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# Activity Levels of Children and Youth: Monitoring Heart Rate Versus Objective Observation

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ACTIVITY LEVELS OF CHILDREN AND YOUTH:  
MONITORING HEART RATE VERSUS OBJECTIVE OBSERVATION

by

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Bachelor of Science, Mayville State University, 1980

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

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This thesis, submitted by Rebecca J. Swift in partial fulfillment of the requirements for the degree of Master of Science from the University, has been read by the Faculty Advisory Committee under whom the work has been completed and is hereby approved.

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                  Monitoring Heart Rate versus Objective Observation

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DEDICATION

to my mother and father—Elaine and Donald

and

children—Amanda and Samantha



## ABSTRACT

The purpose of this study was to investigate children's physical activity levels when assessed by two methods—heart rates and direct observation. Forty-one participants wore Polar Vantage XL HR Monitors and were videotaped in various situations. Videotape analysis was done using the Children's Activity Record System (CARS). Heart rates and CARS data were recorded concurrently every 10 seconds.

Primary research questions included: (a) is there a correlation between heart rates (HR) and observed activity level, (b) do gender differences exist, and if so, what are the differences in observed activity levels, (c) are there gender differences in heart rates at various activity levels; and (d) to what extent did children meet various recommendations and official position stands on health and physical activity levels?

HR and CARS rating correlations were computed for each activity setting, and average correlations were calculated using Fisher's transformation in each case. Analysis of data from ten males (ages 15-17) playing basketball for 48 minutes, revealed an average correlation between HR and CARS of  $r = .64, p < .05$ . For ten 3rd graders (3 males, 7 females) at school recess, HR and CARS correlated  $r = .76, p < .005$ . For fourteen children (8 males and 6 females) in 5th grade PE, HR and CARS correlated  $r = .63, p < .005$ . In a regular (sedentary) classroom setting, seven 4th grade children's HR and CARS correlated  $r = .40, p = NS$ . Further correlation analyses were done with HR progressively lagged from 10-seconds to 60-seconds after CARS rating. In all activity



settings, coefficients were progressively lowered with each 10-second HR time lag. In general, HRs reflected CARS ratings more clearly in varied activity rather than predominantly sedentary situations. HR appears to have reasonable validity for activity monitoring when data are collected at the shortest possible intervals allowed by the HR monitors.

## CHAPTER I

### INTRODUCTION AND REVIEW OF LITERATURE

The past few decades have witnessed a growing interest in of the fitness and wellness of American children and youth. Interest continues to grow as we approach a new century. Authoritative opinions and/or official position stands on children and youth fitness have been published (American College of Sports Medicine, 1988; American Medical Association, 1992; Armstrong, Balding, Gentle, and Kirby, 1990; Corbin, Pangrazi, and Welk, 1994; Sallis and Patrick, 1994). However, those recommendations have differed. Ross and Gilbert (1985) reported that children and youth may not be active or fit enough to maintain good health. Armstrong, Balding, Gentle, and Kirby (1990a, 1990b) and Armstrong et al. (1990) concluded that children exhibit low levels of physical activity, and rarely experience sufficient sustained duration of physical activity to stimulate cardiopulmonary fitness gains. Conversely, Corbin et al. (1994) argued that children are active, but with intermittent physical activity which is sufficient to stimulate physical fitness. Thus, differing interpretations of existing data need further examination. Consequently, increasing interest regarding children's physical activity, and its measurement, remains a pertinent issue.

A detailed review of the literature pertinent to these issues is laid out below. The following topics are discussed: (a) physical activity importance and definitions, (b) physical activity and fitness levels of children and youth, (c) historical perspectives on

children and youth fitness, (d) children's activity patterns, (e) contemporary fitness recommendations for children, (f) health and wellness promotions, (g) measuring children's activity, and (h) a summary.

### *Physical Activity Importance and Definitions*

Physical activity is an important factor in promoting the health of all individuals. Physical activity is an important lifetime health factor for all individuals. Regular physical activity has been associated with reduction in risks of diseases in adults (Baranowski & Parcel, 1981). In 1992, a representative of the American Heart Association stated that a sedentary lifestyle is as important a risk factor for cardiovascular diseases as is high blood pressure, high blood fat levels, and smoking. These types of diseases are rarely found in children. However, Baranowski, Bouchard, Bar-Or, Bricker, Heath, Kimm, Malina, Obarzanek, Pate, Strong, Truman, and Washington (1992, p. 237) found "as many as 60% of children in the United States exhibit at least one modifiable adult risk factor for coronary heart disease by the age of twelve."

Williams et al. (1981) suggested that the process leading to adult diseases could begin as early as childhood and youth. If regular physical activity helps reduce the risks of some diseases in adults, then it would seem logical to promote the importance of regular physical activity at an early age. Dennison, Strauss, Mellits, and Charney (1988) as well as Powell and Dysinger (1987) concluded that childhood physical activity may be an indicator of the level of adult physical activity. The authors believed that individuals



who could benefit the most from physical activity, thus protecting themselves against chronic diseases, are those who adopt active lifestyles and continue them through adult life.

Engstrom's (1986) longitudinal study of physical activity through adulthood revealed the importance of adopting an active lifestyle in childhood. Physical activity appears to have the potential to exhibit health benefits in children and well as adults. There is some contention that children who are exposed to physical activity and exercise programs may develop a better understanding of fitness concepts, fitness skills, and have a tendency to maintain regular physical activity over a lifetime.

Although the words physical activity, exercise, and physical fitness are sometimes used interchangeably, they are distinct concepts. Physical activity has been defined as "any bodily movement produced by skeletal muscles that results in energy expenditure" (Pate, Pratt, Blair, Haskell, Macera, Bouchard, Buchner, Ettinger, Heath, King, Kriska, Leon, Marcus, Morris, Paffenbarger, Patrick, Pollock, Rippe, Sallis, & Wilmore, 1995, p. 402; Caspersen, Powell, & Christenson, 1985, p. 126). Physical activity can vary in mode, frequency, intensity and duration. The term "exercise" is commonly used for purposeful physical activity, and "exercise training" is defined as structured physical activity of specific mode, frequency, intensity, and duration to attain a desired effect (Baranowski et al., 1992). Pate (1988) added that physical activity habits are the primary determinant of physical fitness.

The importance of physical activity in promoting health and lowering the risk of diseases over the past few years has broadened the definition of physical fitness. Corbin

and Lindsey offer a combined definition of physical fitness and wellness. “Physical fitness is the body’s ability to function efficiently and effectively. It consists of health-related physical fitness and skill-related physical fitness, which have at least eleven different components, each of which contributes to total quality of life. Wellness is the integration of all parts of health and fitness (mental, social, emotional, spiritual, and physical) that expands one’s potential to live and work effectively and to make a significant contribution to society. Wellness reflects how one feels (a sense of well-being) about life as well as one’s ability to function effectively” (1997, p. 5).

*Physical Activity and Fitness Levels of Children and Youth*

In 1990, the American College of Sports Medicine recommended an approach incorporating Frequency, Intensity, Time, and Type (F. I. T. T.) for the development and maintenance of cardiorespiratory fitness for adults. F.I.T.T. involves modes of activity using large muscle groups rhythmically and continuously, (a) at a frequency of 3 to 5 times per week, (b) at an intensity of 60 to 90 of maximum heart rate, and (c) over a duration of 20 to 60 minutes per occasion.

The American College of Sports Medicine’s interpretation may have led many adults to believe that any exercise at a moderate-intensity level was not sufficient to be beneficial, and thus, many may have become discouraged by the perception that a large amount of exercise is needed, and at an unrealistically level of intensity. However, continued research has demonstrated that exercise performed at a moderate-intensity level would induce numerous health benefits. These benefits could positively affect

many systems of the body without producing the cardiorespiratory fitness improvements recommended by the 1990 F.I.T.T. regimen.

The U. S. Public Health Service (1991) outlined the public health goal for the United States for the year 2000 in a report titled *Healthy People 2000: National Health Promotion and Disease Prevention Objectives*. This publication was designed to help improve the health of all Americans, and it provided specific objectives with regard to improving the health of children and youth. Several of the objectives in the physical activity and fitness area emphasize the importance of regular physical activity in promoting health and reducing the risk of disease. Objective 1.4 includes an exercise guideline for the promotion of cardiorespiratory fitness among children and youth. Specifically, objective 1.4 recommends: "Increase . . . the proportion of children and adolescents aged 6 through 17 who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness 3 or more days per week for 20 or more minutes per occasion [Note: vigorous physical activities are rhythmic, repetitive physical activities that use large muscle groups at 60% or more of maximum heart rate for age]" (p. 92).

The *Healthy People 2000* report also included a goal for physical education (Objective 1.9). Specifically, it states: "Increase to at least 50 % the proportion of school physical education class time that students spend being physically active, preferably engaged in lifetime physical activities" (p. 104).

In July of 1993, the American College of Sports Medicine and the U. S. Centers of Disease, Control and Prevention released a statement: "Every American adult should



accumulate 30 minutes or more of moderate-intensity physical activity over the course of most days of the weeks". Emphasis being placed on the word "accumulate". In 1995, the American College of Sports Medicine, the U. S. Centers of Disease of Control and Prevention and the President's Council on Physical Fitness and Sports published their recommendation that "every U. S. adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week" (Pate et al., 1995, p. 402). This recommendation provides adults with more ways to perform activity and adopt healthier and active lifestyles.

Health benefits associated with physical activity in adults are well documented. However, there remain disagreements with respect to the effects of physical activity in youth (on chronic diseases in adulthood) because long-term studies are lacking. For that reason, children have often been judged unfit according to the adult standards.

Several national medical and professional organizations have issued opinion statements, or resolutions on guidelines for youth physical activity (American College of Sports Medicine, 1988; American Medical Association, 1992; Rionel, Boerth, Coates, Hennekens, Miller, & Weidman, 1986). However, many of these opinion statements and guidelines are based primarily on studies of adults. A 1992 advisory committee composed of leading scientists and practitioners developed a consensus on physical activity guidelines for adolescents (American Medical Association, 1992). Two general population recommendations were presented. First, "all adolescents should be physically active daily, or nearly everyday, as part of play, games, sports, work, transportation, recreation, physical education, or planned exercise, in the context of family, school, and



community activities; and second adolescents should engage in three or more sessions per week of activities that last 20 minutes or more at a time and that require moderate to vigorous levels of exertion” (Sallis & Patrick, 1994, pp. 307-308). Many adolescents meet the physical activity guidelines and often only need encouragement to remain active. However, recent data from the Youth Risk Behavioral Survey suggests that a substantial number of adolescents, and the majority of girls, are not sufficiently active (Pate, Long, & Heath, 1994, pp. 434-447).

### *Historical Perspective on Children and Youth Fitness*

The concern over children and youth fitness has been a common topic of professional and media debate for decades. For example: Kraus and Hirschland (1954) compared the fitness of American children to that of European children using the Kraus-Weber test. This test consisted of six pass-fail items measuring the strength and flexibility of trunk and leg muscles. Results indicated that nearly 60% of the American children failed one item or more, as compared to less than 10% of the European children. Therefore, Kraus and Hirschland (1954) concluded that American children were relatively unfit. Consequently, President Eisenhower established the President's Council on Youth Fitness in order to improve the fitness of children and youth in America.

After determining that the Kraus-Weber test did not measure all important components of physical fitness (Phillips, Bookwalter, Denman, McAuley, Sherwin, Summers, & Yeakel, 1955), the American Alliance for Health, Physical Education and Recreation (AAHPER) Research Council introduced the AAHPER Youth Fitness Test in 1958. This national fitness survey was designed to evaluate the fitness of children and

youth in America. The test included the evaluation of agility, speed, power, muscular strength and muscular endurance, but ignored any measurement of cardiorespiratory fitness, flexibility, or body composition. In 1975 slight revisions were made to the AAPHER Youth Fitness Test including the deletion of the softball throw and modification of the sit-up test (Hunsicker & Reiff, 1977). The survey was given in 1958, 1965, and 1975. Evaluating the results of the 1975 survey, Hunsicker and Reiff (1977) stated, "The physical fitness of public school children in the conterminous United States has shown little or no improvement" (p. 31).

In the mid-1980's the President's Council on Physical Fitness and Sports conducted the 1985 National School Population Fitness Survey (NSPFS). These tests included agility, speed, power, muscular strength, and muscular endurance along with the evaluation of cardiorespiratory fitness and flexibility. However, the survey did not include a body composition test. Results of the survey led the Council's committee members to conclude that there were low levels of performance in the cardiorespiratory endurance, trunk flexibility, and arm and shoulder strength and endurance areas in children and youth. "The NSPFS summary and conclusion section noted that there is still a low level of performance in important components of physical fitness by millions of children" (Corbin & Pangrazi, 1992, p. 99).

Corbin et al. (1994) reported that "evidence suggest that children are among the most active segment of the population" (p. 6). Generally, children are more active than adults, and like to be active when given the opportunity. Yet, many children are often classified as inactive when judged according to the adult standards. For example, in a



survey of the year-round physical activity of students, only 58.9% of the children in grades 5 through 12 were engaged in sufficient aerobic activity throughout the entire year to achieve a cardiorespiratory training effect (Ross & Gilbert, 1985).

Many studies have focused on children's activity patterns. Studies have monitored children's heart rates during school physical education classes (Li & Dunham, 1993; Strand & Reeder, 1993a, 1993b), school recesses (Hovell, Bursick, Sharkey, & McClure, 1978), and out of school summer vacation (Gilliam, Freedson, Geenen, & Shahraray, 1981). Janz, Golden, Hansen, and Mahoney (1992), concluded that children seldom achieve heart rates high enough and long enough to promote cardiorespiratory fitness. Studies using criteria of heart rate above 140 beats per minute and 20 minutes of continuous exercise found 66% of the girls and 61% of the boys to be inactive (Armstrong et al., 1990b). Armstrong and Bray (1991) reported 88% of the girls and 77% of the boys to be inactive. A recent study by Welk (1994) found 83% of children did not raise their heart rates above 140 beats per minute for a continuous 20 minutes. These studies reveal that children are not continuously active, and thus, may be judged inactive if assessed against adult standards, which stress continuous high intensity exercise.

However, in contrast, in December, 1995, The President's Council on Physical Fitness and Sports noted that, when viewing Physical Activity and Fitness, "Children are not little adults, their responses to activity are quite different from those of adults, activity programs should be planned with these differences in mind" (Bar-Or, Corbin, & Pangrazi, 1995, p. 5).

*Children's Activity Patterns*

Do children typically take part in activity differently than adults? By nature, are children's activity patterns more intermittent and sporadic in nature? Does their activity involve alternating bursts of moderate and vigorous activity with brief periods of rest rather than continuous activity? During these activities might children elevate their heart rates at a high level, but not sustain that high heart rate for a long period of time?

The data of Armstrong et al. (1990b) showed that boys accumulated 68 minutes of activity each day and girls accumulated 59 minutes. Another study by Armstrong and Bray (1991) found few boys and girls who continuously maintained high heart rates for 10 minutes during a day. However boys, on average, accumulated 45 minutes of activity and the girls accumulated 31 minutes each day when total minutes of activity (heart rate above 140 beats per minute) were counted. While children's activity is rarely continuous, they accumulate many more minutes of activity each day than adults.

A study by Welk (1994) using activity and heart rate monitors revealed that 99% of boys and 98% of girls exceeded the energy expenditure of 4 calories/kg/day, slightly higher than the standard recommendation of 3 calories/kg/day (approximately 30 minutes of activity per day). Other evidence points to the Pangrazi et al. (1996) conclusion that "many children do accumulate many minutes of daily activity, but that continuously high heart rates is not necessarily a good criterion for younger children" (p. 40).

Bailey, Olson, Pepper, Porszasz, Barstow, and Cooper (1995) assessed the level and tempo of children's physical activity under free-ranging, natural conditions, experienced by children aged 6-10 years old. Their observational study captured the



tempo of children's energy expenditure, including the duration, intensity, frequency, and type of children's physical activity. Results of that study indicated the children were engaged in activities at a low intensity 77.1% of the time and activity of high intensity 3.1% of the time. Bailey et al. (1995) found children engaged in very short bursts of high intense physical activity interspersed with brief but variable intervals of activities of low and moderate intensity. This study raised questions about how activity patterns of children under natural environment influences the physiological processes of growth and development.

Although experts may not agree on the same standards, they do agree that an effective way to maintain good health throughout a lifetime is through the adoption of an active lifestyle.

Representatives of the American College of Sports Medicine (1988, p. 422) stated, "The necessary amount of exercise for children is not precisely known, yet recommend that children and youth obtain 20 to 30 minutes of vigorous exercise each day." Although there is no consensus statement for how much physical activity children should achieve, recommendations have been stated in the President's Council on Physical Fitness and Sports Physical Activity and Fitness Research Digest prepared by Corbin et al. (1994). These recommendations are outlined in the following section.

#### *Contemporary Fitness Recommendations for Children*

Based on the analysis of children's activity patterns, Corbin et al. (1994) advocated the "Children's Lifetime Physical Activity Model" [C-LPAM] which was suggested as a more appropriate model for judging children's activity. The C-LPAM

recommendations for maintaining The Health Standard include: A Minimum Activity Standard at a moderate intensity (alternating bouts of activity with rest periods as needed or moderate activity such as walking or riding a bike to school), for a duration long enough to expend a least 3 to 4 kcal/kg/day (equal to calorie expenditure in 30 minutes or more activity or moderate sustained activity which may be distributed over 3 or more activity sessions), at a daily frequency (frequent activity sessions of 3 or more each day). Requirements for the optimal functioning standard include: A Goal for All Children to exercise, at a moderate to vigorous intensity, for a duration necessary to expend at least 6 to 8 kcal/kg/day (equal to calorie expenditure in 60 minutes...) at a daily frequency.

Sallis and Patrick (1994) summarized the results of an International Consensus Conference on Physical Activity Guidelines for Adolescents. Specifically, they noted the following: "First, all adolescents should be physically active daily or nearly every day as part of their lifestyles. Second, adolescents should engage in three or more sessions per week of activities that last 20 minutes or more that require moderate to vigorous levels of exertion" (p. 302). This consensus was subsequently endorsed by the Centers for Disease Control and Prevention in 1997.

Most recently (1998), an official statement of guidelines by NASPE committee members (primarily authored by Corbin and Pangrazi), included two recommendations as central aspects of its guidelines: (a) "elementary school aged children should accumulate at least 30 to 60 minutes of age and developmentally appropriate physical activity from a variety of physical activities on all, or most days of the week. (Accumulation of more than 60 minutes up to several hours is encouraged)", and (b) "some of the child's activity



each day should be in periods lasting 10 to 15 minutes or more and include moderate to vigorous activity. This activity will typically be intermittent in nature involving alternating moderate to vigorous activity with brief periods of rest and recovery” (p. 3). The NASPA committee recognized that appropriate activity levels for children should occur over extended periods. Recommended physical activities for elementary school children should include a variety of activities from the Physical Activity Pyramid.

#### *Health and Wellness Promotions*

Physical activity is an important factor to the health of adults (Caspersen et al., 1989). "Among adults, higher levels of physical activity have been associated with a reduced incidence of coronary artery disease, hypertension, noninsulin-dependent diabetes mellitus, depression, colon and reproductive cancers, osteoporotic fractures, and total mortality" (Baranowski et al., 1992, p. 237).

Recognizing that physical activity holds a significant health benefit behavior for most individuals, it is unfortunate that a large population of the America people do not do enough to receive valuable benefits (U.S. Public Health Service, 1991). The U.S. Public Health Service is trying to lower the risk of chronic disease in adults by increasing the activity level of all individuals.

The 1979 publication of *Healthy People: The Surgeon General's Report on Health Promotion and Disease Prevention* was the first publication offered by the U. S. Public Health Service for improving the health of Americans (U.S. Public Health Service, 1979). By 1980, the goals revealed in the publication was revised into specific objectives for the 1980 publication *Promoting Health/Preventing Disease: Objectives for the*



*Nation*. The agency hoped to achieve these objectives by 1990. Early results showed approximately 50 to 75% of the objectives had been or would be achieved by the year 1990 (U.S. Public Health Service, 1990).

The publication *Healthy People 2000: National Health Promotion and Disease Prevention Objectives* (U.S. Public Health Service, 1990) outlined the public health goals for the United States for the year 2000. The intent of this publication was to increase activity and physical fitness levels of children and, more importantly, to encourage children and youth to adopt an active later adult lifestyle.

The positive influence of regular physical activity on reducing the risks of adult diseases has been established (Baranowski et al., 1981). Studies by Dennison et al. (1988) and Powell and Dysinger (1987) found childhood physical activity may be an indicator of physical activity in adulthood. As research continues to link physical activity with positive health benefits, it is likely that the promotion of active lifestyles for people of all ages will increase (Hensley, Ainworth, & Ansorge, 1993). Corbin and Pangrazi (1992) concluded that the need to encourage and monitor regular physical *activity* may supercede the emphasis on physical *fitness*. The physical education profession has a large responsibility in the promotion of active lifestyles for all ages. This responsibility includes providing facilities with programs and services that educate individuals about the importance of active lifestyles. Hensley et al. (1993) added that the profession also needs to monitor and assess the physical activity for individuals of all ages.

*Measuring Children's Activity*

Although the measurement of adult physical activity has become easier in some ways, problems still persist in the measurement of children's physical activity. A number of considerations must be included when determining the most reliable and valid measuring device for assessing physical activity. As research continues to grow concerning the monitoring and assessing of physical activity, one must consider which is the most effective research method. Techniques used to assess children include pencil/paper evaluations (or recall), doubly labeled water, motion sensors, heart rate monitors and direct observation. Advantages and disadvantages of each exist.

Pencil/paper evaluations (or recall) are probably the least desirable because of error due to the inability to accurately recall the type, intensity and frequency of activity (Klesges, Klesges, Swenson, & Pheley, 1985). Another technique known as doubly labeled water has been shown to accurately estimate energy expenditure (Schoeller, 1988). However, doubly labeled water is very expensive and not very feasible. Motion sensors, which directly assess movement, can be more receptive to various physical activities than pencil/paper evaluations or activity recall. Motion sensors are less costly and less time consuming than pencil/paper evaluations or direct observations.

Heart rate monitors have been used successfully to objectively assess physical activity (Gilliam et al., 1981; Strand & Reeder, 1993a, 1993b). Heart rates have been shown to be linearly related to energy expenditures. When monitoring physical activity by heart rate monitors, it is assumed increases in heart rate are related to increases in energy expenditure due to increased activity levels. However, literature shows that heart

rate may be increased as well by psychological factors or influences. Therefore, in some instances the monitored heart rate may not always be only the results of physical activity but also influenced by psychological factors.

The direct observation technique has a major advantage over other methods because the physical (mode, intensity, frequency, and duration) as well as social context of the activity are recorded. Although this method is very time consuming and potentially costly, direct observation provides more information about physical and social environmental influences. Thus, when it is possible to collect direct observation of data, they can be used as a criterion standard against which other indirect methods can be assessed.

#### *Summary*

As research continues to link physical activity with positive health benefits, the interest in children's physical activity continues to grow. Previous researchers monitoring children's heart rates have concluded that children seldom achieve high enough and long enough heart rates to promote cardiorespiratory fitness (Gilliam et al., 1981; Hovell et al., 1978; Janz et al., 1992; Li & Dunham, 1993; Strand & Reeder, 1993a, 1993b). Ross and Gilbert (1985) concluded that children and youth are not as physically active or physically fit as recommended in order to maintain good health. More particularly, Armstrong et al. (1990a, 1990b) and Armstrong et al. (1990) have emphasized their position that children are inactive because they rarely experience sustained duration's of physical activity to stress the cardiopulmonary system. However,



Corbin et al. (1994) have disagreed, saying that children are active, but with intermittent physical activity. Thus, existing data have led to differing opinions.

Thus, the continued interest in children's physical activity and its measurement has raised an important issue. Children and youth may, or may not meet the physical activity recommendations or standards depending on which ones are used to judge them. Accordingly, the main purpose of this study was to systematically explore children's activity patterns in different settings. This research focused attention on two major issues: (a) whether elevated heart rate recordings correlate with different levels of observed physical activity, and (b) whether desired levels of increased heart rate are actually sustained over (10 and 20 minute) periods in different settings that are usually associated with vigorous cardiovascular activities.

Specifically, primary research questions explored whether there was a correlation between heart rates and observed activity level. Inquiry whether gender differences exist, and if so what gender differences were observed during different activities, led to additional questions. These questions included whether there were gender differences in heart rates at the various activity levels, and to what extent children met the various recommendations and official position stands on health and physical activity levels. These questions were examined through use of HR monitors and direct observation (via: video tape recordings).

## CHAPTER II

### METHOD

There are a number of available methods for measuring the level of fitness and wellness of children and youth. Whether physical activity guidelines designed for adults apply equally for children and youth remain unclear. A primary purpose of this study was to investigate if children and youth meet the national physical activity guidelines. Two methods, HR monitors and direct observation, were used to assess whether children's activity and heart rate levels fell within the standards. Specifically, four main questions were addressed in the study. First, is there a correlation between heart rates and observed activity level? Second, do gender differences exist, and if so what are the gender differences in observed activity level? Third, are there gender differences in heart rates at the various activity levels? Fourth, to what extent did the children meet various health and fitness criteria and guidelines during the different activities? This chapter describes how data were collected and analyzed.

#### *Participants*

Participants were solicited through their teachers or coaches. Forty-one students (25 male and 16 female), aged 9-17 years from two schools in Mayville, North Dakota, one school in East Grand Forks, Minnesota volunteered to participate in the study. Data were collected from four different typical settings. Specifically: seven boys and six girls in an elementary physical education class, three boys and five girls in an elementary

recess, five boys and five girls in an elementary classroom, and ten high school boys in a basketball game. The University Institutional Review Board approved all procedures. Participants and their parents were informed of the purpose of the study and were required to sign a consent and agreement to participate form (see Appendix A) before participating. An assurance of confidentiality was given, and it was emphasized to participants that they were free to withdraw from the study at any time without penalties.

#### *Instrumentation and Data Coding*

Polar Vantage XL (Stamford, CT) heart rate monitors (HRMs) and video cameras were used to collect heart rates and activity levels in the various settings. The HRMs were set to record HR every 5-seconds. The HRM consists of a chest band with a sensor-transmitter, and a wrist monitor. The chest band is an adjustable elastic belt that is secured around the chest of the participant. It contains two noninvasive, conductive electrodes that pick up the electrical impulses of the heart. The sensor-transmitter operates on a lithium battery and snaps in place to the conductive electrodes on the chest band. The wrist monitor is a receiver-microcomputer that also operates on a lithium battery.

Wrist monitors are capable of allowing programming of heart rate training zones. An auditory signal is emitted when the heart rate is not within the programmed training zones. Heart rate is monitored continuously recording and storing heart rate data at 5-, 10-, 15-, or 60-second intervals, and automatically recording elapsed time. The data from the wrist monitor memory was transferred to a personal computer for analysis by means of a computer Polar interface unit. Leger and Thivierge (1988), and Treiber, Musante,



Hartdagan, Davis, Levy, and Strong (1989) have shown that the use of HRMs is valid in both laboratory and field settings.

Direct observation of physical activity was also performed, and as frequently recommended (Cone & Foster, 1982), served as a criterion measure of physical activity. Video tape recordings were made of the participants in each setting. The Children's Activity Record System (CARS) was used to code the observed physical activity into meaningful activity scores. CARS consists of 5 different activity categories (1-stationary, 2-stationary with limb movements, 3-slow translocation, 4-moderate translocation, and 5-fast translocation) which identifies the participant's level of physical activity. The observer typically evaluates the level of activity at the end of the 10-second interval. Special codes are used when coding activities that require extra energy expenditure (lifting, jumping, etc.). Studies show that this coding system reveals a high correlation with activity and the energy expenditure (Puhl, Greaves, Hoyt, & Baranowski, 1990).

#### *Procedures*

The study was conducted within the month of May during the 1994-95 school year. The participants were monitored in one of the following settings (an elementary physical education class, an elementary recess, an elementary classroom setting, and a basketball game).

There were a total 14 HRMs available for this study. The HRMs were labeled, and each participant was assigned a specific HRM to wear in each setting along with a numbered cloth vest to help with the observation. Prior to the collection of data, each



participant was briefed on the procedure and carefully fitted for a HRM. To help improve recording accuracy, adhesive tape and/or elastic cloth wrap was used to hold the electrodes onto the skin. HRMs were programmed to record and recall heart rates every 5-, 15- or 60-seconds, depending on the activity. At the end of the each setting, the heart rate data stored on the wrist monitor were transferred to an IBM computer via a Polar interface unit. The wrist monitors were then cleared and reset for use in the next activity. To prevent audio reference to heart rate levels on the HRMs, the training zones were set at a minimum (40) and maximum (240) level. Sweatbands covered the wrist monitors to prevent visual reference to heart rate levels.

For observational purposes, video cameras were placed to enable recording of the entire area. The primary observer used a count down method (5, 4, 3, 2, 1) start to help synchronize the two assessment tools. All video cameras were started one minute prior to the start of the HRMs. After 54-seconds of video taping, the primary observer used the count down method to ensure the two assessment tools were synchronized. Finally, after all data were collected, the primary observer reviewed the tapes and recorded activity data using the CARS observation method.

Teachers and coaches were informed of the procedures and the importance of providing a typical setting for this study. Feedback was not given to the participants unless specifically requested for personal use.

#### *Elementary Physical Education Class*

The physical education class data were gathered from a 5<sup>th</sup> grade class in East Grand Forks, Minnesota. The class represented 13 students (7 boys and 6 girls) who

volunteered to participate. The class was conducted on the outdoor athletic field on a cool and windy day. The class began with a running activity, followed by a game of softball, and ended with a running lap around the bases of the softball field. Heart rates were recorded and stored, while the following movements were observed: running, jumping, standing, sitting, swinging of bats, and talking. The entire observation period totaled 22 minutes.

#### *Elementary Recess*

Eight subjects (3 boys and 5 girls) volunteered to participate in the elementary recess. The recess was held on the elementary playground in Mayville, North Dakota. During this recess, subject's activities included walking, talking, running, jumping, swinging, riding on a merry-go-round, playing kickball, and doing cartwheels in the grass. Data were recorded and stored for a total of 16 minutes.

#### *Elementary Classroom Setting*

Elementary classroom data was collected from a fourth grade class at Mayville, North Dakota. The observation took place in the student's homeroom with 10 participants (5 boys and 5 girls). Each of the participant's heart rates was recorded while they continued with their normal day. During this time various movements were observed: students worked on classroom assignments, individually answered questions when a teacher called on them, read out loud to the class when asked, participated in smaller group discussions for reading time, when asked answered math questions, sat quietly and worked on a paper project, walked around to get things in different areas of the classroom, went to the bathroom, went to get a drink, sat very quietly at their desks,

continued to move in their desks, clapped their hands together as teacher instructed them to do so, and exhibited movements of coughing and laughing. The total observation time was one hour and forty-three minutes.

### *Basketball Game*

The basketball game data were collected from 10 high school boys from Mayville, North Dakota. The game was purposely played continuously for 21- and 22-minute halves with a 5-minute half time break and no time-out breaks. Data were collected over a 48-minute period. The participants were monitored while sitting, walking, running, jumping, throwing, shooting, and dribbling activities occurred.

### *Statistical Analysis*

Heart rate and CARS data were coded and recorded at concurrent 10-second intervals. (Because the HRMs recorded HR every 5-seconds, only the second HR of each 10-second interval was used). The data were then analyzed to evaluate (a) the CARS ratings and HRs in each activity, (b) whether sex differences occurred, and (c) how CARS ratings correlated with HR both contemporaneously, and with the HRs progressively lagged at 10-second intervals from the observed activity scores.

Descriptive statistics were used to calculate HR means and mean CARS scores in different activities. Analysis of variance (ANOVA) and (MANOVA) were used to assess differences in mean HR and CARS between males and females for each individual activity. In addition, HR-CARS rating correlations were computed for each activity setting, and average correlations were calculated using Fisher's transformation in each case. HR-CARS correlations were also analyzed with the HR response to the observed



activity progressively lagged at 10-second intervals from zero to 60 seconds. Again, the mean correlation coefficients were computed for each time period using Fisher's transformation.

Chapter three provides results and conclusions by examining data associated with the various studied physical activity settings. Figures are included to better display the resulting information and articulate the findings in a meaningful fashion.

### CHAPTER III

#### RESULTS AND DISCUSSION

Interest in the interpretation and measurement of physical fitness and wellness of children continues. Technology, such as heart rate (HR) monitors and motion sensors, has been increasingly used to assess habitual physical activity, and activity in various settings such as sport and free play.

The purpose of this study was to contribute to the available literature on assessment of children and youth physical activity. This study applied HR monitoring technology concurrently with actual observation in a variety of settings. The results of this investigation adds to the knowledge and validity of using HR monitorings for measuring physical activity. In addition, this study may help to determine the extent to which various children and youth activities, measured in a variety of settings, meet standard physical activity guidelines. Overall results using the Children's Activity Record System (CARS) and Heart Rates measurements across four different activities provided contributory data.

The results of heart rates and activity data are discussed below. Observational results and recorded HRs for each activity setting are followed by a discussion.

*Elementary Physical Education Class**Results*

Observation of the 13 fifth graders (7 boys and 6 girls) during the 22-minute lesson yields the following results:

- Participants were active (moderate or fast translocation) for 79% of the 22-minutes on average.
- No 10- or 20-minute continuous periods were observed at HR standards of  $\geq 140$  and  $\geq 160$  bpm.
- Only two students sustained continuous activity  $\geq 5$  minutes at HRs  $\geq 140$  bpm.
- On average, the students achieved HRs  $\geq 140$  bpm for 53% of the lesson time.

*Discussion*

Using both HR and CARS data, the students appear to have met the *Healthy People 2000* goal (1.9) of being active at least 50% of the lesson time. The data also suggest that participation in this activity made a substantial contribution to the 1998 NASPE Physical Activity for Children guidelines. However, against the Armstrong et al. (1990) criteria, the students were considered insufficiently active because none sustained continuous 10- or 20-minute periods at HRs  $\geq 140$  bpm.

*Basketball Game**Results*

Ten boys (ages 15-17) played a basketball game for 48 minutes, and the game was purposely played continuously for 21- and 22-minute halves (5-min. half time) with no time-out breaks. Analysis revealed the following:



- CARS data revealed that the players were moderately or vigorously active for 86% of the total time (76% at the most active rating).
- HR was  $\geq 140$  bpm for 87% of the time.
- Only three players sustained 20-minute periods of HRs  $\geq 160$  bpm,.
- Only 5 players sustained 10-minute periods of HRs  $\geq 160$  bpm,.
- Most players (7 out of 10) sustained several 5-minute periods (total of 25) at HRs  $\geq 160$  bpm.
- More sustained periods were recorded at the lower HRs  $\geq 140$  bpm standard, but four of the 10 players did not manage 20 minute sustained periods, and two of 10 did not manage sustained 10-minute periods at the HRs  $\geq 140$  bpm standard.

### *Discussion*

Both CARS and HR data indicate that this activity would appear to make a substantial contribution to the daily and weekly activity goals recommended in *Healthy People 2000* (objective 1.4), and to the recent Consensus Statement on physical activity for adolescents (Sallis & Patrick, 1994). Certainly, all players accumulated considerable vigorous activity. However, despite the fact that the game was purposely played continuously for 21- and 22-minute halves (5-min. half time) with no time-out breaks, the students were only partially successful in meeting the Armstrong et al. (1990) sustained HR criteria.

*Elementary Recess**Results*

Eight 3rd graders (3 males and 5 females) were studied during a 16-minute recess period. Analysis revealed:

- On average, students were moderately (21%) or vigorously active (62%) for 83% of the time.
- Student HRs met the  $\geq 140$  bpm standard 72% of the time.
- No students sustained 5- or 10-minute periods of activity at HRs  $\geq 160$  bpm.
- Only one student sustained a 10-minute period where HRs were  $\geq 140$  bpm.
- Only four of the eight students sustained 5-minute periods with HRs at  $\geq 140$  bpm.

*Discussion*

The activity of most students observed by both HR and CARS during this recess would appear to have made a reasonable contribution to the NASPE Physical Activity for Children guidelines (1998). However, by the Armstrong et al. (1990) HR criteria, the majority failed to sustain sufficient activity.

*Elementary Classroom Setting**Results*

Ten fourth-grade children (5 males and 5 females) were studied in a regular (homeroom) classroom setting for an average of 84.7 minutes per student. Analysis reveal the following results:

- Only two children recorded any HRs  $\geq 140$  bpm. One boy maintained this heart rate for 40 seconds while he was active at the moderate level according to CARS, and for 100 seconds while he made a fast bathroom visit. The other child had a 10-second and one 30-second period where HRs were  $\geq 140$  bpm that occurred during coughing fits while her movement was moderate according to CARS.
- Although on many occasions potentially arousal-inducing stimuli were present, none resulted in HRs  $\geq 140$  bpm in the 10 children.

### *Discussion*

The sedentary classroom observation was conducted because Armstrong et al. (1990) expressed concern about possible HR record contamination due to transient emotional states and other influences. Thus, they advocated judgment based on sustained periods of high HR. However, despite the observation of many events that could have spuriously raised HR through emotional reactions, negligible contamination actually occurred.

### *Sex Difference Analyses*

The analysis below discuss results concerning the existence of possible gender differences and their effect in observed activity levels. The analysis also defines whether there were gender differences in heart rates at the various activity levels.

Average CARS and HRs across the different activities are shown in Figures 1 and 2. An ANOVA revealed no statistical differences in mean HR or CARS between males and females in either physical education or recess. Similarly, Figures 3 through 6 display



results from a MANOVA that revealed no sex differences in HRs within the CARS levels during physical education and recess.

#### *Heart Rate-CARS Correlations*

HR-CARS ratings correlations were moderate to high in physical education, recess, and basketball settings. In the (sedentary) classroom setting, the correlation was moderate/low. Time lag analysis showed that for some individuals  $r$  values were higher when CARS ratings were correlated with the HRs recorded 10-seconds later. However, when correlations were averaged (using Fisher's transformation) in each setting, the coefficients progressively declined with each 10-second time lag of HR from the CARS ratings (see Figure 7).

#### *Overall Discussion and Conclusions*

The CARS data show that considerable moderate-to-vigorous physical activity occurred in the recess, physical education lesson, and basketball settings. The correlation data suggest that those activity levels were reflected by the HR data with moderate to good validity. However, the results of the time lag analysis suggest that validity is maximized when HRs are recorded frequently (e.g., at 5- or 10-second intervals compared to 60-second intervals). The lower correlation of HR and CARS in the classroom setting is likely due to the lack of variability in physical activity when the participants were expected to be sedentary over sustained periods of time. Although it seemed plausible to expect increased coefficient sizes if HR was allowed a short time lag to adjust to the observed activity levels, this hypothesis was not supported.

Thus, with regard to HR data as an indirect measure of physical activity, wrist watch-type monitors appear to have reasonable validity for measuring predominantly moderate-to-vigorous activity when the HR data are collected at frequent (5- or 10-second) intervals; and where sufficient variability is present.

With regard to physical activity patterns, data on the physical activity patterns of children and youth have been collected using different methods, and have been analyzed using different perspectives. This study focused on the HR data analyses, and the results appear to refute the concerns about HR contamination from transient emotional states as raised by Armstrong et al. (1990). Thus, the results, overall, suggest that the Armstrong et al. (1990) criteria may be overly conservative, and may misclassify as insufficiently active many children and youth who would otherwise meet other appropriate federal and professional standards and guidelines for healthful physical activity levels. In this study, the activity observed in the physical education lesson, and during a basketball game and recess, certainly made a good contribution to the goals and recommendations for children and youth that are currently found in the literature.

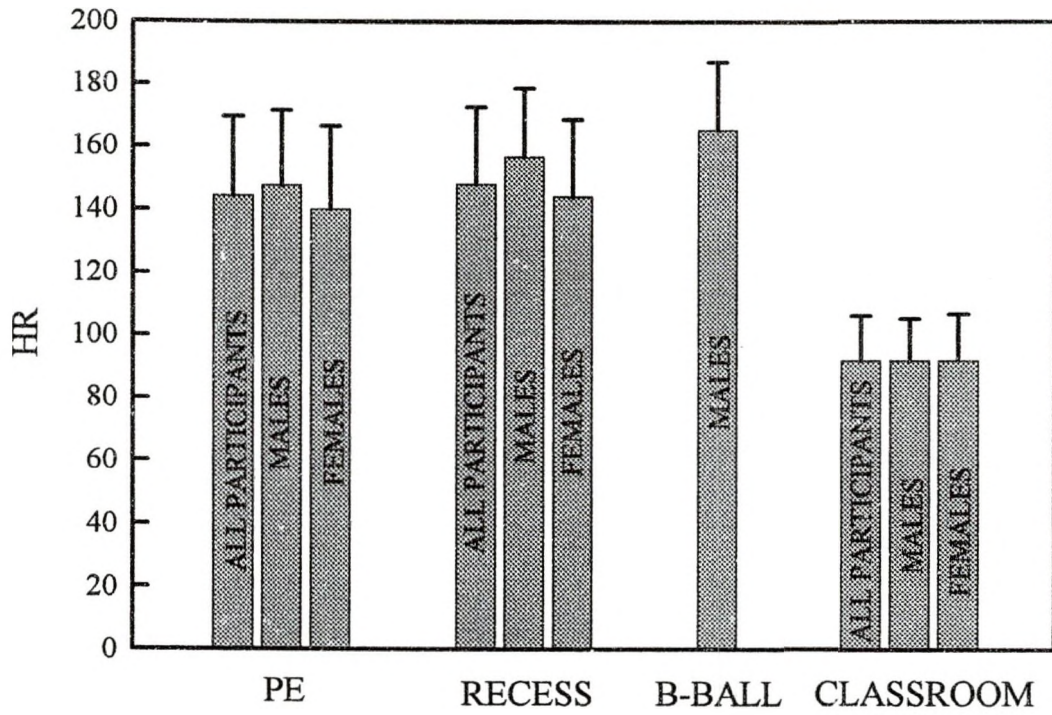


Figure 1. Mean in HR in different activities



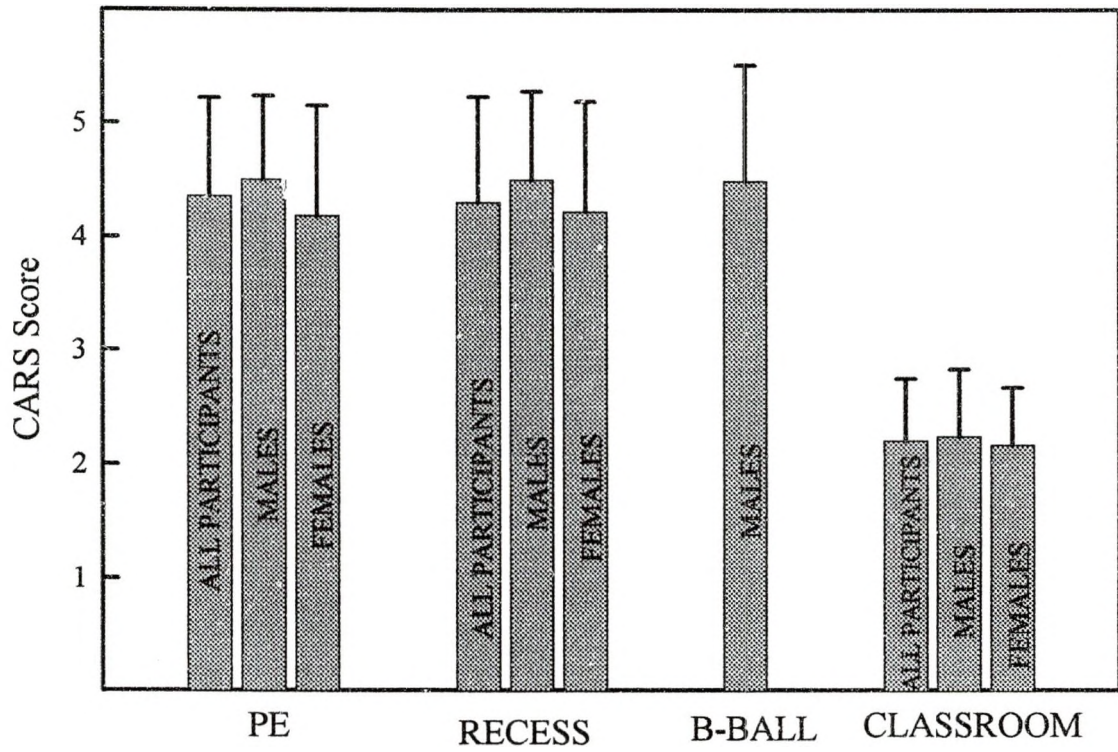
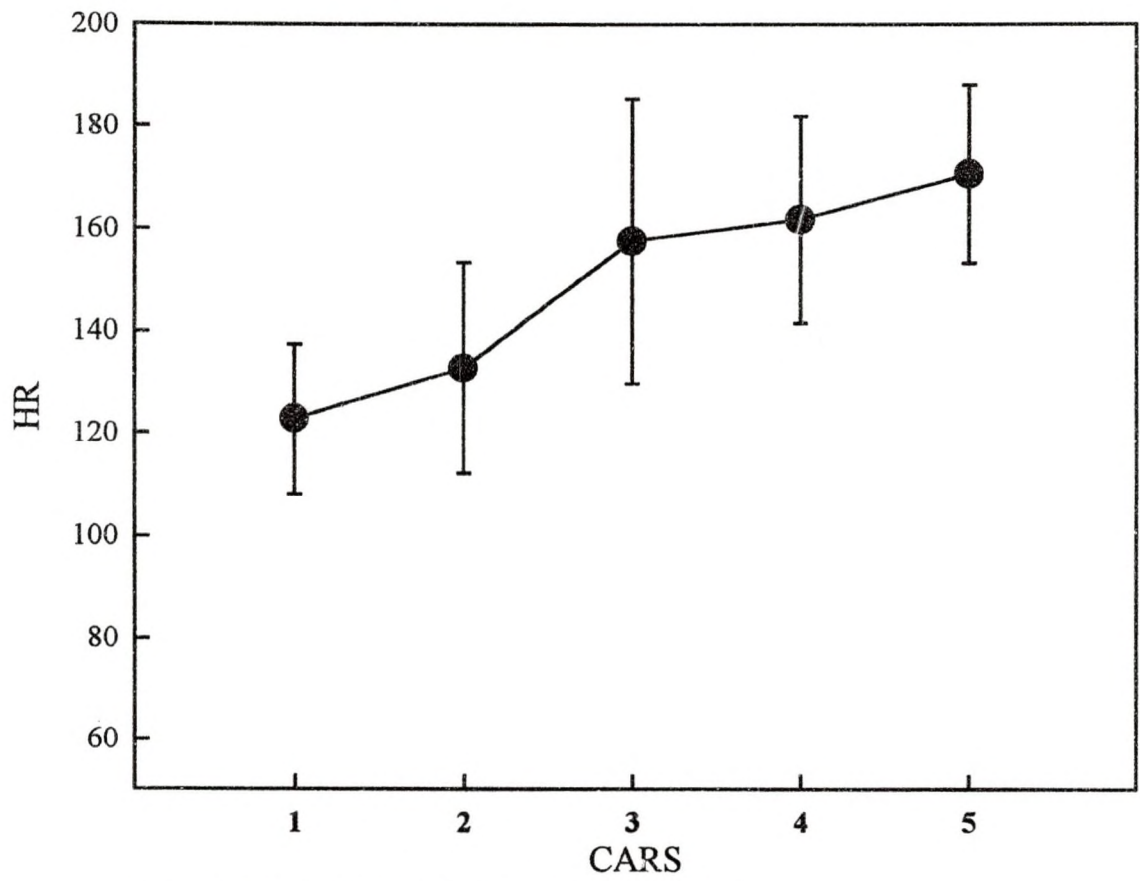


Figure 2. Mean CARS scores in different activities



*Figure 3.* HR at CARS activity levels in Basketball

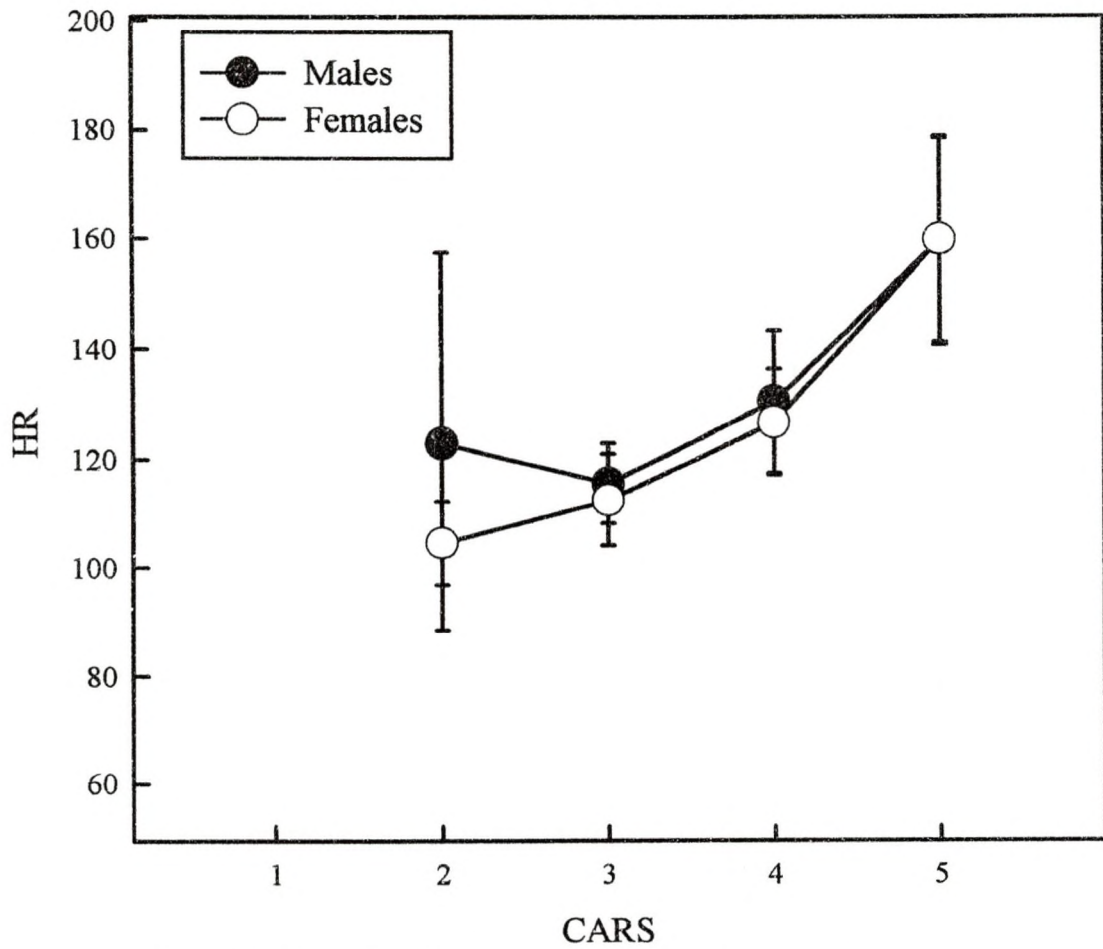


Figure 4. HR at CARS activity levels in Physical Education Class



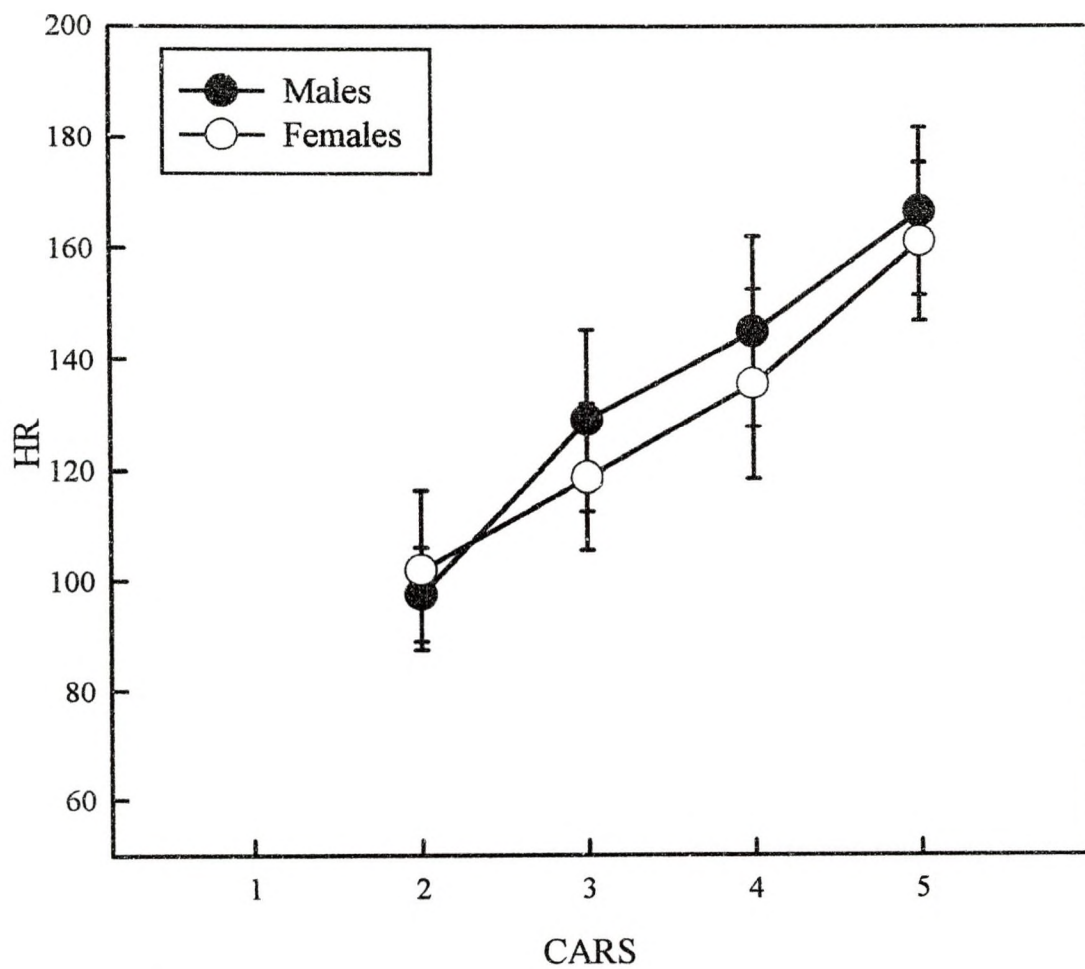


Figure 5. HR at CARS activity levels in recess

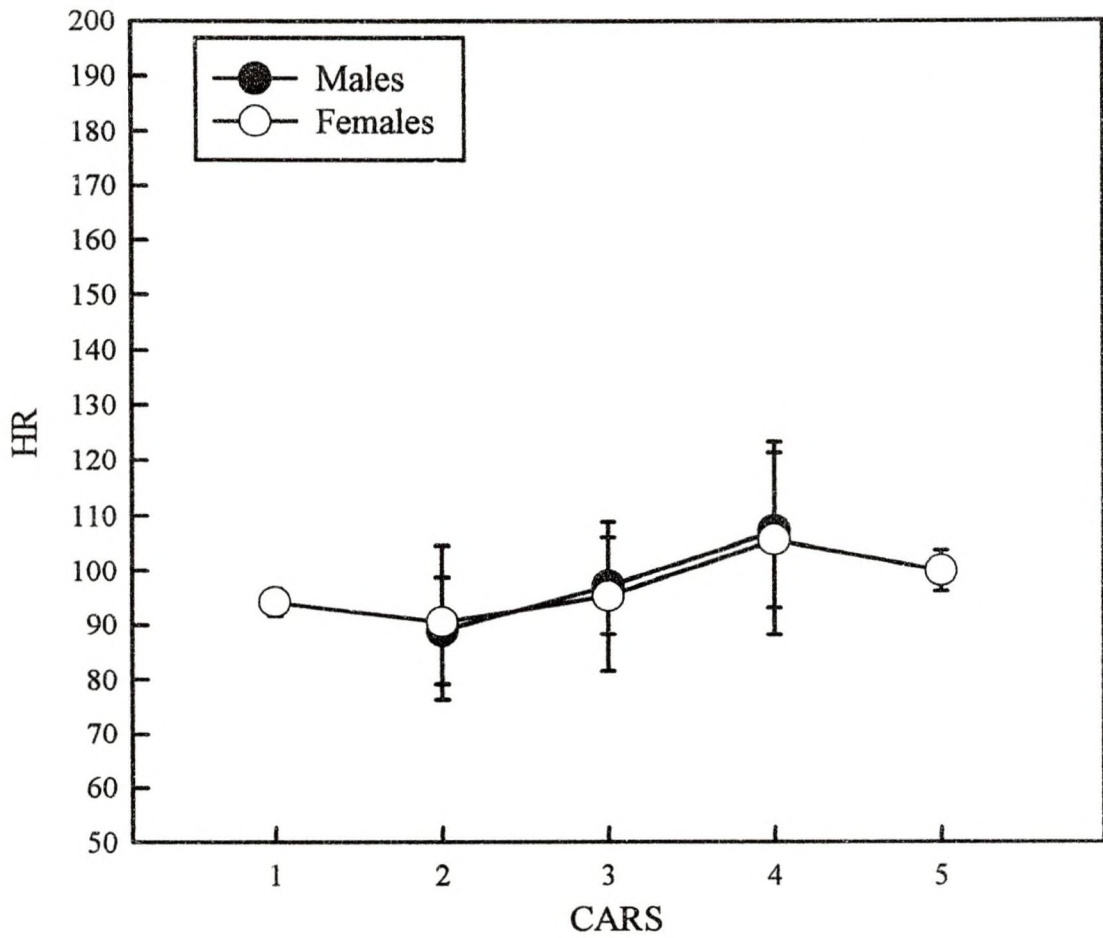


Figure 6. HR at CARS activity levels in classroom

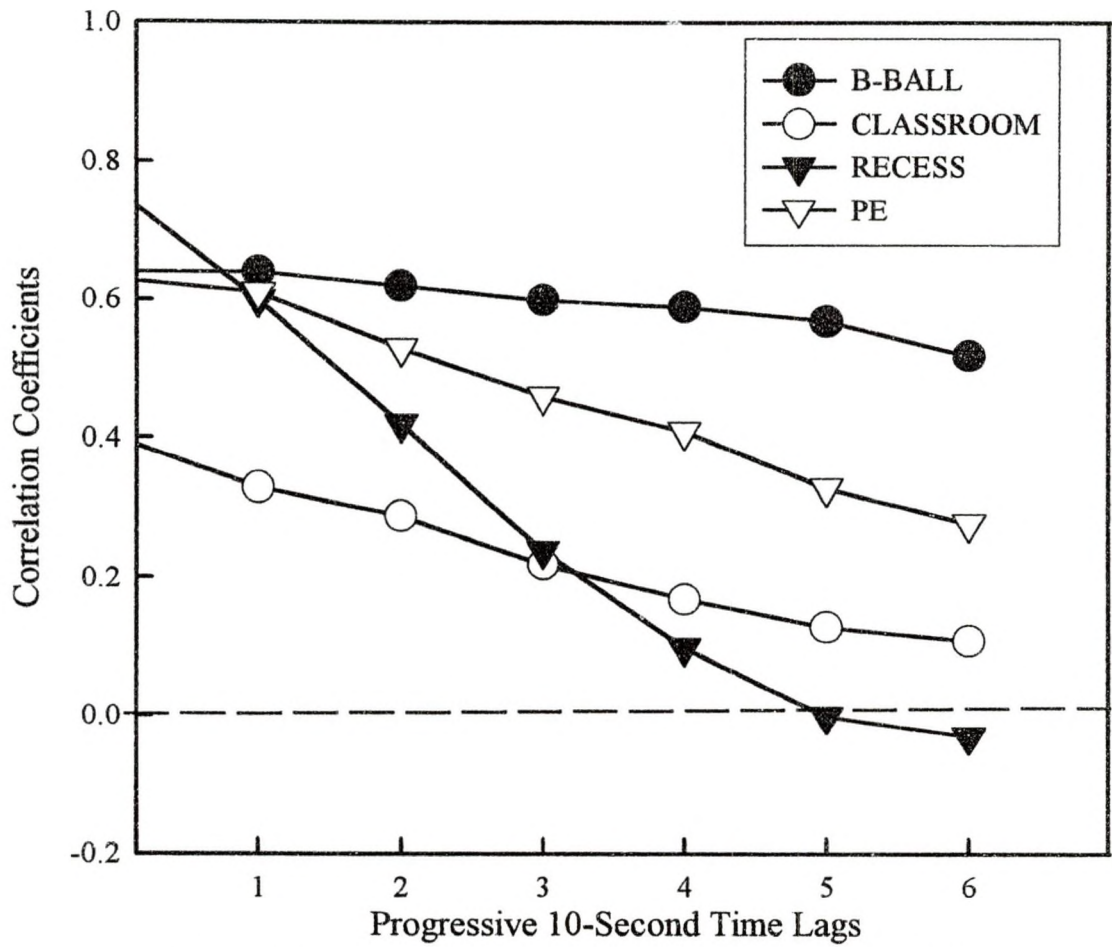


Figure 7. HR - CARS correlations with progressive 10-second time lags



**APPENDIX A**

**CONSENT AND AGREEMENT TO PARTICIPATE FORM**

Consent  
and  
Agreement to Participate Form

Attention Parents:

My name is Rebecca Swift and I am a graduate student at the University of North Dakota. To complete my degree, I am researching the use of heart rate monitors for evaluating children's physical activity. Since regular physical activity is an important health behavior, there is a growing interest and concern with children's physical activity and the measurement of it. This study will provide information on: 1) the extent to which heart rate recordings coincide with physical activity, and 2) whether sustained (10- and 20-minutes) periods of high heart rate occur during typical vigorous sports and class activities.

I would like to invite your son or daughter to participate in this study. Approximately fifty children, both female and male, aged 9-17 years, attending schools in eastern North Dakota will be involved. During one day, your child will be monitored in one of their regular settings (an elementary classroom, an elementary physical education class, an elementary recess, a soccer game, or a basketball game). Heart rate monitors and video tape recordings are commonly used in research studies and in daily physical education class. Your child will be asked to wear a Polar Vantage XL heart rate monitor during one of these activities. The heart rate monitors consist of a chest strap (which contacts against the skin) and a wrist watch-like monitor. Your child will be briefed on how the monitor works and how to start and stop it. Other research studies report no significant discomfort while wearing the heart rate monitor. As your child's heart rate is being monitored, your child will be video taped. These tapes will help compare elevated heart rate to physical activity.

Your child's data will not be used for grading purposes nor viewed by any person other than my research committee and me. All data will be kept confidential. When the study is completed, the original (videotapes, etc.) data will be destroyed. At that time, if you would like the copy of your child's heart rates for your own interest, I will be happy to give them to you and explain it to you.

Research regulations require that in order for your son or daughter to participate in this study, your consent is needed. If you will permit your child to participate in this study, please sign the bottom of this form, detach it, and return it to your child's classroom teacher or coach tomorrow.

If you have any questions at anytime, please call me and I will be happy to answer them. Thank you for your time and cooperation.

Sincerely,

Rebecca Swift  
(701) 777-2992 Work  
(701) 786-3179 Home

---

I give my consent for my son/daughter to participate in this study.

---

Parent/Guardian Signature

---

Son/Daughter's Name

I, \_\_\_\_\_ understand that my parents have given permission for me to participate in a research study. This study is to evaluate the use of heart rate monitors for recording children's physical activity patterns in different setting. My involvement in this study is voluntary, and I may withdraw at any time without penalty.

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Signature



## REFERENCES

- American Academy of Pediatrics Committees on Sports Medicine and School Health. (1987). Physical fitness and the schools. *Pediatrics*, 80, 449-450.
- American College of Sports Medicine. (1988). Opinion statement on physical fitness in children and youth. *Medicine and Science in Sports and Exercise*, 20, 422-423.
- American College of Sports Medicine. (1990). The recommended quantity and quality of exercise for developing and maintaining cardiorespiratory and muscular fitness in healthy adults. *Medicine and Science in Sports and Exercise*, 22, 265-274.
- American Heart Association. (1992). Medical/scientific statement on exercise: Benefits and recommendations for physical activity for all Americans. *Circulation*, 85(1), 2726-2730.
- American Medical Association. (1992). Guidelines for Adolescent Preventive Services. Chicago: Author.
- Armstrong, N., Balding, J., Gentle, P., & Kirby, B. (1990a). Estimation of coronary risk factors in British schoolchildren: a preliminary report. *British Journal of Sports Medicine*, 24(1), 61-66.

Armstrong, N., Balding, J., Gentle, P., & Kirby, B. (1990b). Patterns of physical activity among 11 to 16 year old British children. *British Medical Journal*, *301*, 203-205.

Armstrong, N., Balding, J., Gentle, P., & Williams, J., & Kirby, B. (1990). Peak oxygen uptake and physical activity in 11- to 16- year olds. *Pediatric Exercise Science*, *2*, 349-358.

Armstrong, N., & Bray S. (1991). Physical activity patterns defined by continuous heart rate monitoring. *Archives of Disease in Childhood*, *66*, 245-247.

Bailey, R. C., Olson , J., Pepper, S., Porszasz, J., Barstow, T. J., & Cooper, D. M. (1995). The level and tempo of children's physical activities: An observational study. *Medicine and Science in Sports and Exercise*, *27*(7), 1033-1041.

Baranowski, T., Bouchard, C., Bar-Or, O., Bricker, T., Heath, G., Kimm, S. Y. S., Malina, R., Obarzanek, E., Pate., R. R., Strong, W. B., Truznan, B., & Washington, R. (1992). Assessment, prevalence, and cardiovascular benefits of physical activity fitness in youth. *Medicine and Science in Sports and Exercise*, *24*(Suppl.), S237-S247.

Baranowski, T., & Parcel, G. (1981). Social learning theory and health education. *Journal of Health Education*, *12*(3), 14-18.

Bar-Or, O., Corbin, C. B., & Pangrazi, R. P. (1995). Health benefits of physical activity during childhood and adolescence. *Physical Activity and Fitness Research Digest*, *2*(4), 1-6.

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

Caspersen, C. J., Powell, K. E., Korplan, M., & Ford, T. (1989). Physical activity and chronic diseases. *American Journal of Clinical Nutrition, 49*(5), 999-1006.

Centers for Disease Control and Prevention. (1997). Guidelines for school and community programs to promote lifelong physical activity among young people. *Morbidity and Mortality Weekly Reports, 46*(No. RR-6), 1-36.

Cone, J. D., & Foster, D. L. (1982). Direct observation in clinical psychology. In: P. Kendall & J. Butcher (Ed.), *Research Methods in Clinical Psychology*, (pp. 311-354). New York: John Wiley and Sons.

Cooper, K. H. (1991). *A generation of unfit children*. New York: Bantam.

Corbin, C. B., & Lindsey, R. (1997). *Concepts of Fitness and Wellness* (2nd ed.). Dubuque, IA: A Times Mirror Company or Times Mirror Higher Education Group, Inc.

Corbin, C. B., & Pangrazi, R. P. (1992). Are American children and youth fit? *Research Quarterly for Exercise and Sport, 63*, 96-106.



Corbin, C. B., & Pangrazi, R. P. (1998). *Physical activity for children a statement of Guidelines*. Reston, VA: National Association for Sport and Physical Education.

Corbin, C. B., Pangrazi, R. P., & Welk, G. J. (1994). Toward an understanding of appropriate physical activity levels of youth. *Physical Activity and Fitness Research Digest*, 1(8), 1-8.

Dennison, B. A., Straus, J. H., Mellits, E. D., & Charney, E. (1988). Childhood physical fitness tests: Predictor of adult physical activity levels? *Pediatrics*, 82, 324-330.

Engstrom, L. M. (1986). The process of socialisation into keep-fit activities. *Scandinavian Journal of Sports Science*, 8, 89-97.

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

Hensley, L. D., Ainworth, B. E., & Ansoerge, C. J. (1993). Assessment of physical activity. *Journal of Physical Education, Recreation and Dance*, 64(1), 56-64.

Hovell, M. F., Bursick, J. H., Sharkey, R., & McClure, J. (1978). An evaluation of elementary students' voluntary physical activity during recess. *Research Quarterly*, 49, 460-474.

Hunsicker, P. A., & Reiff, G. G. (1977). Youth fitness report: 1958-1965-1975. *Journal of Physical Education, Recreation, and Dance*, 48(1), 31-33.

Janz, K. F., Golden, J. C., Hansen, J. R., & Mahoney, L. T. (1992). Heart rate monitoring of physical activity in children and adolescents: The Muscatine study. *Pediatrics*, 89, 256-261.

Klesges, R. C., Klesges, L. M., Swenson, A. M., & Pheley, A. (1985). A validation of two motion sensors in the prediction of child and adult physical activity levels. *American Journal of Epidemiology*, 122, 400-410.

Kraus, H., & Hirschland, R. P. (1954). Minimum muscular fitness tests in school children. *Research Quarterly*, 25, 178-188.

Leger, L., & Thivierge, M. (1988). Heart rate monitors; Validity, stability, and functionality. *The Physician and Sportsmedicine*, 16(5), 143-151.

Li, X., & Dunham, P. (1993). Fitness load and exercise time in secondary physical education classes. *Journal of Teaching in Physical Education*, 12, 180-187.

Pangrazi, R. P., Corbin, C. B., & Welk, G. J. (1996). Physical activity for children and youth. *Journal of Physical Educational, Recreation and Dance*, 67(4), 38-42.

Pate, R. R. (1988). The evolving definition of physical fitness. *Quest*, 40, 174-179.

Pate, R. R., Long, B. J., & Heath, G. (1994). Descriptive epidemiology of physical activity in adolescents. *Pediatric Exercise Science, 6*, 434-447.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G. W., King, A. C., Kriska, A., Leon, A. S., Marcus, B. H., Morris, J., Paffenbarger, R. S., Patrick, K., Pollock, M. L., Rippe, J. M., Sallis, J., & Wilmore, J. H. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and American College of Sports Medicine. *Journal of the American Medical Association, 273*(5), 402-407.

Phillips, M., Bookwalter, C., Denman, C., McAuley, J., Sherwin, H., Summers, D., & Yeakel, H. (1955). Analysis of results from the Kraus-Weber Test of minimum muscular fitness in children. *Research Quarterly, 26*, 314-323.

Powell, K. E., & Dysinger, W. (1987). Childhood participation organized school sports and physical education as precursors of adult physical activity. *American Journal of Preventive Medicine, 3*(5), 276-281.

Puhl, J., Greaves, K., Hoyt, M., & Baranowski, T. (1990). Children's Activity Rating Scale (CARS): Description and Calibration. *Research Quarterly for Exercise and Sport, 61*(1), 26-36.

Riopel, D. F., Boerth, R. C., Coates, T. J., Hennekens, C. H., Miller, W. M., & Weidman, W. H. (1986). Coronary risk factor modification in children: Exercise (A statement for physicians by the Committee on Atherosclerosis and Hypertension in

Childhood of the Council on Cardiovascular Disease in young). *Circulation*, 74, 1189A-1191A.

Ross, J. G., & Gilbert, G. G. (1985). The national children and youth fitness study: A summary of findings. *Journal of Physical Education, Recreation and Dance*, 56(1), 45-50.

Sallis, J. S., Buono, J. J., & Freedson, P. S. (1991). Bias in estimating caloric expenditure from physical activity in children. *Sports Medicine*, 11, 203-209.

Sallis, J., & Patrick K. (1994). Physical Activity Guidelines for Adolescents: Consensus Statement. *Pediatric Exercise Science*, 6, 302-314.

Schoeller, D. (1988). Measurement of energy expenditure in free living humans by using doubly labeled water. *Journal of Nutrition*, 118, 1278-1289.

Strand, B., & Reeder, S. (1993a). Analysis of heart rate levels during middle school physical education activities. *Journal of Physical Education, Recreation and Dance*, 64(3), 85-91.

Strand, B., & Reeder, S. (1993b). A comparison of time in the training zone from two independent studies involving middle school students in physical education. *The Physical Educator*, 50, 180-186.



Treiber, F. A., Musante, L., Hartdagan, S., Davis, H., Levy, M., & Strong, W. B. (1989). Validation of a heart rate monitor with children in laboratory and field settings. *Medicine and Science in Sports and Exercise*, 21, 338-342.

U. S. Public Health Service. (1991). *Healthy people 2000: National health promotion and disease prevention objectives*. Washington, DC: U. S. Government Printing Office.

Welk G. L. (1994). A comparison of methods for the assessment of physical activity in children. Unpublished doctoral dissertation, Arizona State University, Tempe, Arizona.

Williams, C. L., Carter B. J., & Wynder E. L. (1981). Prevalence of selected cardiovascular and cancer risk factors in a pediatric population: The "Know Your Body" Project. *Preventive Medicine*, 10, 235-250.