolescents

Lead author	Sample	Validity Coefficient	SEE (ml/kg/min)
Bono et al. (1991)	15 M & 15 F (each), 5th, 8th ,11th grade	-.76 ; -.80 ; -.85	4.6 ; 4.9 ; 4.3
	45 M & 45 F, 5-11th grade	-.73	5.3
	45 M & 45 F, 5-11th grade	-.84[a]	4.3
Cureton et al. (1977)	140 M & 56 F, 7-11th grade	-.66	4.9
Cureton et al. (1994)	490 M & 263 F, 8-25yr	-.72[b]	4.8

[a] Prediction from age, gender, weight, sum of two skinfolds, and one-mile run/walk

[b] Prediction from age * gender, BMI, MRW (Mile Run/Walk), and MRW2; M-male, F-female

2.12.2 Rationale, reliability and validity of skinfold for body composition

Research has shown that excessive fatness (above 25% fat for boys and above 32% for girls) is associated with higher cardiovascular risk factors (e.g., blood pressure and blood lipids (Williams, et al., 1992). In addition several studies by Berenson and his colleagues with the Bogalusa Heart Study, have found relationships between measures of fatness and blood lipids, lipoprotein, blood pressure and glucose tolerance (Aristimuno et al., 1984; Berenson, McMahon & Voors, 1980; Berenson et al., 1982). Furthermore, tracking studies show a relationship between adult obesity and childhood obesity especially as children become adolescents. Together these studies indicate that body fatness in children and youth increase the likelihood of obesity-related adult diseases including coronary heart disease, hypertension and hyperlipodemia and type II diabetes.

As children become pubescent, they are somewhat more likely to become overfat and as they become postpubescent many become less fat, especially for boys, In general the degree of fatness increases with age in girls. Children are fatter today than ten to fifteen years ago.

Most laboratory and field methods have errors of 2.5 to 4.0 percent for prediction of body fatness. The laboratory approach using underwater weighing, total body water and total bone mineral (called a multicomponent approach) is the most accurate with an error of 2 percent or less. Underwater weighing and DXA have an error of 2.5 to 3.0 percent for estimating fatness. Skinfolds and circumference have errors of 3 to 4 percent fat.

FITNESSGRAM uses skinfolds as the field method to estimate body fatness. The use of two skinfolds (triceps plus calf) can be successfully used to predict the percentage of fat in children of all ages. Skinfolds have been proven to be one of the most effective field methods for estimating body fatness with standard errors of estimate of 3 to 4 percent body fat. A second method using height and weight, called body mass index (BMI), is also available for estimating body fatness, however, the prediction error is considerably larger (5.6%) and therefore this approach will not be as effective in identifying moderately overweight children (Lohman & Going, 1998).

Skinfolds are reliable measures of body composition (getting similar results with repeated measures) providing the teacher or nurse has sufficient training and experience in the skinfold measurement approach and has followed the standardized protocols for triceps and medial calf skinfold measurements. Studies have shown general agreement between Harpenden, Lange, and Lafayette calipers, designed for research. The FITNESSGRAM Healthy Fitness Zone standards for body composition (25% fat for boys and 32% fat for girls) are based on cardiovascular risk factor and their association with body fatness. Using blood lipid and blood pressure data from the Bogalusa Heart Study in boys and girls from 7-18 years of age, the experts found that children above 25 percent for boys and 32 percent for girls were at increased risk for elevated levels of blood lipids and blood pressure (Williams et al., 1992).

The best way to obtain reliable and valid skinfolds is to train with an expert or with a videotape demonstration (Human Kinetics, Champaign, IL). The mean skinfolds for 6 to 10 subjects should agree within 15 percent of the expert for each skinfold site if training is successful.

Recent charts have been published by the Center for Disease Control and Prevention (CDC) for body mass index (BMI) in boys and girls, 2 to 20 years. These charts are percentiles showing the distribution of BMI at a given age and can be used to identify children who are overweight (however they may not be overfat). BMI, a ratio of weight over height expressed as kg/m^2 (kg per meter squared), is a better measure of fatness than height and weight tables and thus the BMI tables offer a slight improvement. The FITNESSGRAM Healthy Fitness Zone cut-points for BMI are based on health-related criteria and this differs somewhat from the new CDC standards. For young children (7 to 10 years old) the BMIs are higher than the CDC value at the 90th percentile because these children are not obese in relation to their body fat content (25% for boys, 32% for girls), yet they are heavy for their age (some of these children may become obese as adolescents or adults).

2.12.3 Rationale, reliability and validity of curl-up for abdominal strength/endurance

A cadence-based curl-up test is recommended for abdominal strength/endurance testing in the FITNESSGRAM battery. The selection of this test as opposed to a full sit-up assessment was based on extensive research and biomechanical analyses of arm placement, leg position, feet support, and range of motion of the movement (Plowman, 1992). The use of a cadence (20 repetitions per minute) with the curl-up also has been found to eliminate many of the concerns about the ballistic nature of one-minute all-out speed tests (Jetté et al., 1984; Liemohn et al., 1988). Such timed tests with legs straight or bent often result in bouncing, jarring movements and reflect more power than strength or endurance properties (Sparling et al., 1997). In addition, the use of a cadence allows students to focus on their own performance. There can be no competitive speeding up.

There are a number of different positions used for abdominal assessments. In particular, arm position, leg position, and the degree of trunk flexion are varied. Each variation imposes different musculoskeletal demands on the body. Among the different abdominal exercises studied by Axler and McGill, curl-ups resulted in the highest abdominal muscle activation to compression load in the upper and lower rectus abdominus. The abdominals are responsible for only the first 30°-45° of movement in the sit-up, with the hip flexors being responsible for the rest (Flint, 1965; Ricci et al., 1981). If the motion is continued beyond approximately 45° the already shortened hip flexors are exercised through only a short arc which can lead to adaptive shortening. Thus, the curl-up should be a more specific and safer test than a full sit-up (Liemohn et al., 1988).

Table 2-16 Test-Retest Reliability of Field Tests of curl-up

Lead Author (Date)	Subjects (N/sex/Age)		Reliability Coefficients [interclass (r) or intraclass (R)]
Anderson (1997)	107M/109F	6-10yr	R = .70 knees flexed, feet free 20 rpm curl-up
Bennington (1998)	84 M/F	10-12yr	R_M= .90, R_F= .85 FITNESSGRAM Curl-Up Test
Buxton (1957)	53 M&F	6-15 y	r = .94 knees flexed, feet held, total N
Cureton (1975)	49M	8-11 y	r = .60 legs straight, feet held, N to max of 100
Magnusson (1957)	55M/F	1st grade	r = .68 knee flexed, timed
	66 M/F	3th &4th grade	r = .82
	66 M/F	6th grade	r = .77
Jetté (1984)	43M&F	School	r = .88
Robertson (1987)	12M	College	R = .93 4 inch curl-up, min
	12F	College	R = .97 knees flexed, feet free, 1 min
Safrit (1987)	27M/44F	11yr	r = .62(M)/ r = .64(F) knees flexed, feet held ,1min
	88M/92F	12yr	r = .83(M)/ r = .85(F) knees flexed, feet held ,1min
	104M/85F	13yr	r = .79(M)/ r = .89(F) knees flexed, feet held ,1min
	58M/43F	14yr	r = .86(M)/ r = .81(F) knees flexed, feet held ,1min
Vincent (1980)	70M&40F	7-12	r = .94 knees flexed, feet free, curl 4s fwd,
	138M&22F	High school	r = .53 knees flexed, feet free, curl 4s fwd,
	19M	College	r = .71 knees flexed, feet free, curl 4s fwd,
Zorn (1992)	15M/13F	10-12y	r = .83/ r = .79 knees flexed, feet free, arms crossed, 1 min
			r = .79/ r = .74 knees flexed, feet free, arms straight, 1 min

A number of studies (Table 2-16) have investigated the reliability of the curl-up assessment (Anderson et al., 1997; Jetté et al., 1984; Robertson & Magnusdottir, 1987; Vincent & Britten, 1980). Due to considerable differences in measurement protocol, only few data are directly comparable. The Robertson and Magnusdottir (1987) results indicate a high degree of consistency (R = .97) among a college student population but the number of subjects is small. Values from the Anderson et al. (1997) study with younger children (ages 6-10) were lower (R = .70).

The curl-up test possesses logical (i.e., content and construct) validity (Axler & McGill, 1997; Flint, 1965; Godfrey et al., 1977; Noble, 1981; Juker et al., 1998) as a test of abdominal strength/endurance. This observation is supported on the basis of anatomical analyses and through electromyography studies. Due to the lack of definitive criterion measures of abdominal strength it is difficult to fully document the absolute validity of the curl-up assessment as a field test of abdominal strength/endurance. Studies have compared performances of full sit-ups and curl-ups (Robertson & Magnusdottir, 1987; Sparling et al., 1997; Vincent & Britten, 1980). The degree of association between sit-ups and curl-ups was found to account for only 7 to 42 percent of the variance. This means that the tests cannot be used interchangeably. The curl-up test is measuring in terms of abdominal function; it is different from whatever the traditional sit-up is measuring. More validation work is needed for the curl-up.

Table 2-17 Validity of Field Tests of curl up in child and adolescent

Lead Author	Subjects (N/sex/Age)	Test[a]	Criterion Test strength	r	Criterion Test Muscle Endurance	r
Ball (1993)	144M (18-33yr)	Knee flexed, feet held, arms across chest 1 min	1-RM trunk flexion	.57	60% 1-RM	.40
Craven (1968)	61M college	1. straight leg situps, 1min	Tensiometer, static MVC	.60		
		2. bent leg sit-ups,1 min;		.36		
		3. straight leg situps, N		.53		
Hall (1992)	23M (M=23y) 28F(M=22y)	1. Knee straight, feet held, hand behind head, 1 min	isokinetic dynamometer, peak torque single effort concentric (C) and eccentric (E)	M:-.18(C)/-.21(E) F: .42(C)/ .40(E)		
		2. knees flexed, feet free, 4 inch curl-up, 1 min		M:-.41(C)/-.38(E) F:- .07(C)/-.08(E)		
		3. knees flexed, feet held, arms across chest, 1min		M:-.25(C)/-.28(E) F: .27 (C)/ .32 (E)		

[a] Convergent validity correlations between full range of motion sit-ups (knees flexed, feet held, arms crossed on chest, 1 min) and various forms of curl-ups (knees flexed, feet free, partial range of motion, Georgia Tech) have Been reported between r = .27 and .67 (Diener, et al.,1995; Sparling et al., 1997).

2.12.4 Rationale, reliability and validity of Trunk Extension Test?

Low back pain is a major source of disability and discomfort in our society. Risks are greater with advancing age but awareness and attention to trunk musculature at an early age are important to reduce future risks. Of the five anatomical and physiological areas which have been identified as critical for the development and maintenance of low back function (low back lumbar, hamstring, and hip flexor flexibility plus abdominal and trunk extensor strength/endurance), only trunk extension strength/endurance has been shown to predict both first time and recurrent low back pain (Plowman, 1992). All retrospective studies of low back pain which have included a measure of trunk extension strength/endurance have shown significant relationships between them, including three in which electromyographic records were able to distinguish between those who did and did not have low back pain (DeVries, 1968; Roy et al., 1989, 1990).

Little information is available on the test-retest reliability of any version of trunk extension (see Table 2-18). Three reliability studies (Figure 2-18) utilized a prone back extension task but without the 12 inch upper limit. In all cases test-retest reliability for a single trial was found to be high (.85 to .96). However, reliability is still not available for elementary aged children.

Patterson et al. (1997) provide the only data on individuals younger than college age. They evaluated a modified version of the trunk lift (subjects were not stopped at 12 inches) in high school students and obtained concurrent validity correlations of .68 (F) and .70 (M). These results seem to confirm the multi-component nature of the trunk lift test.

Table 2-18 Reliability and Validity of Field Tests of Trunk Extension

Lead author	Subject(N/Sex/Age)		Reliability	Field Test	r (M/F)	Criterion Validity	
						Test	r (M/F)
Jackson (1996)	118M/142F	College	Best trial;	Single trial	R_B = .96; R_S = .86		
Patterson (1997)	43M/45F	High school	Best trial		R_M = .95, R_F = .93	Gonio	r = .70/ .68
			Single trial		R_M = .90, R_F = .85	-meter	
Wear (1963)	62 M	College	Prone back extension		r = .96*		
			Supine back extension		r = .92*		

* r =interclass (r) or R = intraclass

2.12.5 Rationale, reliability and validity of 90° Push-up Test?

A number of assessments of upper arm and shoulder girdle strength have been used in various youth fitness batteries. The most commonly used assessment is the pull-up test. The 90° push-up was selected as the recommended test item in FITNESSGRAM because it has some very practical advantages over the pull-up. The most important advantages are that it requires no equipment and very few zero scores occur.

Data from the U.S. National Children and Youth Fitness Study I-NCYFS I (Ross, Dotson, Gilbert, & Katz, 1985) showed that 10 to 30 percent of the boys from 10 to 14 years of age and over 60 percent of the girls from 10 to 18 years of age could not do even one chin-up! The President's Council on Physical Fitness and Sports National School Population Fitness Survey (Reiff et al., 1986) showed similar results: 40 percent of boys aged 6-12 years old could not do more than one pull-up and 25 percent could not do even one; 70 percent of all girls 6-17 years old could not do more than one pull-up and 55 percent could not do any. Furthermore, 45 percent of the boys ages 6-14 years and 55 percent of the girls ages 6-17 years could not perform the flexed arm hang for more than 10 seconds. Obviously such tests are not discriminating.

The majority of children can successfully perform the push-up assessment and have a more favorable experience. The primary difficulty with the modified pull-up is that it requires equipment that must be adjusted as each student is tested. The impact of body weight/body composition on upper arm and shoulder girdle test scores has long been recognized and recently reaffirmed (Lloyd, et al., 2000; Walker, et al., 2000). The reason the modified pull-up and 90° push-up provide a better range of scores is probably related to the fact that, in both, part of the body weight is supported (Pate, et al., 1987). However, Engelman and Morrow (1991) found that the modified pull-up does not negate the effect of body composition on upper body strength performance. Students need a realistic chance to be successful in testing and to improve with training in order to be motivated to try. For the majority of students, the 90° pushup provides this chance, given appropriate instruction, training and supervision. An additional advantage is that with training push-up scores improve while this is not always the case for chin-ups, pull-ups, or the flexed arm hang (Rutherford & Corbin, 1994). While most studies have evaluated full length push-ups without a cadence, one study has investigated the reliability of the 90° push-up in elementary school children (Saint et al., 2001). The value (0.64 to 0.99) is acceptable.

Jackson et al. (1994) reported excellent reliability for the 90° push-up with college age subjects although the females did the push-ups from their knees. McManis et al. (2000) attempted to determine the reliability of the 90° push-up in three separate samples of elementary, high school and college students. Intraclass stability reliability coefficients for elementary and high school students were determined based on partner counts and ranged from 0.50 to 0.86.

Specific validation data are available for the 90° push-up as a strength measure in only one study conducted on college age females (Rutherford & Corbin, 1993) and one on college males (Jackson et al., 1994). These correlations (Table 2-20) are of the same order of magnitude as the other studies where males were used as subjects, and, thus, much better than the lower values typically obtained with females. In addition, the 90° push-up test shows a higher correlation with the criterion tests than the field tests that are supposedly anatomically matched (i.e., pull-ups and latissimus pull-downs; flexed arm hang and biceps arm curl). When the 90° push-up test was correlated with the sum of the three criterion tests (bench press, latissimus pull-downs, and arm curl) divided by body weight in the Rutherford and Corbin (1993) study the validity coefficient improved to 0.70, showing that body weight is a factor in this test. The validity coefficients between the 90° push up and muscular endurance are better than most other items but not good (Jackson et al., 1994). More research is needed on the 90° push-up, especially with elementary and secondary school children.

Table 2-19 Test-retest reliability of Push up test

Lead Author	Subject(N/Sex/Age)		Reliability Coefficients interclass (r)/ intraclass (R)	
			Two Trials	Single Trial
Jackson(1994)	40M/23F 24.5yr/24.7yr	90º push-up	R =.96/.98	-
McManis	83M/73F 3rd, 4th, 5th grade	90º push-up	-	R = .71/ .64*
(2000)	36M/34/F 9th & 10th grade			R = .50/ .86*
McManis	25M/20F 3rd, 4th, 5th grade	90º push-up	R_M=.90; R_F=.91; R_{All}=.90	R_M=.82; R_F=.84; R_{All}=.83
(1994)	32M/23/F 9th & 10th grade		R_M=.59; R_F=.94; R_{All}=.75	R_M=.42; R_F=.88; R_{All}=.60
Pate(1993)	38M/56F (9-10y)	Pull-up	-	R_M=.80; R_F=.66; R_{All}=.79
		Flexed arm hang		R_M=.90; R_F=.85; R_{All}=.88
		90º push-up		R_M=.83; R_F=.71; R_{All}=.85
		MPU/Overhand grip		R_M=.83; R_F=.81; R_{All}=.83
		MPU/Underhand grip		R_M=.85; R_F=.88; R_{All}=.87
Romain(2001)	30M/32F	90º push-up	R_M=.99; R_F=.94; R_{All}=.98	R_M=.99; R_F =.97;R_{All} =.99

* based on student counted scores MPU- Modified Push Up

Table 2-20 Validity of Push up test

Lead Author	N/Sex/Age	Test[a]	Criterion Tests Strength r	Criterion Tests Endurance r
Ball (1993)	144M college	Push-up	BP 1-M .56	BP 60%1-RM, 30 lifts/min, N .17
Jackson (1994)	40M M=24.5y	90º Push-up	BP 1-M .30	Max Rep at 45.5 kg .41
	23F M=24.7	knees on floor	BP 1-M .23	Max Rep at 22.7 kg .40
Pate (1993)	38M/56F 9-10y	Push-up	BP 1-M .36/ .02	BP 50%1-RM, N .47/-.14
Rutheford (1993)	204F college	90º Push-up/Pull-up	BP 1-M .37/ .27	
		90º Push-up/Pull-up	LPD .47/ .19	
		90º Push-up	Arm Curl 1-RM .46	
		Flexed Arm Hang	Arm Curl 1-RM .26	

[a] Correlations between the field tests (Pull-ups, Push-ups, Flexed Arm Hang and the variations of the Modified Pull-ups - Vermont, New York, and Baumgartner) have been reported from r = .31 to .81 (Engelman & Morrow, 1991; Pate, Burgess, Woods, Ross & Baumgartner, 1993; Saint Romain & Mahar, 2001). BP= Bench Press, LPD= Latissimus Pull-downs

2.12.6 Rationale, reliability and validity of Back-Saver Sit and Reach*?*

The sit-and-reach test has a long history of inclusion in fitness batteries. The prudential FITNESSGRAM recommendation for lower body flexibility assessment is the Back-saver Sit and Reach Test. The assessment is conceptually similar to the more traditional Sit and Reach test but is intended to be safer on the back by restricting flexion somewhat. With the traditional sit and reach assessment, the forward flexion movement of the trunk with the legs extended causes the anterior portion of the vertebrae to come closer together such that the posterior bulge discs and the muscles, facia, and ligaments of the back are stretched. It also involves a forward rotation of the pelvis and sacrum, which elongates the hamstrings. Cailliet (1988, p.179) has pointed out that stretching both hamstrings simultaneously results in "overstretching" the low back, especially in terms of excessive disc compression and posterior ligament and erector spine muscle strain. He believes that stretching one hamstring at a time, by having the other leg flexed, "...'protects' the low back by avoiding excessive flexion of the lumbosacral spine" (Cailliet, 1988, p. 179). In addition, Cailliet points out that a lack of flexibility in one leg or the other causes asymmetrical restriction of the pelvis, pelvic rotation and lateral flexion. This asymmetrical reaction is transmitted to the lumbosacral spine and has been considered a mechanical cause or aggravation of low back pain (Cailliet, 1988, p. 179). Liemohn, Sharpe and Wasserman (1994b) investigated to determine whether there was less L1-S1 flexion in the back saver unilateral sit-and-reach than in the traditional bilateral sit-and-reach. The amount of flexion occurring in the lumbar spine was quantified by resistance changing signals using an Ady-Hall lumbar monitor. The amount of flexion did not differ between the two versions of the sit and reach. However, those subjects who indicated a preference said they were more comfortable holding the unilateral stretch rather than the bilateral version. An additional advantage of the Back-saver sit and reach is that it allows the legs to be evaluated separately. This allows for the determination of symmetry (or asymmetry) in hamstring flexibility. In addition, testing one leg at a time eliminates the possibility of hyperextension of both knees. Patterson et al. (1996) reported that three out of forty boys and four out of forty-four girls passed the Back-saver sit and reach on one side of leg and failed it on the other side of leg. Both Liemohn et al. (1994a) and Patterson et al. (1996) emphasized that there is value in detecting such differences both when the asymmetry is a result of an injury and is an imbalance that might lead to a potential injury or postural disturbance. If identified, feedback can be given and remedial exercises prescribed.

Reliability data spanning a period of 50 years have shown that the Stand and Reach test, the Sit and Reach test, and the Sit and Reach test modified to accommodate anatomical differences are extremely consistent. Four recent studies (Hui & Yuen, 2000; Liemohn et al., 1994a & 1994b; Patterson, et al, 1996) have established intraclass reliability for the Back-saver sit and reach with correlations of 0.93 to 0.99 (Table 2-21) and 95 percent confidence intervals of 0.89 to 0.99 at the widest. Subjects in these studies included males and females from 6 to 41 years of age. The range of coefficients includes right and left legs (see Figure 2-21). The Modified Schober test (Macrae & Wright, 1969) is the most common criterion test of low back (so called lumbar or vertebral) flexibility. Both the passive straight leg raise and the active knee extension measured by flexometer, goniometer, or inclinometer are used as criterion tests of hamstring (hip) flexibility. The results of the validity of Back-saver sit and reach test (Table 2-22) are acceptable. The correlation between Sit and Reach and Stand and Reach scores has been reported to range between 0.73 and 0.95 (Mathews et al., 1957 & 1959; Wells & Dillon, 1952). The correlation between the two-legged Sit and Reach and the one-egged "Back saver" Sit and Reach has been reported to be between 0.91 and 0.92 in seventy-nine 7-13 yr boys and girls (Gilbert & Plowman, 1993).

Table 2-21 Test-Retest Reliability of Field Tests of Hamstring Flexibility

Lead Author	Subjects (N/Sex/Age)	Assessment	Reliability Coefficients Intraclass (R)	Interclass (r)
Buxton (1957)	50 M&F (6-15y)	Stand & Reach		-r =.95
Hui (2000)	62M/96F (17-41yr)	BS	R_M = .93(L)/ .98(R) R_F = .97(L)/ .98(R)	
		MBS	R_M = .96(L)/ .97(R) R_F = .97(L)/ .97(R)	
		SR	R_M = .98 R_F = .96	
		V-SR	R_M = .96 R_F = .89	
Liemohn (1994a, b)	40 M & F college	BS / MBS / SR	R = .98 / R = .99 /R = .99	
Magunsson (1957)	53 M & F 1st grade	BS / MBS / SR	R = .98 / R = .99 /R = .99	
Patterson (1996)	42M/46F 11-15yr	Back saver	R_M = .99(L)/ .99(R) R_F = .99(L)/ .99(R)	

R=right leg. L=left leg; BS- Back Saver Sit and Reach; MBS- Modified Back Saver Sit & Reach; SR-Sit and Reach

Table 2-22 Validity of Back-saver Sit and Reach/Sit and Reach

Lead Author	Subject (Age)	Test	Criterion Test Hamstring r	Low Back r
Broer (1958)	100 F college	Stand & Reach	Leighton flexometer .81	
Hui (2000)	62 M 17-41	Back Saver	Goniometer .67(R), .61(L)	MS .27(R) .24(L)
	96 F 17-41	Back Saver	Goniometer .50(R), .39(L)	MS .15 (R) .18(L)
	62 M 17-41	Sit and Reach	Goniometer .67(R), .61(L)	MS .27 (R)
	96 F 17-41	Sit and Reach	Goniometer .53(R), .46(L)	MS .24 (R)
Liemohn (1994a,b)	20M/20F college	Back Saver	Straight leg raise .76	Inclinometer .38
Mathews (1957)	66 F college	Stand & Reach Sit	LF .80	
		& Reach	LF .74	
Patterson (1996)	42M 11-15y	Back Saver	Straight leg raise .72(L) .68 (R)	MS .15(L), .10(R)
	46F 11-15y		Goniometer .51(L), .52 (R)	MS .17(L), .25(R)
Sinclair (1993)	52M/48F 15-16y	Sit and Reach	Pelvi-spinometer .79	Pelvi-spinometer .32

R=right leg, L=left leg, LF=Leighton flexometer (trunk & hip), MS= Modified Schober

2.13 INTERNATIONAL STANDARDS FOR CHILD OBESITY

The body is composed of water, protein, minerals, and fat. A two-component model of body composition divides the body into a fat component and fat-free component. Body fat is the most variable component of the body. Essential fat is necessary for normal bodily functioning. The essential fat of women is higher than that of men because it includes sex-characteristic fat related to child-bearing. The body fat ranges for optimal health (18%-30% for women & 10%-25% for men) are based on several epidemiological studies of the general population (Williams et al., 1992).

The prevalence of child obesity is increasing rapidly worldwide (WHO, 1998). It is increasing at an alarming rate and is predictive of adulthood obesity (Guo et al., 1999; Troiano et al, 1995). Increasing obesity and its strong relation with health risk highlight the importance of identifying accurate techniques for measuring total body fat in children. Practical methods of assessing body composition such as skinfolds, bioelectrical impedance analysis (BIA), and hydrostatic weighing are based on the two-component (fat and fat-free mass) model of body composition. Most laboratory and field methods have errors of 2.5 to 4.0 percent for prediction of body fatness. The laboratory approach using underwater weighing, total body water and total bone mineral (called a multicomponent approach) is the most accurate with an error of 2 percent or less. Underwater weighing and DXA have an error of 2.5 percent to 3.0 percent for estimating fatness. Skinfolds and circumferencing have errors of 3 to 4 percent fat.

Because of their public health importance, the trends in child obesity should be closely monitored. Trends are, however, difficult to quantify or to compare internationally, as a wide variety of definitions of child obesity are in use and no commonly accepted standard has yet emerged. Body Mass Index (BMI) is widely used in adult populations, and a cut-off point of 25 and 30 kg/m^2 is recognized internationally as a definition of adult overweight and obesity respectively (WHO, 2002a).

The BMI in childhood changes substantially with age (Cole et al., 1995). At birth the median is as low as 13 kg/m^2, increases to 17 kg/m^2 at age one, decreases to 15.5 kg/m^2 at age 6, and then increases to 21 kg/m^2 at age twenty. Clearly a cut-off point related to age is needed to define child obesity, based on the same principle at different ages, for example, using reference centiles (Power et al., 1997). In the United States, the 85^{th} and 95^{th} centiles of body mass index for age and sex based on nationally representative survey data have been recommended as cut-off points to identify overweight and obesity (Barlow & Dietz, 1998). For wider international use this definition raises two questions: why base it on data from the United States and why use the 85^{th} or 95^{th} centile? Other countries are unlikely to base a cut-off point solely on American data, and the 85th or 95th centile is intrinsically no more valid than the 90^{th}, 91^{st}, 97^{th}, or 98^{th} centile. Regardless of centile or reference population, the cut-off point can still be criticised as arbitrary. The Childhood Obesity Working Group of the International Obesity Task Force (Cole et al., 2000) obtained data on body mass index for children from six large nationally representative cross-sectional surveys on growth in Brazil, Great Britain, Hong Kong, the Netherlands, Singapore, and the United States. Each survey had over 10 000 subjects, with ages ranging from 6-18 years. IOTF has developed cut-off criteria (Appendix-12) with relative (age-specific) BMI centile charts for children (2-18 yrs). The IOTF authors point out that although these cut-off points are less arbitrary, they are more internationally acceptable than others that have been used (Cole et al., 2000).

2.14 ASSESSMENT OF PHYSICAL ACTIVITY LEVELS IN YOUNG PEOPLE

Table 2-23 Comparing the Measurement of Physical Activity in Youth

Category/Measure	(1)Objectivity/(2)Expense/(3)Advantages/(4)Disadvantages
1. Criterion Standards 1.1 Doubly Labelled Water	(1) High; (2) High; (3) Physiological marker, highly accurate; (4) Expensive; No activity patterns; Not suitable for large studies
1.2 Direct Observation	(1) High; (2) Low to moderate; (3) Provides quantitative and qualitative information about PA Accurate; PA patterns[1]; Directly observe movement; (4) Need trained observers; Subject reactions[2]; Not suitable for large studies (track several students at a time); time consuming.
2. Objective Measures 2.1 Heart Rate Monitor	(1) High; (2) Moderate; (3) Physiological marker, Accurate, indicator at the group PA level; Good educational potential for cardiovascular system; (4) Subject compliance; Difficult to assess large numbers of children, Relevant only to aerobic activity, Influenced by environmental and dietary factors
3. Motion Sensors 3.1 Accelerometers	(1) High; (2) Moderate ; (3) Objectivity; Activity patterns; Accurate indicator of PA; Good educational potential for accumulating activity over day; (4) High cost; Time-intensive to download; Difficult to assess large numbers of children; Do not detect all body movements: Subject compliance
3.2 Pedometers	(1) High; (2) Low to Moderate ; (3)Objectivity, Easy to use; (4)Records “quantity” but not “quality” of movement; require subject input for activity patterns; Subject compliance
4. Subjective Measures 4.1 Self-Report Q	(1) Low; (2) Low; (3) Easy to administer to large groups Good educational potential for use in curriculum; (4) Potential problems with validity and reliability. The respondent must have the cognitive ability to self-report PA for a segmented day or across days
4.1 Interview	(1)Low; (2) Low; (3) Large studies; Inexpensive; (4)Need trained interviewers; Response bias & errors
4.2 Proxy-Report	(1)Low; (2) Low; (3)Avoid limited memory of children (4) Low survey validity; Recall errors
4.3 Diary	(1)Low; (2) Low; (3) Accurate; Activity patterns, (4)High subject burden; Subject reactions

[1]The ability to measure changes in PA over short time periods,[2] Subject reactions to measurement device or protocol.
Adapted from Welk & Wood (2000); Welk (2002).

2.14.1 Overview physical activity levels assessment in youth

The methods of measuring physical activity are classified as direct and indirect. Direct methods, which provide measures of the energy cost, types, and patterns of human movement, and physiological responses to human movement, include: the use of doubly-labelled water; behavioural observation techniques; diaries and logs; motion sensors; self-reported PA. We list here some measurements of PA in youth (Table 2-23).

The measurement of physical activity levels among children and youth is complex and measurement of validity and reliability of these tests lack consistency (Kohl et al., 2000). There are problems with all of these measurements; no one measurement is suitable for all purposes. All of these methods are attended by various degrees of cost, reliability, validity and acceptability to the respondent. If assessments are needed for research purposes, the reliability and validity of the assessments may be more important factors (Welk, 2002).

2.14.2 Use of questionnaire to assess physical activity levels

For the purpose of population surveys, self-report measures of participation in physical activity represent the best compromise between acceptability and accuracy. The most commonly used method of estimating population levels of physical activity is by a self-report survey, which can be administered by mail, telephone or face-to-face by personal interview (Booth et al 1996). The time frame for recall of activities in most commonly used surveys ranges from 24 hours to 14 days but can be as long as 12 months.

Self-report instruments are the most commonly used format to collect large-scale information about physical activity. Depending on their scope, they can provide very detailed or very general information about physical activity (Sallis, 1991). An advantage of self-reports is that they are inexpensive, easy to use and can be administered to large groups in a cost-effective manner. A limitation of self-reports is that they usually require some form of recall and can be subjective. The tendency for people to report socially desirable responses can be problematic, but this may be less of an issue with children. Despite these limitations, the low cost, ease of use and the education potential of self-report instruments make them well suited for use in physical education curriculum, assuming they have the cognitive ability to complete the task in a valid manner.

Self-report measures vary considerably in the time frame and format used for the assessment. Some measures are designed to provide a general assessment of a child's normal level of physical activity. They often rely on a recall of activity completed over a representative period of time, such as one week. A limitation of this format is that it assumes that the recent week is representative of the child's activity in other weeks. Other instruments avoid this problem by using more general questions about "typical exercise behavior". These instruments, however, cannot provide the same detail as recall-based measures. Another class of self-report measures utilizes detailed logs or activity records collected or recalled over several days. An advantage of this approach is that children have an easier time recalling specific activities from a previous day than generalizing over a longer period of time. Another advantage is that these instruments can provide considerable details regarding the type, intensity and duration of activity. A disadvantage of these instruments is that the results may not generalize to a child's typical activity level. Readers interested in more specific information about the validity and reliability of various self-reports in children are referred to several excellent reviews (Sallis, 1991; Sallis & Saelens, 2000).

The current international recommendations for health-enhancing physical activity (HEPA) call for 30-minutes of moderate-intensity activities, which causes a person to be slightly out of breath, on most, or preferably all, days of the week such a regimen can have significant positive health effects and the activities can be accumulated by shorter bouts, each lasting for around 10 minutes (Pate et al., 1995; PCPFS, 2000). The international Physical Activity Questionnaire (IPAQ) was developed by a global working group of physical activity researchers from 14 countries in 1998. It was sponsored by the U.S. Centers for Disease Control (CDC, Atlanta), and the Karolinska Institute (Sweden), and with the support of the World Health Organization. The questionnaire has been tested worldwide and is now recommended for use in national population-based prevalence studies (Craig et al., 2003). It assesses the total amount of vigorous and moderate-intensity physical activity covering all its domains, for example work/education, transport, domestic chores and recreation during the last seven days or a usual week. In addition, the amount of weekly walking and sitting are assessed. IPAQ is a recently proposed set of questionnaires for the assessment of health-related physical fitness. Eight versions of the instrument were tested for feasibility, reliability and validity (Craig et al., 2003).

2.14.3 Use of heart rate monitor to assess physical activity levels

To assess children's physical activity levels, the heart rate monitor (HRM) is probably the more common objective method, due to its validity and reliability (DuRant et al., 1993), relatively low cost and its ability to record value over time (Louie et al., 1999). HRM is also a good tool for assessing moderate to vigorous physical activity (Riddoch & Boreham, 1995). HRM has been used in physical education for nearly 40 years (Faulkner et al., 1963). Recently, there has been a significant improvement in the technology available to measure heart rate, which can be measured at 5-second or beat-to-beat intervals using lightweight, portable, short wave, radio telemetry system to capture reliable and detailed heart rates (Stratton, 1996).

Heart rate monitors provide an accurate determination of exercise intensity and can track and record data over extended periods of time. They are becoming increasingly popular in many physical education programs to teach children about the cardiovascular system and to track activity within the class. Many teachers concerned about keeping students active have used heart monitors to ensure that the students are in the appropriate heart rate zone during their entire lesson. These may be well-intentioned efforts but they may impose too much structure into a program. Children typically prefer intermittent activity and need opportunities for rest. Being forced to keep their heart rate elevated may make activity less enjoyable. Individual variability in heart rates may also make the use of specific target zones inappropriate for some children. If heart rate monitors are used in physical education, a low threshold should be used to define bouts of activity. The goal should also be to accumulate a certain number of minutes in the target zone rather than emphasizing continuous activity with elevated heart rates.

While HRM can provide a useful indicator during specific bouts of exercise (e.g., physical education), they are not as useful for tracking activity patterns during normal daily activities (Welk, Corbin & Dale, 2000). For example, heart rate can be influenced by nervousness, dehydration or stress. There are also some transmission problems with the signal when heart rate monitors are worn over extended periods of time. Many children also find the transmission strap uncomfortable when worn over long periods of time.

2.15 FACTORS THAT INFLUENCE PHYSICAL FITNESS IN YOUTH

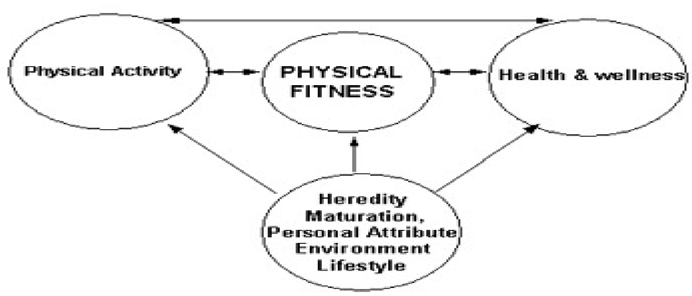
2.15.1 The view on physical fitness assessment

Historically, physical fitness assessments for children and adolescents have been a mainstay of the physical education curriculum. If used correctly, fitness assessments can enhance instruction of fitness concepts, provide diagnosis of fitness needs for individual exercise prescription, facilitate fitness goal-setting and self-monitoring skills, and promote fitness knowledge and self-testing skills (Whitehead et al., 1990). However, there are many factors other than physical activity that can influence a child's performance on physical fitness tests (e.g., maturation, heredity, predisposition / trainability and body composition). An overemphasis on fitness testing in the curriculum can send the wrong message to children about physical activity. For example, some children may get discouraged in physical education if they score poorly on fitness tests despite being physically active. Alternately, children may incorrectly believe that they don't need to be active if their fitness levels are in the healthy fitness zone. Studies have demonstrated that negative feedback from fitness testing can lead to reduction in a child's level of intrinsic motivation toward physical activity (Whitehead & Corbin, 1991). These concerns have caused many experts to question the continued emphasis on physical fitness testing in the curriculum (Kemper & van Mechelen, 1996).

Recently, there has been a conceptual shift in the physical education field toward the promotion of physical activity. While fitness is still a desirable outcome, more emphasis is being placed on promoting the behavior of physical activity. For example, in the current National Association for Sport and Physical Education (NASPE) definition of a "physically educated person", three of the five components refer specifically to physical activity (NASPE, 1995). In addition to having good skills and reasonable levels of fitness, a physically educated person participates in regular activity, knows the benefits of participation and values the contribution activity can make to a healthy lifestyle. Incorporating physical activity assessments into the curriculum allows for better instruction on physical activity concepts and avoids some of the problems associated with fitness testing. An additional benefit is that by emphasizing a behavior, all children can be successful.

Many people assume that physical activity and physical fitness are directly related, but they actually represent very different things. Physical activity is a behavior, while physical fitness is a characteristic. While physical activity will contribute to physical fitness, the relationship is not as strong as one would expect. There are a variety of other factors that influence levels of physical fitness and many are beyond a person's control (Figure 2-09). The relationship between physical inactivity and obesity is also not as high as would be expected (especially among children). Even if a relationship is present, it is not clear that it is a "causal" factor. Physical inactivity can lead to obesity, but it is equally plausible that obesity leads to inactivity. The current consensus is that physical activity and physical fitness are reciprocally related (bi-directional arrow) and that they exert independent effects on health. This implies that a person needs to be physically active even if they have reasonable levels of fitness. Individuals with low levels of fitness can also obtain health benefits by remaining physically active. Because some of the factors influencing fitness are beyond a person's control (e.g. genetics and rate of maturation), emphasis should be placed on being physically active. The model presented above is useful in understanding the relationships between physical activity, physical fitness and health (Corbin, 2001)

Figure 2-09 The complex relationships among physical activity, physical fitness, health wellness and etc

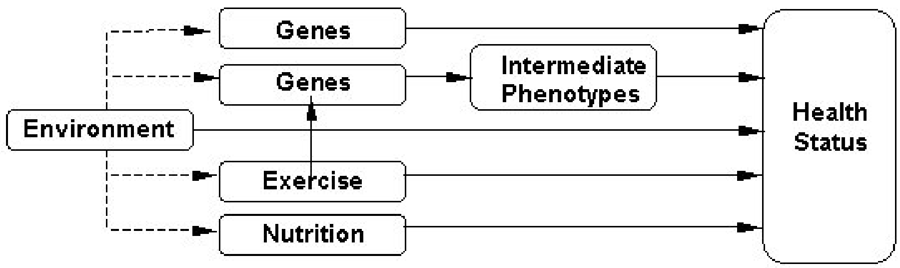


Source: Adapted from Bouchard et al., 1990

2.15.2 Heredity and physical fitness in children and adolescents

A significant amount of fitness test performance is explained by heredity (Bouchard, 1990; Bouchard et al., 1992). Various factors such as environment, nutrition, heredity, and maturation affect fitness performance as reflected in physical fitness test scores. Research shows that heredity and maturation strongly impact fitness scores (Bouchard et al., 1992; Pangrazi & Corbin, 1990). Figure 2-10 shows the complex interaction among exercise, genes, nutrition and environmental factors.

Figure 2-10 The complex interaction among exercise, genes, nutrition and environmental factors



Source: Adopted from Bray (2000). *J. Appl. Physiol.* 88: 788–792.

These factors may have more to do with youth fitness scores than does activity level. Life style and environmental factors also make a difference. For example, nutrition is a life-style factor that can influence test scores, and environmental conditions (heat, humidity, and pollution) strongly modify test performances. Some youngsters have a definite advantage on tests because of the physical characteristics they inherit. Even in an untrained state these children score better because of heredity. Recent research has shown that "trainability" has strong genetic limitations (Bouchard et al., 1992). Trainability means that some individuals receive more benefit from training (regular physical activity) than do others.

2.15.3 Maturation and physical fitness in children and adolescents:

Sexual maturation is a biological process, which occurs from the time the sex hormones start increasing in the body to the achievement of adulthood at the age of 21 for girls and 25 years for boys. According to the report of USDHHS (2000b), it begins at puberty and is associated with rapid growth and appearance of secondary sexual characteristics.

Physical educators know that some youngsters mature faster than others. If two children are the same age and sex, but one is physiologically older (advanced skeletal maturation), the more mature child usually performs better on physical fitness tests than does the less mature child. Examining fitness norms shows that. It is widely believed that biological maturity influences physical fitness test performance. Children can be advantaged or disadvantaged in physical fitness tests by being more or less mature than counterparts of the same chronological age (Jones et al., 2000). Studies examining skeletal age (Gruelich & Pyle, 1959; Krahenbuhl & Pangrazi, 1983) consistently show that a 5- to 6-year variation in skeletal maturity exists in a typical classroom of youngsters. For example, the class of third graders who are all 8 years old chronologically range in skeletal age from 5 to 11 years. This means that some youngsters are actually 5-year-olds skeletally and are trying to compete with others who are as skeletally mature as 11-year-olds. Effective programs must offer activities that are developmentally appropriate and suited to their level of maturity. Clarke (1971) indicated that the motor performance of boys is related to skeletal maturity in that a more mature boy usually performs better on motor tasks. However, motor performance of girls appears not to be related to physiological maturity. Physical education programs often ask students to learn at the same rate, even though this practice may be detrimental to the development of students who are maturing at a faster or slower rate. Students do not mature at the same rate and are not at similar levels of readiness to learn. Offering a wide spectrum of developmentally appropriate activities designed to help youngsters at different maturity levels encourages participation in physical activities. Malina & Bouchard (1991, p.274) indicated that early-maturing children of both sexes are taller and heavier than their average and late maturing and sex peers from about age 6 onward. Armstrong & Welsman (2001) indicate that VO_2 peak increased with age and maturation in both sexes. But when maximum oxygen uptake is adjusted per kilogram of body weight, it shows little change for boys (no increase) as they mature and a gradual decrease for girls (Bar-Or, 1983). This decrease in females is due to an increase in body fat and a decrease in lean body mass.

Armstrong et al. (1999) indicated that maturation did not influence the VO_2 peak response to submaximal exercise for 97 boys and 97 girls with a mean age of 12.2 years. Viru et al. (1998) indicated that a probability for an accelerated improvement in aerobic endurance was found for the periods of 11-15 years in boys and 11 - 13 years in girls (Consensus Index values were highest in 12 - 13 year old boys and in 11 - 12 year old girls). For both latter traits, the accelerated improvement was associated with the last stages of sexual maturation.

Naughton et al. (2000) indicated that many young athletes were being encouraged to train intensely for sporting competitions from an early age. Compared with studies in adults, less was known about the physiological trainability of adolescents. The velocity of physical growth during the adolescent years makes research with a group of young athletes particularly difficult. Naughton et al. (2000) expressed resistance-training studies in male adolescents and to lesser extent female adolescents and highlighted the substantial relative strength gains that could be obtained. Aerobic trainability in young boys appears to improve markedly during the adolescent years (>13yr). Studies of aerobic trainability in adolescent girls are too scarce to be conclusive. Sexual maturation that can be measured by self-assessment of sexual maturity status shows moderate to high correlations in boys (r=0.63-0.93) and girl (r=0.55-0.88) (Roemmich and Rogol, 1995). Mota (2002) also found a significant influence of sexual maturity on the variance in aerobic fitness (5% in boys, 8% in girls) among 494 Portuguese children aged from 8 to 16 years.

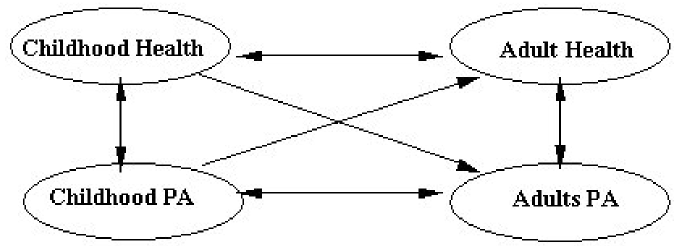
2.15.4 Does physical activity affect physical fitness of children and adolescents?

The health benefits of regular physical activity for adults are now well established. The question is whether physical activity can increase physical fitness (especially aerobic performance) of children. Research results are split. Some researchers have found an increase in aerobic power through training; others report that training has no impact on the aerobic system. Payne and Morrow (1993) reviewed 69 studies examining training and aerobic performance in children and concluded that improvement was small to moderate in prepubescent children.

2.15.5 Physical activity and physical fitness of children and adults

A direct relationship between physical activity and specific health outcomes has been established primarily among adults. Research conducted on the health benefits of activity in children is not strong (Malina, 2001) and harder to detect (Baranowski et al., 1992). Malina (2001) suggested that the presently available evidence indicated significant, but generally low to moderate relationships between childhood physical activity and health-related physical fitness. Taylor et al. (1999) concluded that the relationship between childhood and adolescent experience in physical activity and adults exercise habits were weak overall. But they suggested a potentially important role for motor skill development and emphasized a need to give young people a voice or choice in their physical activity and sport participation.

Figure 2-11 The relationships between physical activity and physical fitness of children and adults

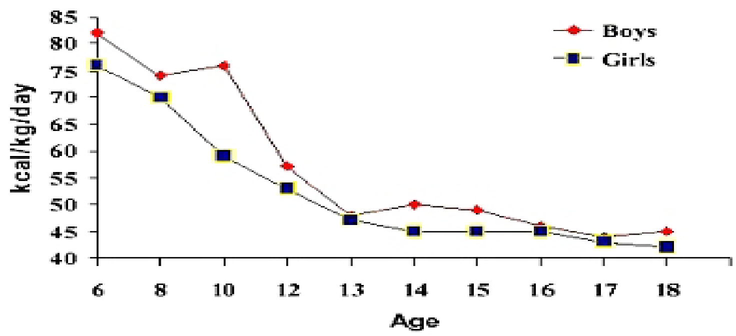


Source: Blair et al., 1989

Bar-Or & Malina (1995) suggested that there were significant health benefits associated with physical activity for children, but that the relationship would likely be contingent on continued involvement over time. Therefore, a more important rationale for promoting physical activity is to establish long-term interest in physical activity. Thus, the goal for youth activity promotion should be to help children develop the cognitive and behavioral skills to help them be active through adolescence and into adulthood. Blair et al., (1989) present a conceptual model describing the links and relationships between children's physical activity and health (Figure 2-11). An important concept in this model is that there are reciprocal relationships between physical activity and health. Physical activity is needed for good health, but it is also true that a person must have reasonable levels of health and fitness to be able to participate in physical activity. The same is true regarding body composition as physical inactivity is both a cause and consequence of overweight and obesity. Physical inactivity clearly increases risks for becoming overweight or obese, but once a person is overweight physical activity becomes less enjoyable and more strenuous. This is true for both children and adults. A second key concept is that good health requires that healthy behaviors be maintained over time. An active child will benefit from physical activity during childhood, but these benefits will not be retained unless the child adopts an active lifestyle as an adult. While fitness is important in childhood, the more significant, long-term objective is to promote activity habits so that active children eventually become active adults. This concept serves as one of the key aspects of the overall FITNESSGRAM philosophy.

Rowland (1996) indicated that a minimum of thirty minutes of daily physical activity was recommended, but sixty minutes of daily activity was a preferred dosage because children become less active as they mature. Figure 2-12 shows the decrease in total daily activity (60 minutes of daily physical activity) of children with age. The Figure illustrates the need to ask youngsters to do more that 30 minutes of activity each day, because the urge to move decreases with age. If youngsters are taught that 30 minutes of daily activity is adequate, as they mature, even less activity will be performed.

Figure 2-12: Trends in Total Daily Energy Expenditure with Age



Source: Rowland TW (1996). Developmental Exercise Physiology, Human Kinetics

2.16 SUMMARY

In a world in which health and the definitions of what constitutes a healthy person are in transition, promoting physical activity during childhood and adolescence has taken on even greater importance. Research clearly suggests that there is a need for promotion of physical activity, especially for young children. Studies suggest that comprehensive school health programs and the increased development of school health coordinators as an integral part of school-based physical education programs are a cost-effective approach to developing healthy children and lifetime patterns of good diet and regular physical activity. Studies showed that educational approaches to diet and physical activity usually have weak, short-term effects; future intervention should consider the powerful components already available in schools, such as school lunches and school physical education programs (Sallis, et al. 1993; Sallis et al. 1995).

School physical education programs should be considered an important part of national public health programs (Sallis & Mckenzie, 1991). In recent years, school physical education has begun to place greater emphasis on health-related exercise or conceptual physical education, focusing upon the knowledge, skill and attitudes required to promote health and well-being and to encourage active lifestyles (Harris, 1994). But experts suggest that students need to spend more class time being physical active (Pate & Hohn 1994; USDHHS, 2000b) and that more physical education programs should promote lifetime physical activity (Nader, et al., 1999; Sallis, 1992; USDHHS, 2000a).

Physical education programs that include aerobic exercises have been found very popular in the school health interventions and have had some health benefits for the undergraduate boys (Wang, 1997) and the middle school girls (Daley et al., 1999). The health benefits of regular physical activity for adults are now well established. More research is needed to study the relationships among children’s physical activity, physical fitness, behavior and lifestyle. Accurate, less expensive, and large-scale child-reachable research methods should be considered for measuring children's physical activity in school physical education and also in leisure time. The validity, reliability, and health-criterion standard are important for future study.