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Analysis of the Caloric Expenditure of Students in Middle School Physical Education Classes

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ANALYSIS OF THE CALORIC EXPENDITURE OF STUDENTS
IN MIDDLE SCHOOL PHYSICAL EDUCATION CLASSES

by

Wendy Granum Frappier
Bachelor of Science, Moorhead State University, 1989
Master of Science, North Dakota State University, 1992

A Dissertation
Submitted to the Graduate Faculty
of the
University of North Dakota
in partial fulfillment of the requirements
for the degree of
Doctor of Philosophy

Grand Forks, North Dakota
July
1999
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Thomas Moss

This dissertation meets the standard of appearance, conforms to the style and format requirements of the Graduate School at the University of North Dakota, and is hereby approved.

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Don't ever give up your dream...and never leave them behind.

Find them; make them yours, and all through your life.

cherish them, and never let them go.

(Elisa Costanza)

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ABSTRACT

According to the recent Surgeon General's Report guidelines, all Americans including children need to burn a minimum of 150 calories in daily physical activity or approximately 1,000 calories a week to meet minimum healthy activity standards. The purpose of the study was to assess the caloric expenditure of students in middle school physical education classes to determine if they were expending a sufficient amount of calories in physical education classes to meet the minimum healthy activity recommendations. More specifically, the study determined the differences in caloric expenditure and various physical activities, the relationship between heart rate and caloric expenditure, sex differences in caloric expenditure, the relationship of fitness levels and caloric expenditure, and the students' attitudes and knowledge about physical activity and healthy behaviors.

The subjects for the study consisted of 56 students (11 males and 45 females) in two middle school physical education classes taught by the same instructor. The age range of the subjects was 11 to 14 years. Data was collected over 19 days or 38 total class periods. These instruments were used to collect the data: the Caltrac accelerometer, the Polar Vantage XL heart rate monitor, and a survey instrument designed by the researcher.

The study indicated that students expended an average of 71.1 activity calories per class period with a range between 36.8 and 120.5 calories. The study revealed that...
there were significant differences between calories expended among nine different physical activities taught in physical education. There were moderate correlations between caloric expenditure and heart rates above, in, and below the target heart rate zone and an inverse relationship between caloric expenditure and heart rates below the target heart rate zone. The study also revealed that there were significant differences in caloric expenditure in males in comparison to females. There were no significant differences between the PACER, sit and reach, sit-up, and push-up fitness tests and caloric expenditure. There were significant differences in caloric expenditure and body mass index. Students with a higher body mass index burned significantly more calories. In addition, there were positive correlations between attitude and knowledge in regards to physical activity and healthy behaviors.
CHAPTER I
INTRODUCTION

A quality life is a healthy life with two major components to living a healthy life. The first component is getting adequate physical activity to prevent risk factors leading to debilitating diseases. Physical activity is defined as "any bodily movement produced by skeletal muscles that results in caloric expenditure" (McKenzie, 1999, p. 16). The second component is eating properly to decrease the potential of obesity and all the health problems associated with being overweight or obese. In today's society we see the problem of inactivity and being overweight or obesity affecting our children. Educating children about the importance of adequate exercise and proper nutrition, which includes caloric consumption and expenditure, should be an essential educational component in physical education classes. Physical education plays a vital role in promoting physical activity in children and adolescents. It is important that students become aware of the recommended activity guidelines and also the benefits of daily physical activity. To determine if students are getting enough physical activity, assessment techniques (i.e. heart rate monitors and Caltracs) can be used in physical education classes. In addition, students need to be educated about the consequences of inactivity and its relationship to obesity and risk factors for heart and other diseases.

The most recent Surgeon General's Report (U.S. Department of Health and Human Services, 1996a) suggests that all Americans, including children, need to burn a
minimum of 150 calories a day in physical activity or approximately 1,000 calories a week. The greatest decrease in coronary artery disease was observed by those individuals who expended 300 calories a day or an excess of 2,000 calories a week in physical activity (Paffenbarger et al., 1994; Paffenbarger, Hyde, Wing & Hsieh, 1986). In addition, Paffenbarger and colleagues (1994, 1986) revealed that the risk of dying from all diseases decreased as a result of burning 500 calories a day or 3,500 calories a week in physical activity. The risk of death from all causes becomes progressively lower as the physical activity level increases from 500 a day or about 3,500 calories burned per week (Paffenbarger, et al., 1986). The risk of diabetes dropped six percent for every 500 calorie increase in activity from 500 to 3,500 calories per week. Estimate reductions in risk for disease and cancers for an expenditure of 500 calories per week in leisure-time activity demonstrates a nine percent decrease in all causes of death, 15 percent decrease in cardiovascular disease, 12 percent decrease in coronary heart disease, 18 percent decrease of stroke, 17 percent decrease in colon cancer, 18 percent decrease in prostate cancer, and a six percent decrease for non-insulin diabetes (Paffenbarger et al., 1994). By slightly increasing physical activities, including increased caloric expenditure, people can significantly decrease their risks for various cancers and diseases. According to the Surgeon General's Report, "there is substantial evidence that physical activity provides children and adolescents with immediate and long term health benefits" (McKenzie, 1999, p. 16).

Role of Physical Education

Generally, physical education is the primary source for physical activity promotion (McKenzie, 1999). Physical education and health are the only curricular areas...
which have a primary focus of addressing and assessing the benefits of regular physical activity and its relationship to nutrition and healthy lifestyle. The President’s Council on Physical Fitness and Sports (1996) suggests that physical education teachers develop programs focused on lifetime activities and self-management skills necessary for an active lifestyle.

A basic function of physical education is the engagement of children in moderate to vigorous physical activity. Quality physical education should consist of health and motor skill development benefits and should contribute to a child’s health in general (Sallis & McKenzie, 1991). Two reports, The Schools and Health: Our Nation’s Investment (Allensworth, Lawson, Nicholson & Wyche, 1997) and Health is Academic: A Guide to Coordinated School Health Programs (Marx & Woody, 1998), substantiate the importance of school physical education programs and related physical activity programs as having a major role in supporting public health programs. Unfortunately in schools today, participation in physical education has decreased, especially in the high school. In 1996, 23 percent of children in grades four through 12 had no physical education (Williams, 1998).

Recommended Activity Guidelines for Children and Adolescents

There have been several recommendations or established guidelines for health-related physical activity standards for children and adolescents. First, it is recommended that all students do some activity, regardless of intensity, daily or almost every day to increase health benefits (Pate, Pratt et al., 1995; Health Reference, 1996). The President’s Council on Physical Fitness and Sports (1996) recommends that people of all ages complete a minimum of 30 minutes of moderately intense physical activity on most, if
It seems that this recommendation has been met by most children and adolescents (Sallis & Patrick, 1994). The second recommendation is to engage in vigorous exercise three or more times a week for at least 30 minutes simultaneously with a heart rate intensity of 75 percent of maximum heart rate (Sallis, et al., 1994). In addition, Pangrazi, Corbin & Welk (1996) suggest 60 minutes of accumulated physical activity a day as an optimal standard for children. Their rationale for accumulated physical activity is based on the research that associates decreased health risks with increased energy expenditure of three to four calories per kilogram of body weight per day. An hour of activity would equate to approximately six to eight calories per kilogram of body weight per day. This accumulated increase in physical activity would meet the caloric expenditure recommendations for decreased health risks (Pangrazi et al., 1996).

Health related physical activity standards have only recently been developed by the Counsel of Physical Education for Children (COPEC, 1998); Health Education Authority (1998); Sallis and Patrick (1994); and the U.S. Public Health Service (1991). There are several other general recommendations for adolescents and children. First, adolescents and children should be active daily in a variety of physical activities because daily weight bearing activities of even brief duration during childhood can be critical for enhancing bone development that affects skeletal health throughout life (Sallis et al., 1994). Second, adolescents and children should be involved in a diversity of activities ranging from moderate to vigorous, using large muscle groups, and lasting a minimum of 20 minutes (Sallis et al., 1994). In addition, the fact that physical activity not only promotes physical health, but psychological health as well is a strong rationale for
adolescents to participate in physical activity (Trost, Pate, Ward, Saunders & Riner, 1999).

Benefits of Regular Physical Activity

According to the recent Surgeon General's report on health (U.S. Department of Health and Human Services, 1996a), individuals who perform regular physical activity reduce the risk of dying from cardiovascular disease. Regular physical activity reduces the risks of developing diabetes, high blood pressure, and colon cancer; helps control weight; and helps develop healthy bones, muscles, and joints. Consistent physical activity also promotes psychological well-being by reducing feelings of depression and anxiety (U.S. Department of Health and Human Services, 1996b). J. F. Sallis' article states that, "...results from randomized trials in small samples, provide strong support for the notion that physical activity is an important influence on psychological health in adolescents" (Sallis, 1996, p. 1779).

Physical Activity Assessment Techniques

One problem for physical educators is encouraging children to participate in physical activity. In the past, there have been limited techniques to assess physical activity in children. Today, many assessment techniques have been utilized to determine if children are getting the recommended amount of physical activity to promote a healthy lifestyle. The selection of assessment techniques for field monitoring physical activity in children and adolescents has been difficult (Freedson, 1989). Generally, physical activity assessment techniques measure the quantity of physical activity (total amount of elevated energy expenditure) and the quality or intensity of the bodily movements. To measure and assess physical activity in physical education, these techniques have been employed.
self-reports, direct observations, electric motion sensors (e.g. Caltrac), and heart rate monitors (McKenzie, 1999).

One of the commonly used assessments in physical education is termed a self-report. This method tends to be a subjective evaluation on the perception of one's activity level. The reliability of self-reports are generally low due to children's limited ability to recall daily physical activities (Freedson, 1989; Luke, Maki, Barkey, Cooper & McGee, 1997; Simons-Morton, Taylor & Huang, 1994).

Another technique used more specifically by researchers is direct observation. This technique tends to be more useful for assessing the time of student activity engagement, lesson or curriculum content, and teacher behavior. Use of this technique can be time consuming and expensive due to the time to train the observers. In addition, lessons not being taught during regular times or even on regular days, leads to wasted time by the observers (McKenzie, Sallis, Faucette, Roby & Kolody, 1993).

Accelerometers can assess or measure quantity and quality of bodily movement. Klesges and Klesges (1987) validated the accelerometer in a sample of 28 preschool children by use of the direct observation method. Heart rate monitoring of children has also been used as an assessment technique. Most research has focused on the assessment of continuous whole day heart rate to evaluate physical activity, but recently more research has been done in physical education (Strand & Reeder, 1993). Although heart rates may be influenced by such factors as emotional stress and type of muscle contraction, Freedson (1989) has recommended heart rate monitoring as a valid and practical measure of children’s physical activity (Durant et al., 1992).
According to McKenzie (1999), the use of heart rate monitors, accelerometers, and direct observation provides the most objective measurement of activity level with the main limitations of high cost and some inconvenience. There tends to be limited data on the validity of field based measures of activities of children. Recommendations for the future include objective monitoring by direct observation and the use of motion sensors (e.g., Caltrac), and heart rate monitors. These techniques may be more objective than self-reports since in self-reporting children may have a limited ability to recall physical activities (Freedson, 1989; Luke et al., 1997; Simons-Morton et al., 1994).

Inactivity and Obesity

The quality of a person's life can be affected by lack of exercise and being overweight. These two components increase one's risk factors for diseases and generally poor health. It has been suggested by several studies (Kutner, 1995; Malina, 1996; Schwenk, 1997) that inactivity in childhood may relate to adult health problems. Although large clinical studies involving children and weight problems have not been completed, it is estimated that 25 to 30 percent of children are either overweight or obese. Some of these children grow out of obesity or being overweight during adolescence, so by young adulthood few have kept their childhood obesity (Stare, Olson & Whelan, 1989).

Most overweight or obese children are unlikely to benefit from a strict dietary program. An exercise program is more advisable for these children. This is important because exercise programs established as children, and habits formed from doing so, tend to carry over into adulthood (Malina, 1996). Studies show that obese children do not consume extremely large amounts of calories, but they are relatively inactive (Stare et al., 1989).
Exercise has been shown to be important in weight control at all ages and may be particularly helpful early in life. Moreover, results show that 10 to 35 percent of adolescents (Health Reference, 1996), 20 percent of adult males, and 40 percent of adult females are overweight (Paffenbarger et al., 1994). The recent results of a Louis Harris Survey show that approximately 66 percent of the United States population is overweight. This constitutes 100 to 165 million American adults (Paffenbarger et al., 1994).

Risk Factors for Heart and Other Diseases

Lack of exercise and inadequate nutrition are considered major risk factors for heart disease. Cardiovascular disease is the leading killer in the United States (Bouchard, Shephard, Stephens, Sutton & McPherson, 1990). Its treatment is costing the country nearly 130 billion dollars a year (Kirkpatrick & Birnbaum, 1997). Currently, cardiovascular fitness continues to decline, body fat percentages continue to increase, and risk factors for heart disease are now known to exist in nearly half of all elementary children in the country (Bouchard et al., 1990). Williams (1998) points out that

A diet low in total and saturated fat may reduce the risk of future atherosclerosis and coronary heart disease. A diet low in total fat may reduce the risk of cancer in particular cancer of the breast, prostate, colon, and ovary. Dietary fat increases caloric density of the diet and encourages passive over-consumption of calories. Along with inadequate physical activity, dietary fat may play a role in increasing prevalence of childhood obesity. Reducing dietary fat intake and increasing energy expenditure should help prevent the early onset of obesity and reverse this trend. Dietary patterns established during childhood are likely to persist over time; thus it is preferable to establish healthy eating patterns early in life rather than attempt the difficult task of changing unhealthy eating patterns later in life. A healthy, fat-controlled diet during childhood can safely and effectively be achieved through the application of a wide variety of fat-reducing strategies following the principles of the USDA Food Guide Pyramid. (p. 155)
Six out of 10 Americans are at risk for various diseases because they do not get enough physical activity (Paffenbarger et al., 1994). Additional risks from being overweight and inactive include increase in cholesterol, increase risk of gall bladder disease, gout, some cancers, and osteoarthritis in weight bearing joints (U.S. Department of Health and Public Services, 1996b). In addition to being overweight, risks of physical inactivity can increase immune system problems and lipid abnormalities (Health Reference, 1996).

Need for the Study

The Surgeon General’s Report and the Paffenbarger studies reveal that burning 150 to 500 calories in physical activity significantly decreases the risks of various diseases and the potential of being overweight or obese. In addition to the increased health benefits of burning 500 calories in a week through physical activity, this practice of consistent physical activity may increase overall life expectancy. The Paffenbarger Harvard Alumni Study shows that each increment of 500 calories per week in leisure time activity may increase longevity by .7 years (Paffenbarger et al., 1986). The Harvard Alumni study, which spanned over the past 30 years, reported that men with a sedentary lifestyle (i.e. physical inactivity) have a 31 percent greater risk of death from all causes than men that exercise regularly (Powers & Dodd, 1996). This translates into a longer life span for those who exercise regularly (Paffenbarger et al., 1994; Powers et al., 1996).

The results of the previously cited studies show that one can benefit from any increase in physical activity. Moreover, mild and moderate physical activity gives excellent benefits. The Aerobics Center Longitudinal Study completed by Dr. Steven Blair concluded that relatively little activity leads to much lower death rates (Blair &
Connelly, 1996). A brisk two-mile walk five to seven days a week in a 30 to 40 minute time span is enough to get a person into the shape achieved by the people in his study. The study showed that even three separate 10 minute periods of walking over the day had the same impact as a 30 minute continuous walk (Blair & Connelly, 1996).

It is important to educate students about how their current behaviors may affect the quality of their lives in the future. Moreover, expending a minimum of 150 calories in daily physical activity is the recommended standard (U.S. Department of Health and Human Services, 1996a). According to current literature, burning an additional 500 calories a day in physical activity decreases the risk of diseases and promotes overall health benefits (Paffenbarger et al., 1996). Physical education needs to take an active role in assisting students to meet the minimum recommendations for activity.

Additionally, physical educators need to provide an educational component to explain and demonstrate the benefits of daily physical activity. Moreover, physical educators need to utilize objective field monitoring techniques (e.g. motion sensors and heart rate monitors) to determine if students are meeting the recommended activity guidelines. By assessing caloric expenditure of children in physical education classes, we can determine how many calories are expended in various physical activities. This information can be utilized to educate teachers and students about what activities burn the adequate amount of calories for increased health benefits. It is necessary to determine if the activities in physical education may be adequate or vigorous enough to burn the recommended amount of calories.
Purpose of the Study

The purpose of this study is to analyze the caloric expenditure of students in middle school physical education classes to determine if they are burning an adequate amount of calories in these classes to meet daily recommendations for optimum health benefits. The following research questions will be used to guide the study.

1. Is there a difference between the caloric expenditure in the various activities taught in middle school physical education classes?

2. What is the relationship between heart rate and caloric expenditure of students in middle school physical education classes?

3. Are there sex differences in caloric expenditure during middle school physical education classes?

4. Is there a difference in students' fitness levels (assessed previously by fitness testing) and caloric expenditure in physical education classes?

5. What are middle school students' attitudes and knowledge about physical activity and healthy behaviors?

Limitations

The results of this study were limited by the following factors:

1. The study included a small segment of the population. The focus of the study consisted of students in two middle school physical education classes in a large middle school in North Dakota. One class consisted of an all girls' 7th grade physical education class, and the other class consisted of a 6th grade co-educational class. Both classes were taught by the same teacher.
2. The Caltrac motion sensor and heart rate monitors were used to collect data for the study. A few days during the research study, limited equipment was available because the loaned equipment was being used for other purposes.

3. The survey data was collected by means of an original survey instrument. While the survey instrument was reviewed by the faculty advisory committee and pilot tested with subjects similar to those in the selected population, normed validity and reliability was not established.

4. It was assumed that the students' responses to the survey represented their true attitudes, perceptions, and knowledge about physical activity and healthy behaviors.

5. The fitness test results may not be as accurate or reliable as possible. The students in the study completed the fitness testing with a partner and then recorded their own results.

6. This study did not take into account the instructional goals of the lessons observed or the teaching strategies that were used. The focus of the physical education lessons and the way the teacher taught the lessons may have had an impact on heart rates and the students' caloric expenditure.

Definition of Terms

Atherosclerosis: the accumulation of lipid and plaque in the lining of the blood vessels (Donetelle, Snow-Harter & Wilcox, 1995).

Balanced Diet: "A diet made up of a variety of foods from different food groups (Basic Four) so that all the many nutrients are obtained in proper or balanced amounts" (Stare et al., 1989, p. 351).

Basal Metabolic Rate: The rate at which heat is given off by an organism at complete rest.
**Body Composition:** The relative amounts of fat and lean body tissue (bone, muscle, organ) found in the body (Powers et al., 1996).

**Body Mass Index:** "Ratio of weight to height, used to determine thinness and fatness and risk for disease" (Hoeger & Hoeger, 1999, p. 421).

**Calorie:** "The unit by which the energy value of food is measured. The calorie, or energy value of foods, is defined as the amount of heat energy required to raise 1000 grams of water one degree Centigrade. The calorie value is determined by calculation using the composition of the food in terms of fat, protein, and carbohydrate. Each gram of fat produces nine calories, and each gram of protein and carbohydrate produces four calories" (Stare et al., 1989, p. 351).

**Caltrac:** Device that measures an individual's basal metabolic rate and the calories burned daily from activity.

**Cardiovascular Disease:** "Any disease that affects the heart or blood vessels" (Powers et al., 1996, p.384)

**Cholesterol:** "The commonest member of a group of compounds called sterols. these are composed of carbon, hydrogen, and oxygen,. Cholesterol is present in all animal tissues but not in plant tissues, though the latter contain similar sterols. Cholesterol is present in many foods, but only foods in animal origins. Egg yolk, sweetbreads, liver, and brains are especially rich sources. It is also make by the body. It is essential raw material for the manufacture of sex and adrenal hormones, of vitamin D, and is a constituent of the abnormal deposits in the inner layer of arteries giving rise to atherosclerosis" (Stare et al., 1989).
Coronary Heart Disease: "Also called coronary artery disease CHD is the result of atherosclerotic plaque forming a blockage of one or more coronary arteries (the blood vessels supplying the heart)" (Powers et al., 1996, p. 385).

Desirable Weight: "That weight at which most people will live longest" (Stare et al., 1989).

Energy: "In nutrition the caloric equivalent of the heat and work necessary to maintain the temperature of the body and permit muscular contraction and thus perform work" (Stare et al., 1989).

Energy Balance Equation: It has three parts. First, eating more calories than one burns causes weight gain and increased fat; second, eating fewer calories than one burns causes weight loss and decreased fat; third, eating the same number of calories as one burns causes a person to stay at the same weight.

Exercise: "Planned, structured, and repetitive bodily movement done to improve or maintain one or more components of physical fitness" (Caspersen, Powell & Christenson, 1985).

Exercise Metabolic Rate: The energy expenditure during any form of exercise.

Fat: A chemical compound composed of three fatty acids combined with a molecule of glycerol. Fats are either animal or vegetable in origin and may be solid or liquid. They also may be man-made - that is synthesized in the laboratory.

FITNESSGRAM: A group of criterion-referenced fitness tests used to assess health-related fitness in children (CIAR, 1992).

Heart Rate: "Number of heart beats per minute" (Powers et al., 1996, p. 386).
High Density Lipoprotein: "A combination of protein, triglycerides, and cholesterol in the blood, composed of relatively large amounts of protein. Protects against the fatty plaque accumulation in the coronary arteries of the heart that leads to heart disease. Research has shown that individuals with high blood HDL-cholesterol levels have a decreased risk of CHD. Therefore, HDL-cholesterol is often called "good cholesterol" (Powers et al., 1996, p. 386).

Isocaloric Balance: "Food energy intake that equals energy expenditure" (Powers et al., 1996, p. 386).

Low Density Lipoprotein: "A combination of protein, triglycerides, and cholesterol in the blood, composed of relatively large amounts of cholesterol. Promotes the fatty plaque accumulation in the coronary arteries in the heart that leads to heart disease. The association between elevated total blood cholesterol and the increased risk of CHD is due primarily to LDL cholesterol. Research has shown that individuals with high blood LDL cholesterol levels have an increased risk of CHD. Because of this relationship, LDL cholesterol has been labeled the bad cholesterol" (Powers et al., 1996, p. 386-387).

Obesity: Excess body weight due to the presence of a surplus of body fat sometimes defined as 20 percent or more above desirable weight.

Osteoporosis: "The loss of bone mass and strength, which increases the risk of bone fractures (Powers et al., 1996, p. 387).

Overweight: Sometimes defined as 10 to 20 percent over desirable weight.

PACER: Progressive aerobic cardiovascular endurance run. It is a fitness test to measure aerobic capacity.
Positive Caloric Balance: "Consuming more calories than are expended" (Powers et al., 1996, p. 387).

Physical activity: "any bodily movement produced by skeletal muscles that results in caloric expenditure" (McKenzie, 1999, p. 16).

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

Resting Metabolic Rate (RMR): "The amount of energy expended during all sedentary activities" (Powers et al., 1996, p. 388).

Target Heart Rate: "The range of heart rates that corresponds to an exercise intensity of approximately 50 to 85 percent VO2 max. That is the range of training heart rates that results in improvement of aerobic capacity" (Powers et al., 1996, p.388).

VO2 max: The highest oxygen consumption achievable during exercise. It is a laboratory measure of endurance capacity of both the cardiorespiratory system and exercising skeletal muscles (Powers et al., 1996).

Organization of the Study

Chapters to follow consist of a review of the literature, methodology, presentations of the findings, conclusions and recommendations. Chapter II, the review of literature, familiarizes the reader with the recommended guidelines for children and adolescents regarding activity levels, caloric expenditure, and fitness levels. In addition, the literature review covers the research completed in physical education that relates to the instruments used in the study (i.e., heart rate monitors and the Caltrac accelerometer) and information on sex and physical activity of children and an overview of the findings of children's and adolescent's attitudes and knowledge about physical activity and

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healthy behaviors. A description of the methods employed in the study are detailed in Chapter III and includes information in regards to the subjects in the study, the description of the instruments used (i.e. Caltrac, heart rate monitors, and survey instrument), the data collection process, and statistical treatment of the data. The data analysis and an explanation of the findings are presented in Chapter IV. Finally, Chapter V concludes the study with a discussion of the implications and meanings of the findings and recommendations for use of the research results.
CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter is to review the current literature related to the study. The following topics will be addressed: physical activity guidelines for children and adolescents; recommended caloric expenditure for children and adolescents; physical fitness levels of children and adolescents; physical activity assessment techniques such as heart rate monitoring and use of accelerometers (e.g., Caltrac) in physical education; children's attitudes and knowledge about physical activity and healthy behaviors; and sex and physical activity of children.

Physical Activity Guidelines for Children and Adolescents

This section of the review of literature will address the relationship between lack of physical activity and health, the short-term and long-term benefits of regular physical activity, the factors that may affect or influence physical activity in children and adolescents, caloric expenditure recommendations, the recommended guidelines for physical activity, and how physical education programs may play a significant role in increasing physical activity of children and adolescents.

Relationship Between Physical Activity and Health

The recent report completed by the Surgeon General (1996) indicated that nearly half of young people ages 12 to 21 years are not vigorously active on a regular basis, and one-fourth of young people reported they did not perform any vigorous activity (U.S.)
Department of Health and Human Services, 1996). For example, among high school students, only 52 percent of girls and 74 percent of boys reported that they exercised vigorously on at least three of previous seven days (National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control (CDC) and Prevention, 1997). In addition, physical activity declines dramatically with age during adolescence. The CDC report (1997) indicated that 69 percent of young people 12 to 13 years of age but only 38 percent of those 18 to 21 years of age exercised vigorously on at least three of the preceding seven days, 72 percent of ninth grade students but only 55 percent of twelfth grade students engaged in this level of activity. Female adolescents are much less active than male adolescents (U.S. Department of Health and Human Services, 1996a).

The Center for Disease Control (CDC) has recognized that there is an association between lack of physical activity and many health problems, which include cardiovascular disease, colon, breast, and prostate cancer, non-insulin dependent diabetes mellitus, osteoporosis, and depression (U.S. Department of Health and Human Services, 1996b).

Generally, low fitness or lack of physical activity can be a precursor of mortality (Blair, Kampert et al., 1996; U.S. Department of Health and Human Services, 1996). Several studies have shown that an increase in physical activity and overall physical fitness can assist people in decreasing health risk factors or health problems, and in addition, increase their longevity (Blair, Kampert et al., 1996; Lee & Paffenbarger, 1996; Paffenbarger et al., 1986).

The relationship between physical activity and fitness in children and youth is currently of major interest. There is an assertion that lifetime physical activity and health
patterns are, or should be, established in childhood, which would translate that active children would be active adults (Katzmarzyk, Malina, Song & Bouchard, 1998). Evidence is limited to a relatively small number of longitudinal studies and generally low inter-age correlations for estimates of physical activity during childhood and adolescence and estimates in adulthood. Although it has been assumed that habits of physical activities developed in childhood and adolescence continues into adulthood, the data tends to be inconsistent (Taylor, Blair, Cummings, Wun & Malina, 1999). Some components of health-related fitness may have a stronger connection from childhood to adulthood. In a study done by Marshall, Sarkin, Sallis & McKenzie (1998), measures of body mass index, sum of skinfolds, and relative weight have been found to track significantly from childhood to adulthood.

Benefits of Regular Physical Activity

There is increasing evidence to support that physical activity may be an important factor in protecting against or the development of several health problems. One of the main problems in examining the relationship between physical activity and chronic disease is the latency of its effects on disease development. Research on habitual physical activity in children and adolescents might contribute to the understanding of disease processes later in life (Koo & Rohan, 1999). Throughout the literature review, there tends to be a significant relationship between adequate physical activity and health. Documentation by the 1996 Surgeon General’s Report concluded that people of all ages, both male and female, who are physically active, derive many benefits. Here are some of the observations from the report:
• Significant health benefits can be obtained by including a moderate amount of physical activity (e.g., 30 minutes of brisk walking, or 15 minutes of running on most if not all days of the week). Through a modest increase of physical activity, most Americans can improve their health (p. 4).

• Additional health benefits can be gained through greater amounts of physical activity. People, who can maintain a regular regime of physical activity that is longer in duration or of more vigorous intensity, are likely to derive greater benefits (p. 4).

• Physical activity reduces the risk of premature mortality in general, and of coronary heart disease, hypertension, colon cancer, and diabetes mellitus in particular. Physical activity also improves mental health and is important for the health and maintenance of muscles, bones, and joints (p. 4).

• Consistent influences on physical activity patterns among all people include confidence in one’s ability to engage in regular physical activity (e.g., self-efficacy), enjoyment of physical activity, support for others, positive beliefs concerning the benefit of physical activity, and the lack of perceived barriers for physical activity (p. 249).

• Physical activity appears to improve health-related quality of life by enhancing psychological well-being and by improving physical functioning in persons experiencing poor health (U.S. Department of Health and Human Services, 1996b, p. 8).

Several studies have documented the positive connection between physical activity and its significance in decreasing coronary risk factors (Boreham, Twisk, Savage, Cran &
Strain, 1997; Schmidt, Walkuski & Stensel, 1998). Boreham’s study (1997) indicated that physical activity and sports participation appeared to be beneficially associated with coronary risk status of adolescents, particularly at age 15, and in males rather than females. In Singapore, the School of Physical Education conducted a Youth Coronary Risk and Physical Activity Study. This study revealed that physical activity was significantly correlated with a decrease in total cholesterol, increase in high-density lipoprotein, and decrease in triglycerides (Schmidt et al., 1998).

Factors That May Influence Physical Activity in Children and Adolescents

The review of the literature reveals that there may be many factors that influence a child’s or adolescent’s reluctance to participate in physical activities, or their willingness and desire to participate in physical activities. One study revealed that children being forced to exercise during childhood may have potentially negative consequences for later physical activity (Taylor et al., 1999). This finding may indicate that experiences related to participation in activity during childhood and adolescence may have some influence on adult physical activity (Taylor et al., 1999).

When discussing the factors that influence a child or adolescent’s participation in physical activities, it is important to take into consideration the developmental, psychological, and behavioral characteristics that distinguish children from adults. For example, children have an inability to delay gratification in pursuit of some future promise of enhanced health or fitness levels. Children may rely more heavily on parents and peers for their values and beliefs (Biddle & Goudas, 1996; Reynolds, Killen & Bryson, 1990; Zakarian, Hovell Hoffsteter, Sallis & Keating, 1994). Children are more clearly motivated by adults. Theories such as Bandura’s (1986) social cognitive theory
suggest that behavior is influenced by reciprocal relationships between an individual and the social and physical environment (cited in Welk, 1999).

To understand exercise behaviors in children, it is important to observe environmental factors such as social, cultural, physical and institutional influences. These environmental factors may or may not directly influence a child’s behavior to participate in physical activity (Welk, 1999). For example, having access to programs and equipment may influence whether a child participates in physical activity. Several researchers suggest that self-efficacy may be another strong indicator of child or adolescent participation in physical activity (Reynolds et al., 1990; Trost, Pate, Dowda, et al., 1996; Welk, 1999; Zakarian et al., 1994). If children feel comfortable with their abilities and have support of friends and parents, they are more likely to participate in physical activities.

Welk (1999) also suggests that children may participate in physical activities based on the expectancy-value theory. Children tend to participate if they feel competent, have safe access to facilities, parental encouragement, and interest in the activity. Other reinforcing factors for children and adolescent participation in physical activities may include parental modeling of activity, socialization to be active and biological factors such as physical skill and appropriate body fat. Children are more likely to participate if they have a positive self-concept (Reynolds et al., 1990; Welk, 1999).

**Recommended Guidelines for Physical Activity**

Healthy People 2000 goals were to increase longevity and the quality of life for Americans by the year 2000. Physical activity and fitness was listed first of the 22
different health topics identified by Healthy People 2000 Objectives (U.S. Department of Health and Human Services, 1996). Clearly, the accumulated evidence suggests that people who are physically active are healthier, and live higher quality lives. Healthy People 2000 made two recommendations regarding physical activity for children. The first recommendation is to increase the proportion of children who participate regularly in daily physical education. The second recommendation is to increase the amount of time children are actively participating in physical education to approximately 50 percent of the time (U.S. Department of Health and Human Services, 1996).

In addition to these recommendations, Healthy People 2000 goals suggest improvements in these areas for children and adolescents: decreasing the proportion of overweight children below 15 percent, increasing to 75 percent of the proportion of children and adolescents who engage in vigorous physical activity that promotes the development and maintenance of cardiorespiratory fitness more than three days a week and greater than or equal to 20 minutes, and increase to 40 percent of all people who regularly perform physical activities that enhance and maintain muscular strength, muscular endurance and flexibility (National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, 1997).

There have been several recommendations for physical activity of children and adolescents from a variety of different sources. Generally, it is recommended that all children do some activity, regardless of intensity, daily or almost every day to increase health benefits (Pate, 1995). The President's Council on Physical Fitness and Sport (1996) recommends that people of all ages complete 30 minutes of moderately intense...
physical activity on most, if not all days of the week (Health Reference, 1996; Sallis et al., 1994).

Pangrazi et al., (1996) suggest that 60 minutes of accumulated physical activity per day is an optimal standard for young children. Their rationale is that the largest decrease in health risks is associated with the energy expenditure of three to four calories per kilogram of body weight per day, and additional risk reduction is associated with increased amounts of physical activity. Pangrazi et al., (1996) imply that if a child can meet the one hour accumulated activity per day, which is six to eight calories per kilogram per day, he/she is more likely to meet the 30 minute minimum standard as an adult. Moreover, they recommend increasing a child’s activity time to provide time for skill development and active participation (Pangrazi et al., 1996).

Another recommendation for children and adolescents is that they should engage in moderate to vigorous activity three or more times a week for at least 30 minutes simultaneously with a heart rate intensity of 75 percent of maximum heart rate (Sallis et al. 1994). Moreover, it is suggested that children and adolescents need to be involved in a variety of daily physical activities. Daily weight bearing activities contribute to bone development that may affect skeletal health throughout an individual’s life (Sallis et al., 1994). In addition, it is recommended that children and adolescents should participate in activities which utilize large muscle groups, and last a minimum of 20 minutes (Sallis et al., 1994).

A report by the National Center for Chronic Disease Prevention and Health Promotion, and Centers for Disease Control and Prevention (1997) summarized recommendations to encourage physical activity among young people so that they will
continue to engage in physical activity in adulthood and obtain the benefits of physical activity throughout their life.

The guidelines include recommendations about 10 aspects of school and community programs to promote lifelong physical activity among young people: policies that promote enjoyable, lifelong physical activity; physical and social environments that encourage and enable physical activity; physical education curricula and instruction; health education curricula and instruction; extracurricular physical activity programs that meet the needs and interests of students; involvement of parents and guardians in physical activity instruction and programs for young people; personnel training; health services for children and adolescents; developmentally appropriate community sports and recreation programs that are attractive to young people; and regular evaluation of physical activity instruction, programs and facilities. (p. 220)

Role of Physical Education

Physical education is a crucial component of education. The failure to educate students regarding their health and their bodies can have serious consequences (Graham, Holt/Hale & Parker, 1998). Required school physical education programs provide some opportunities for physical activity, but the frequency and the amount of time children are active during class is not adequate to meet national standards for physical activity (McKenzie et al., 1995; U.S. Public Health Services, 1991). McKenzie and colleagues (1993) point out that total time spent in physical activity or energy expended, may be one of the most important health outcomes and national physical education standards that need to be defined and included in the recommended guidelines for total minutes in physical activity.

McKenzie et al., (1993) recommends practical curricular revisions in physical education. He suggests that physical education should promote high levels of physical activity in children regardless of their skill level. Physical education should also promote health-related fitness through aerobic activities and allow for sports skill development to
enhance success and enjoyment of the activities. But most importantly, curricular changes need to be practical and able to be implemented by all teachers (McKenzie et al., 1993). In addition, it has been suggested that it is important to improve teaching behaviors such as modeling, prompting, and reinforcing students to increase active participation (Welk, 1999). This means physical educators need to promote the learning of skills and new activities (McKenzie et al., 1993). Physical education has been recognized as an optimal vehicle for influencing physical activity habits among children and adolescents. It provides an existing organizational structure and opportunity to reach the majority of youth (Welk, 1999).

**Caloric Expenditure Recommendations**

Increasing the calories spent in daily physical activities helps to maintain health and allows people to eat a nutritious and enjoyable diet (Health Reference, 1996). To maintain a healthy weight, children need to balance food and drinks consumed with the amount of calories that their body uses. Because our work today requires very little energy, and our leisure time is relatively inactive with the use of computers and television, people need to concentrate on incorporating physical activity into their lifestyles (Health Reference, 1996). To burn calories, less time should be devoted to sedentary activities and more time to moderate physical activity.

In addition to adequate physical activity, maintenance of an appropriate body weight or body composition is essential to increase longevity. The most recent recommendation made in the Surgeon General’s Report (U.S. Department of Health and Human Services, 1996) and research by Paffenbarger and colleagues (1994, 1986), suggests that all Americans, including children, need to expend 150 calories per day...
(1,000 calories per week) in physical activity to reduce the various health risks. Strand and Roesler (in press) have termed this recommendation as the standard for reduced health risks.

The standard for reduced coronary heart disease is set at the 300 calories per day mark (Strand, et. al., in press). Paffenbarger and colleagues (1994, 1986) indicated that the greatest decrease in coronary artery disease was observed among individuals who expended 300 calories a day or 2,000 calories a week. In addition, Paffenbarger and colleagues (1994, 1986) concluded that there was a 28 percent less risk of death in men who expended the recommended calories per week.

The standard for reduced mortality is set at the 500 calories a day or 3,500 calories a week recommendation (Strand et al., in press). The research of Paffenbarger and colleagues (1994, 1986) revealed that the risk of death from all causes became progressively lower as the physical activity increased to this caloric expenditure level. In conclusion, the literature suggests that appropriate caloric expenditure through adequate physical activity is recommended to increase health benefits and longevity.

Fitness Levels of Children and Adolescents

This section of the review of literature will discuss the association between fitness and health, the changes in fitness testing, and the role of physical education and its relationship to the current results. The research today on children's fitness indicates that school age children show risk factors for cardiovascular diseases such as obesity, high cholesterol, and high blood pressure, children are heavier today, and there is a decline in their aerobic fitness as measured by distance runs (Kuntzleman & Reiff, 1992). According to Sallis, McKenzie & Alcarz (1993), substantial evidence supports the
conclusion that both increased physical activity, and physical fitness and health are associated with improved health indexes even in children (Baranowski et al., 1992).

It is important to understand the association between physical activity and physical fitness (Sallis et al., 1993). Generally, health-related fitness is associated with health outcomes, which can be modified through physical activity or exercise (Sallis et al., 1993). Fitness tests such as the Prudential FITNESSGRAM have been developed by researchers to assess health-related components of physical fitness (CIAR, 1992). This criterion-referenced test is generally administered by physical educators to determine children’s level of fitness as far as cardiovascular endurance, muscular strength, muscular endurance, flexibility and appropriate body composition (CIAR, 1992). Sallis, McKenzie & Alcaraz (1993) used different measures to assess physical activity (e.g., accelerometers, parent reports, self-reports, and a physical activity index) and found that active children appear to engage in a sufficient variety of activities to enhance multiple components of health-related fitness.

Changes in Fitness Testing

Fitness testing has progressed from measuring abilities considered to be important for physical education objectives such as proficiency in running and jumping in 1958, skill-related physical fitness in 1965 and 1976, to health-related in 1980. Although there are many tests to assess physical fitness, two of the most well known tests for health-related fitness are the AAPHERD Physical Best Test and the Prudential FITNESSGRAM (Corbin & Pangrazi, 1992). Corbin and Pangrazi (1992) found that children may not have improved fitness levels in regards to scores on fitness tests, but fitness has not significantly declined either. Corbin and Pangrazi (1992) analyzed data they gathered...
and data from the National School Population Fitness Survey to assess the fitness of American children. They compared norm-referenced tests to criterion-referenced standards for test items in the FITNESSGRAM and AAPHERD Physical Best Test. Corbin and Pangrazi (1992) suggested, with the exception of measure of arm and shoulder girdle strength and endurance, that more children will meet the criterion-referenced health standards in comparison to the norm-referenced standards. Moreover, these researchers suggest that there tends to be very little evidence that high levels of fitness may be necessary for good health (Pangrazi et al., 1996).

**Role of Physical Education and the Current Fitness Testing Results**

Physical education may play a role in the health and physical fitness of children. Several studies have indicated that fitness is generally low, and physical education is not contributing to improved fitness test results (Corbin & Pangrazi, 1992; Ross, Dotson & Gilbert, 1985). According to the National Children and Youth Fitness Studies I and II, approximately 36 percent of all students grades 1 - 12 were enrolled in daily physical education. Students in grades one through four had about 33 minutes a day of physical education compared to students in fifth through twelfth grade who had approximately 47 minutes (cited in Strand et al., 1993). Physical education classes focused more on motor skill performance rather than lifetime fitness activities. Lacy and LaMaster (1990) observed that junior high school students were involved in fitness activities for fewer than five minutes of a class period. In addition, in approximately 25 percent of the classes observed there was no time set-aside for fitness activities (Lacy & LaMaster, 1990). The American College of Sports Medicine (ACSM) Position Statement (1978) on the quality and quantity of exercise for developing and maintaining adequate physical
fitness recommends that exercise should be done three to five days a week at an intensity level of 60 to 90 percent of maximum heart rate for 15 to 60 minutes of continuous aerobic activity.

In summary, although there is an association among physical activity, fitness and health, little evidence supports the concept that a child or adolescent who is more physically fit is healthier. As a result of the decreased amount of time spent in physical education, and more specifically in health-related fitness activities, fitness in our youth has not improved.

Assessment Techniques in Physical Education

There is growing evidence that physical activity is important to the short and long-term health of children and adolescents. Many physical activity guidelines for children and adolescents have been established to promote physical activity and its positive relationship to health. In addition to the recommendations of time and intensity in physical activity, caloric expenditure recommendations have been suggested. According to the Surgeon General's Report (1996), all people should burn a minimum of 150 calories in daily physical activity (U.S. Department of Health and Human Services, 1996). Since physical activity has an important connection to overall health, there has been interest in assessment techniques which measure physical activity and caloric expenditure. This section of the review of literature will discuss the use and feasibility of assessment techniques used for research regarding physical activity in children and adolescents, the validity and reliability of accelerometers, and the various studies previously completed that assess physical activity and caloric expenditure in children and adolescents.
Researchers have used questionnaires, direct observations, heart rate monitoring, and motion sensors to assess children’s physical activity (Coleman, Saelens, Wiedrich-Smith, Finn & Epstein, 1997). Self-report questionnaires or recall interviews of physical activity represent the simplest procedures, but have moderate reliability and validity in children, due to their inability to accurately recall physical activities (Freedson, 1989; Luke et al., 1997; Sallis et al., 1990; Simons-Morton et al., 1994). Generally, research has demonstrated a poor relationship between self-reported activity and motion sensors. Low levels of agreement between these two measures are assumed to result from the fact that children overestimate both duration and intensity of physical activity (Coleman et al., 1997). Direct observation provides reliable and valid estimates of activity, but it is very time consuming and expensive, especially if assessing leisure time activities of children (McMurray, Harrell, Bradley, Webb & Goodman, 1998). Heart rate monitoring provides reliable measures of activity induced energy expenditure, but results may be affected by many other variables than changes in activity (Coleman et al., 1997). Yet, heart rate has been shown to have a linear relationship to oxygen consumption (Coleman et al., 1997). One of the limitations of heart rate monitors is that they have difficulty measuring energy expenditure at times of low intensity activities (Luke et al., 1997).

Accelerometer

A practical and feasible option for monitoring activity and energy expenditure is by the use of motion sensors or accelerometers (Coleman et al., 1997). Since it is already known that correlations between energy expenditure and heart rate at high levels of energy expenditure are good, motion sensors may provide a better measure of the
relationship at the low end of energy expenditure (Luke et al., 1997). "...the use of a motion sensor in conjunction with heart rate monitoring was a better predictor of oxygen consumption in a laboratory setting that simulated activities of daily life than heart rate alone" (Luke et al., 1997, p. 148). According to the Meijer, Klaas, Westerterp, Koper & Hoor study (1989), there is a strong linear relationship between accelerometer output and energy expenditure. One of the limitations of motion sensors is that they may have difficulty detecting movements of different parts of the body and static exercises that are part of normal daily activity (Luke et al., 1997).

The Caltrac device is a single-plane accelerometer that measures both the quantity and intensity of movement in the vertical plane (Sallis et al., 1990). The Caltrac is about the size of a pocket calculator and is available commercially. The Caltrac displays a cumulative movement count on a small liquid screen (Sallis et al., 1990). To accurately assess basal metabolic rate and calories burned during physical activity, age, height, weight, and sex need to be entered into the Caltrac prior to its use.

Validity and Reliability of Accelerometers

Several research studies have concluded that electronic motion sensors are a valid and reliable assessment tool to measure physical activity (Coleman et al., 1997; LaPorte et al., 1979; Meijer et al., 1989; Pambianco, Wing & Robertson, 1990; Sallis, Buono, Roby, Carlson & Nelson, 1990; Simons-Morton et al., 1994; Trost et al., 1998; Wong, Webster, Montoye & Washburn, 1981). Inter-reliability of the Caltrac has been shown to be 94.4 percent in a study of children eight to 11 years old (Simons-Morton et al., 1994), and 87 percent in a study of children ages 10 to 14 (Trost et al., 1998). Pambianco et al., (1990) determined that there was a significant correlation that ranged from .68 to .79
between caloric expenditure measured by the Caltrac and the caloric expenditure derived from VO$_2$ testing. Similarly, Trost and colleagues (1998) determined that there was significant correlation from .77 to .87 ($p < .001$) between caloric expenditure, VO$_2$, and heart rate. Aerobic capacity (VO$_2$) is the highest rate oxygen can be taken up and utilized by the body during exercise (CIAR, 1992). VO$_2$ is a laboratory measure of the endurance capacity of both the cardiorespiratory system and the exercising skeletal muscles (Powers, et al., 1996). Washburn and LaPorte, (1988), and Montoye et al., (1983) reported Caltrac reliability between .70 and .94 in adults. These results suggest that accelerometers are as reliable in children as adults (Sallis et al., 1990). Klesges and Klesges (1987) found correlations between Caltrac readings and physical activity assessed by all-day personal observation in children aged 24 to 48 months (cited in Washburn, Janney & Fester, 1990).

To determine reliability of accelerometers, Welk and Corbin (1995) tested the Caltrac accelerometer against the Tritrac-R3d Activity Monitor. Although the Caltrac and Tritrac both assess caloric expenditure, the Tritrac has additional features. Instead of measuring movement in a single-plane or with a vertical motion sensor such as the Caltrac, the Tritrac is considered a triaxial accelerometer because it measures movement in three dimensions. The triaxial accelerometer may provide more accurate estimates of low levels of energy expenditure (Coleman et al., 1997). In addition, the Tritrac has a timing device that measures minute-by-minute accounts of physical activity and the results download into the computer for a visual representation of the data. Although the correlations with heart rate data were slightly higher for the Tritrac monitor ($r = .58$) compared to the Caltrac ($r = .52$), they were not significantly different. The correlations
between the Tritrac and Caltrac averaged ($r = .88$) across the three day trials. Welk and Corbin (1995) concluded that the Tritrac accelerometer is a valid and reliable instrument to measure caloric expenditure, but the higher cost of the instrument may not justify its use when only a rough estimate of total activity is needed.

**Assessing Physical Activity and Caloric Expenditure**

Most research studies involving children and assessment of the quantity, intensity, and duration of physical activities and caloric expenditure were completed by monitoring activities of children during a day or approximately a 12-hour period. Sallis, Buono, Roby, Carlson and Nelson (1990) determined that there was a significant correlation between the Caltrac accelerometer and heart rate monitoring in a two-day period of measurement. The correlations, $r = .54$ on day one and $r = .42$ on day two, were moderate but significant. The relationship between Caltrac counts and mean activity heart rates for both days of monitoring was $r = .49$. Similar studies found moderate correlations ($r = .52$) between heart rate and Caltrac monitors (Sallis et al., 1990; Simons-Morton et al., 1994). The correlations found between accelerometer scores and activity were significant for all subgroups, but higher correlations were found for boys ($r = .65$) and children with low body mass indexes ($r = .62$). Lower correlations for accelerometer scores and activity were found in younger children ($r = .39$) and children with higher body mass indexes ($r = .37$).

Previous studies employing the Caltrac (Klesges, Klesges, Swenson & Phelay, 1985; Sallis et al., 1990; Simons-Morton et al., 1994) have reported activity counts from nine to 10 an hour with elementary aged children. Moreover, Welk and Corbin (1995)
reported an average of 11.3 counts per hour during all day physical activity monitoring in fourth and fifth grade boys.

Anderson (1998) completed activity profiles over a 12-hour period with six children age ranges from eight to 14 in rural Canada. A Caltrac accelerometer was used to assess caloric expenditure readings, which were taken every 20 minutes. The results of the study indicated that the children in this study expended the most calories in physical education class (approximately 60 calories for girls and 80 calories for boys) in comparison to all other times during the day (Anderson, 1998).

In summary, the Caltrac accelerometer is a practical, valid and reliable instrument to assess caloric expenditure in children and adolescents. Although studies assessing caloric expenditure have been done with children, most of these studies have been done in conjunction with observations or recall of physical activities in all day situations with heart rate monitoring or in laboratory-based research situations. There have been limited studies using accelerometers in physical education settings to assess caloric expenditure. Trost and colleagues (1996) recommended that future studies need to be completed to assess the relationship between activity monitor (accelerometers) counts and children’s energy expenditure during free play and other non-laboratory-based situations.

Heart Rate Monitoring in Physical Education

This section of the review of literature will discuss the purpose of heart rate monitoring, the validity and reliability of heart rate monitors, the recommended trainable heart rate for children and adolescents, and heart rate monitoring research studies in physical education. One of the more recent trends in physical education is using technology in the gymnasium. Heart rate monitors are one assessment technique
commonly used to determine whether a student is getting adequate physical activity. Heart rate monitoring may indicate how hard children are working in a physical education setting. This type of training may sensitize children so they take more interest in other health-related information. In addition, new knowledge of physical activity patterns is needed to serve as a cornerstone in establishing appropriate federal health objectives and physical education curricula for children (Janz, Golden, Hansen & Mahoney, 1992).

Today, heart rate monitors are used as an educational tool to teach students about appropriate heart rates and the various zones of physical activity (Strand & Mathias, 1995; Strand, Mauch & Terbizan, 1997). In addition, students learn how the intensity and the duration of the heart rate relates to recommended standards and a healthy lifestyle (Kirkpatrick & Buck, 1995; Strand, et al., 1995). Heart rate monitoring can be used as educational laboratory experiences for students and for assessing teacher effectiveness. A few of the ideas developed by Strand and Mathias (1995) include: students can learn how to program, download the watches, and use the computer software, they can develop creative cardiovascular work-outs, evaluate the benefits of various activities and sports, and work on comparing an activity performed in various ways. Another creative way to use the heart rate monitors is for a lifestyle education activity called the Heart Adventure. This is an aerobic fitness activity set-up in representation of the human heart. Children are required to do various physical activities as they work their way through and learn the chambers of the heart (Kirkpatrick et al., 1995).
Validity and Reliability of Heart Rate Monitors

In a study by Durant et al., (1992) to determine the reliability and variability of heart rate monitoring in three, four, and five year old children, and with five, six, and seven year old children (1993), the results revealed that heart rate monitoring was recommended as a valid and practical measure of children’s physical activity. Janz et al., (1992) suggested that whole day heart rate monitoring is an objective, non-obtrusive method for measuring physical activity in children.

Recommended Trainable Heart Rates for Children and Adolescents

To establish a safe and effective heart rate range, Karvonen, Kentala, and Mustala (1957) recommend using the age-predicted maximum heart rate, the individual’s resting heart rate, and 60 to 85 percent of the trainable heart rate (cited in Seigel, 1988). Using target heart rates assists children in developing proper pacing for aerobic activities (Siegel, 1988). To determine an individual’s target heart rate range the following formula can be used: take the number 220 and subtract the individual’s age, (this indicates the maximum heart rate); take the number of the maximum heart rate and minus the resting heart rate, which indicates the trainable heart rate; take the trainable heart rate and take that number times 60 percent and add back in the resting heart rate value, which indicates the lower value of the target heart rate; take the trainable heart rate and take that number times 85 percent and add back in the resting heart rate value, which indicates the upper value of the target heart rate; and the range between 60 and 85 percent is considered the individual’s target heart rate zone (Siegel, 1988). For example, to calculate the target heart rate range for a ten year old child the steps are as follows: step one, $220 - 10 = 210$, which is the maximum heart rate; step two, $210 - 90$ (resting heart
rate) = 120, which is the trainable heart rate; step three, 120 x .60 = 72 + 90 = 162, which is the lower value of the target heart rate; step four, 120 x .85 = 102 + 90 = 192, which is the higher value of the target heart rate; step five, 162 to 192 = target heart rate range.

Heart Rate Monitors and Research in Physical Education

One of the purposes of using heart rate monitoring in physical education is to investigate the heart rate levels of students participating in physical activities. In a study by Strand and Reeder (1993), 55 male physical education students in a middle school in northern Utah participated in a study to collect data on the physical activities of children. Data were collected for 96 days, during 335 class periods. The results indicated that students were involved in physical education activity for an average of 34.63 minutes per day. The actual time for the physical education class was 45 minutes. Results also demonstrated that students were below the recommended 60 to 90 percent of heart rate training zone 61.72 percent or 21.4 minutes. Students were within their target heart rate zone 35.31 percent or 12.2 minutes and above their zone only 2.96 percent or 1.0 minute. Although 100 percent of the students exercised at the intensity level that raised their heart rates into their training zones, none of the students reached the training zone for the ASCM recommended duration (Strand et al., 1995). In only three of the activities (i.e., basketball, speedball and football) the students were able to attain heart rates necessary to develop cardiovascular fitness. Results of this study support the fact that children do not get adequate aerobic activity in physical education classes. The results also help explain why children are not as fit or healthy as physical education and other professionals think they should be.
In a study in Singapore (1995) to assess physical activity patterns of school children aged 9 - 10 years old through continuous all-day heart rate monitoring, the results showed that only 11.4% of the children experienced a daily 10-minute period of continuous activity at a heart rate of 140 bpm or above (Gilbey & Gilbey, 1995). Twenty percent of boys and fifty percent of girls never achieved a single 10-minute period of continuous activity with a heart rate above 140 bpm. Boys achieved more periods of moderate physical activity compared to girls. Lean girls were more active than obese girls. No differences in activity were detected on the weekend (Gilbey & Gilbey, 1995). The results indicated that Singapore school children(125,239),(944,869) rarely experienced the quality or quantity of physical activity needed for maintenance and development of health and cardiovascular fitness.

In summary, there are many reasons to use heart rate monitors as an assessment technique to measure physical activity of children. Researchers have indicated that heart rate monitors are a valid and reliable assessment technique to assess physical activity in children. The use of heart rate monitoring in physical education is increasing and many studies have been completed using the heart rate monitors. Heart rate monitors are not only a research tool in physical education, but also an educational tool to teach students fitness-based concepts.

Attitude and Knowledge about Physical Activity and Healthy Behaviors

Another assessment technique commonly used is surveys or questionnaires to determine physical activity or attitudes and knowledge about physical activity. Surveys in the form of questionnaires are currently the most widely used approach, especially in large-scale studies, to assess physical activity because of their convenience, low cost and
ability to characterize long-term behavior (Koo & Rohan, 1999). Most surveys and/or questionnaires attempt to measure mode, frequency, intensity, and duration of physical activity through recall of daily activities (Weston, Petosa & Pate, 1997). Other surveys intent to measure knowledge, attitudes and beliefs about physical activities and attempt to predict the exercise intent and behavior of children (Ferguson, Yesalis, Pomrehn & Kirkpatrick, 1989). This section of the review of literature will discuss the importance of developing positive attitudes and the relationship to physical activity, and factors that may influence attitudes and participation in physical activity.

**Attitude and the Relationship to Physical Activity**

Developing positive attitudes towards exercise and healthy behaviors may be established in childhood (Simons-Morton, O'Hara, Simons-Morton & Parcel, 1987). Trost et al., (1999) determined that there was a positive relationship between physical self-efficacy and objectively measured physical activity status in sixth grade African-American youth. Students who reported higher ratings of self-efficacy were more active in comparison to students who reported lower ratings of self-efficacy (Trost et al., 1999). Previous studies involving high school-aged adolescents have documented the positive relationship between self-efficacy and exercise behavior (Reynolds et al., 1990, Zakarian et al., 1994). Decrease in exercise behaviors may be related to a lack of enjoyable physical activity in adolescents or possibly negative experiences related to exercise (Ferguson, et al., 1989). In addition, a perceived barrier to physical activity may be lack of time, particularly in adolescence (Tappe, Duda & Menges-Ehrnwald, 1990).
Factors that Influence Attitudes About Physical Activity

Several factors may influence whether a child has a positive attitude towards physical activity and exercise. These factors relate to current exercise behavior and intent to exercise: beliefs about themselves such as perceived self-esteem, perceived athletic ability, and perceived ability to maintain commitments (Ferguson et al., 1989; Trost et al., 1996). According to Ferguson et al., (1989), students who had positive attitudes towards physical education were more likely to indicate that they planned to exercise in the future. In addition, promoting positive attitudes during physical education could influence intent to exercise, even for those students who do not exercise much outside of physical education class. Providing feedback to students regarding their fitness goals was also a positive way to convince them of the positive benefits of exercise. Self-esteem was another factor that suggested positive and significant correlations with the intent to exercise and current exercise behavior (Ferguson et al., 1989).

Perceived benefits from engaging in physical activity or being involved in sports is positively associated with increased physical activity among young people (Zakarian et al., 1994). These perceived benefits include excitement and having fun, learning and improving skills, staying in shape, improving appearance, and increasing fitness components such as strength, endurance and flexibility (Tappe et al., 1990).

Interpersonal and environmental factors may play a role in positively affecting physical activity among youth. Children and adolescents are more likely to participate if they have support from peers and parents (Biddle & Goudas, 1996; Reynolds et al., 1990; Zakarian et al., 1994). Physical activity among young people is also positively correlated

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with having access to convenient play space, sports equipment, and transportation to sports or fitness programs (Garcia et al., 1995).

In conclusion, early development of positive attitudes towards physical activity may play an important role in a child's future choice of lifestyle. Promoting positive attitudes could influence intent to exercise. In Ferguson et al.'s study (1989), students perceived exercise as beneficial, exhibited positive attitudes about physical education, had good self-esteem, and perceived themselves as able to maintain commitments were more likely to exercise in the future in comparison to those who did not exhibit such attitudes. Survey research may be a valuable assessment tool to determine attitudes towards physical activity and healthy behaviors. Programs that make attending physical education a pleasant experience and explain specific benefits of exercise can assist students in developing a more active lifestyle. Furthermore, to promote physical activity in our youth there needs to be a combined effort of schools, the community and parents to promote programs that enhance physical activity related knowledge, positive attitudes and healthy behaviors.

Sex and Participation in Physical Activity

Sex and participation in physical activity or sports has been a topic of major interest. This section of the review of literature will discuss the relationship between sex in regards to children and adolescents and their participation in physical activity. Sex differences in children will be addressed in these areas: participation in physical activity, learning motor skills, play and play preferences, motivation to participate, and factors that may influence participation in physical activity.
The review of literature reveals that boys tend to be more physically active in comparison to girls (Brustad, 1996; McKenzie, 1997; Thorne, 1993; Trost et al., 1996). McKenzie (1997) concluded that boys participate in moderate to vigorous physical activity 11 percent more often than girls. Moreover, boys receive 29 percent more prompts for physical activity than girls. Although several research studies indicate that boys tend to be more active than girls are, McKenzie's study (1997) was the first to observe the uneven number of prompts that encourage boys to participate in physical activity. Through self-disclosure documentation, boys indicated that they were more vigorously active than girls at each age group from 10 to 17 years (Schmidt et al., 1998). On the other hand, girls disclosed that they exercised at an easier pace in comparison to boys (Schmidt et al., 1998).

The rationale for sex differences in physical activity and play varies. One of the most suggested theories of differential treatment by gender differences is socialization (Garcia, 1994). The expectations for behavior based on sex start early in childhood. Studies indicated that gender identity was firmly established for both sexes by the time the child was around three years of age (Garcia, 1994). There were significant differences in gender identity for boys and girls. For males, issues of separation and individualization were critically tied to gender identity. Females tended to be more concerned with other's needs (Garcia, 1994).

Gender Differences in Learning Motor Skills

According to a study by Garcia (1994), there are differences in the way preschool children socially interact when learning motor skills. Girls demonstrated more instances of cooperative, caring, and sharing interactions. They were more concerned with...
connecting with others and helping each other than being successful at learning the specific motor skills. On the other hand, boys’ behavior was more competitive, individualized, and egocentric. Boys were more likely to strive to be better than each other. According to Garcia (1994), girls made more attempts to interact with boys. They would either invite the boys to chase them or they would chase the boys. The boys’ interactions with the girls were physically rough and aggressive, sometimes intimidating. Garcia’s observations suggested that some of the girls had difficulty in coping with the rough and aggressive behavior of the boys and they seemed scared or intimidated. Other girls seemed to accept or understand that this was the way boys acted or behaved. On other occasions, girls attempted to avoid conflict with boys by giving up equipment or moving out of the way (Garcia, 1994).

Girls may actually separate from boys to avoid being dominated (Thorne, 1993). In mixed pairs, girls tended to help the boys by giving them more trials and by complementing their efforts. In contrast, boys had to be reminded to give girls their turn, to throw balls in a controlled manner to the girls, and to stop yelling at the girls to get their equipment (Garcia, 1994). In conclusion, boys and girls interact and learn motor skills differently.

**Sex Differences in Play and Play Preference**

Watching children play has revealed sex differences in children (Lever, 1976). According to Thorne (1993), playgrounds are a heavily gendered place. Boys tend to control the large spaces designated for team sports such as basketball courts or softball/baseball diamonds. Girls tend to dominate areas such as jungle gyms, places for jumping rope, an area for four square, or places to play hopscotch. Observations revealed
that girls' areas of play were approximately one tenth the size of boys' areas and usually closer to the building (Sadker & Sadker, 1994; Thorne, 1993).

Research has continually contrasted the different cultures of boys and girls. Characteristics of a boys' world include: playing outdoors, participating in activities that require more space, forming male gangs or buddies, engaging in rougher play, acting on themes of physical strength and force, having a hierarchy of competitive social relationships with other males, and making and arguing about rules that are more likely to be broken than not (Thorne, 1993). In contrast, a girls' world includes: forming smaller groups, showing concern and intimacy for others, being less likely to play team sports, and being more likely to take turns and cooperate (Thorne, 1993). Sex differences were observed in boys' and girls' play preferences. Girls were found to engage in more pretense play than boys, and boys were found to engage in more physical play (Lindsey, Mize & Pettit, 1997). Gendered play may influence a child's socialization into the stereotypic sex roles (Mead & Ignico, 1992).

Differing Motivation for Participation in Physical Activity

Even motivation to participate in physical activity tends to differ between males and females. According to Welk (1999), boys tend to be more intrinsically motivated to participate in physical activities, in comparison to girls who tend to be more extrinsically motivated. Boys and girls may be motivated to participate in physical activity for different reasons. Boys may be more influenced to participate in physical activity due to self-efficacy, beliefs about activity, social influences, and involvement in community programs (Trost et al., 1999). In comparison, girls also tend to participate in physical activity because of self-efficacy and involvement in community programs, but also
because they enjoy physical activity. Boys may be more encouraged to participate in physical activities by the support and encouragement of friends and family. Girls on the other hand, will participate in physical activity if they enjoy it and there is parental modeling, especially by the mother for physical activity (Welk, 1999).

Factors that Influence Participation in Physical Activities

In a 1991 study, Eccles and Harold examined the roles of the parent and child belief system in relation to sex differences in sport involvement. The researchers revealed that children's perceptions of the value of their sport involvement in relationship to their parents was significantly related to the children's self-perceptions of their physical ability. In the same study, girls reported that their parents placed lower value on sports participation than the parents of boys (Brustad, 1996). This may predict a child's involvement to participate in physical activities or sports. Moore, Lombardi, White, Campbell, Oliveria, and Ellison (1991) revealed that children of active mothers, as measured by average Caltrac accelerometer counts per hour, were two times more likely to be active in comparison to children of inactive mothers. When both parents were active, the children were 5.8 times more likely to be active than children with inactive parents (Moore et al., 1991).

Jacobs and Eccles (1992) examined the mother's beliefs in relation to their 11 and 12 year old children's self-perceptions of ability in sports, mathematics, and social domains. This study revealed that mother's gender-related stereotypes did exist in relation to each of these achievement areas. The findings of this study led researchers to conclude that mothers' appraisals of their children's natural abilities in each achievement area was affected by their gender-role stereotype (Brustad, 1996). Thus, stereotyping of
children did have an effect on their participation in sports, which in turn, may affect their participation in all physical activities. According to a study by Mead and Ignico (1992), gender-labeling of activities may encourage participation based on sex. The results of the Physical Activity Stereotype Index revealed that there were different perceptions in regards to which activities were more appropriate for girls in comparison to boys. Boys were more likely to gender-label physical activities compared to girls (Mead et al., 1992).

Teacher and parental expectations of children may also influence a child's participation in physical activities. Teacher expectations on performance can affect aspiration levels of students. Klein (1989) observed that teachers had different expectations of boys in comparison to girls during participation in physical activity. Teachers tended to apply higher performance standards for physical activity for boys than for girls (Klein, 1989). In addition, observations in an elementary physical education class revealed that girls tended to be left out of game interactions even when they were more highly skilled than boys (Klein, 1989). According to Sadker and Sadker (1994), parents may be placing children in stereotypic roles by their actions. For example, fathers are more likely to protect their daughters and compliment them on their appearance. On the other hand, fathers are more likely to play roughly with their sons, and encourage them to participate in sports or physical activities (Colley, Griffiths, Hugh, Landers & Jaggli, 1996). Sex roles are explored, learned, and reinforced by parents, teachers and even peers.

In conclusion, the review of literature supports the theory that males are more physically active in comparison to females. Males and females tend to display different behaviors when learning motor skills, in play activities, and also in play preference. In
addition, boys and girls are motivated for different reasons to participate in physical activity. Several factors such as parental modeling and support, and teacher expectations may influence a child's level of participation in physical activity and sports.
CHAPTER III
METHODOLOGY

The purpose of the study was to assess the caloric expenditure of students in middle school physical education classes to determine if they were burning a sufficient amount of calories during physical education to meet the optimal health recommendations. According to the Surgeon General's Report (U.S. Department of Health and Human Services, 1996) and research by Paffenbarger and colleagues (1994, 1986), it is recommended that all people including children need to expend a minimum of 150 calories in daily physical activity. Specifically, this investigation was designed to collect data to answer the following questions:

1. Is there a difference between the caloric expenditure in the various physical activities taught in middle school physical education classes?

2. What is the relationship between heart rate and caloric expenditure of students in middle school physical education classes?

3. Are there sex differences in caloric expenditure during middle school physical education classes?

4. Is there a difference in students' fitness levels and caloric expenditure in physical education classes?

5. What are middle school students' attitudes and knowledge about physical activity and healthy behaviors?
This chapter contains the description of the sample, of the instruments, and of the methods used to collect and analyze the data.

Selection of the Study Sample

The sample was 56 students in two middle school physical education classes taught by the same instructor. The first class participating in the study was a 7th grade girls' class of 28 students. The second class was a 6th grade co-education class consisting of 30 students (11 boys and 19 girls). Two parents returned the form and indicated that they did not want their child to participate in the study.

The age range of the participants was 11 to 14 years. The researcher contacted the principal and the physical education teacher, and both consented to participate in the research project. Passive consent was used to acquire participants for the study. Letters were sent out to parents informing them that their child would be participating in the Caloric Expenditure Study in physical education for the next few months. Parents who did not want their children to participate in the study were asked to send back the form attached to the letter which stated they did not want their child to participate in the Caloric Expenditure Study. The parent and child needed to sign the form and return it to the physical education teacher prior to the study.

The research took place over a ten-week period. Data for the study were collected over 19 days or 38 total class periods. The first day of the research was used to collect height, weight, age, and sex of the subjects that participated in the study. The Caltrac and heart rate monitors were used to collect data for 18 days of the study.
Description of the Instruments

The researcher utilized three different instruments in the study in an attempt to examine a variety of variables. The Caltrac was used to determine the total amount of calories and more specifically activity calories burned during participation in physical education class. The students also wore heart rate monitors to determine their heart rate response during physical activity and to determine if there was a relationship between heart rate and calories burned during activity. The survey instrument was designed by the researcher to examine the middle school students' attitudes and knowledge about physical activity and healthy behaviors.

Caltrac

The Caltrac is an electronic accelerometer that is about the size and weight of a pocket calculator. It is used as an activity monitor that assesses both the quantity and intensity of movement in the vertical plane (Sallis et al., 1989). During movement, the accelerometer detects motion and sends an electrical signal to the microprocessor. The microprocessor translates the signal into a display of calories burned. As the intensity of the motion increases, the accelerometer bends more reflecting the faster rate of calories burned (Muscle Dynamic Fitness Network, 1998).

To individually program the Caltrac for each student, information such as age, sex, height and weight was obtained prior to data collection. For this study, the Caltrac measured the total number of calories burned and also the number of calories burned during physical activity. The total calories burned represents the calories burned based upon the student's basal metabolic rate in conjunction with the calories they expended.
during physical activity. The calories burned during activity reflected the total number of calories a student expended during their participation in physical activity.

**Heart Rate Monitor**

The heart rate monitor consists of a transmitter, wrist monitor or watch, and a computer interface. The transmitter is put on by the student and worn around the chest. The transmitter sends a signal to the wrist monitor indicating the number of heartbeats per minute with electrocardiogram accuracy. The Polar Vantage XL heart rate monitor does the following: gives the students optimal exercise intensity through HI/LO visual alarms; records the total exercise time in, above, or below the target heart rate zone; and computes and displays average heart rate for an entire workout or class period. The IBM compatible computer interface allows for downloading the heart rate information stored in the watch onto the computer. The computer interface allows individualized heart rate printouts for each student for safety and evaluation of the class or individual activity. Printouts provide hard copy data of the minute-by-minute analysis of the physical education class (Kirkpatrick et al., 1997). In addition to the Caltrac, heart rate monitors were used during the study to obtain heart rate information. The teacher had been using heart rate monitors in the physical education class, therefore they were used according to the teacher's directions. Since students were used to wearing the heart rate monitors in class, facilitating use of the Caltrac in conjunction with the heart rate monitors was not difficult.

For the study, the following data were collected from the heart rate monitors: the total time a student spent in activity (activity time), the student's average heart rate
during the class period, the student’s heart rate above, in, and, below the target heart rate zone, and the student’s maximum heart rate.

**Survey Instrument**

A survey instrument (see Appendix A) was designed by the researcher to determine the student’s attitude and knowledge of physical activity and healthy behaviors. The survey was constructed by using several examples of existing surveys and modifying them for the purpose of this study (Corbin, Nielson, Bordorf & Laurie, 1987; Shaw & Wright, 1967). In responding to the survey questions, students were asked to circle the appropriate letters (SD, D, U, A, or SA) that described whether they strongly disagreed, disagreed, were uncertain, agreed, or strongly agreed most of the time with statements about their attitudes toward physical activity and their knowledge about healthy behaviors. The students were told that there was not a right or wrong way to answer the survey questions. The students were also given examples of what may be defined as physical activities. Some examples included individual activities, team sports, badminton, and basketball. Healthy behaviors were defined as those actions that help maintain a person’s well being.

**Piloting the Survey Instrument**

The researcher designed the survey instrument. Some of the questions were similar to a scale called Feelings Towards Physical Activity (Corbin et al., 1987). Initially, 15 attitude questions and 13 knowledge questions were part of the survey. The survey was then pilot tested. The 28-item survey was given to two physical education classes not participating in the research study. The physical education teacher was also given the survey and asked for input or suggestions regarding the readability and
appropriateness of the survey for the age level. From the pilot survey, an item analysis was completed to determine what questions were appropriate for the final draft of the survey. Four items were removed from the original survey; therefore the final survey contained 24 questions (13 attitude and 11 knowledge). The reliability coefficient of the survey was .86 for the items on the survey that represented attitude, and .72 for items that represented knowledge.

Key for the Survey

A key for the survey (See Appendix A) was developed by the researcher to determine the attitudes and knowledge about physical activity and healthy behaviors of the students participating in the study. The questions reflecting the student's attitude were numbered one, two, three, four, five, six, seven, eight, nine, 17, 21, 22, and 23 on the survey. The questions to determine the students' knowledge were numbered 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, and 24. Positive attitude questions (1, 4, 5, 9, 17, and 22) were scored with one point if the student strongly disagreed, two points if they disagreed, three points if they were uncertain, four points if they agreed and five points if they strongly agreed with the statement. Positive responses to these statements indicated that students have a positive attitude or good feelings toward physical activity. Negative attitude questions (2, 3, 6, 7, 8, 21, and 23) were scored with five points if they strongly disagreed to one point if they strongly agreed. Negative responses to these statements indicated that students may have negative thoughts or feelings toward physical activity. The positive knowledge questions (10, 11, 13, 15, 16, 18, 19, 20 and 24) were scored with one point if they strongly disagreed to five points if the student strongly agreed. Positive responses to these statements indicated that students' have more knowledge.
about physical activity and healthy behaviors. The negative knowledge questions (12 and 14) were scored with five points if they strongly disagreed to one point if they strongly agreed. Negative responses to these questions indicated that students have limited knowledge about physical activity and healthy behaviors.

Students were then scored on their attitude about physical activity and knowledge of healthy behaviors. It was decided by the researcher that a score between 59 and 65 points indicated a very favorable attitude about physical activity. A score of 46 to 58 points indicated that students had favorable feelings towards physical activity. A score of 33 to 45 points suggested that students had neutral or uncertain feelings about physical activity. A score of 20 to 32 points implied that students had unfavorable feelings towards physical activity, and if they scored below 20 points on the survey it indicated that they had very unfavorable feelings towards physical activity. Students that were very knowledgeable about physical activity and healthy behaviors scored in the range of 50 to 59 points. Students who were knowledgeable scored between 39 and 49 points. A score of 28 to 38 reflected a neutral knowledge about physical activity and healthy behaviors. A score of 17 to 27 suggested that students had very little knowledge about physical activity and healthy behaviors. Students with a score below 17 points were termed as not knowledgeable about physical activity and healthy behaviors.

Collection of Data

Data were collected by using 14 Caltrac units and 14 heart rate monitors. Students were divided into two groups and participated almost every other day in the research study. A local university loaned 10 Caltracs to the researcher. Other teachers in the public school district loaned the other four Caltracs to the researcher. Prior to data
collection, personal information such as height, weight, age, and sex was obtained to program or set the Caltrac unit. Ten heart rate monitors were loaned from a local university and four heart rate monitors from the public school in which the study was implemented. In conjunction with the Caltrac, numbered Polar Vantage XL Heart Rate Monitors were distributed by the researcher and put on by the students' prior to the beginning of each class period.

Caltrac Data Collection

When the Caltrac was in the user data mode, the researcher entered the student's personal data. To measure the calories expended by a student, weight, height, age, and gender were entered into the student's assigned Caltrac unit. For this research study, the Caltrac was set at CALS USED/ACTM, which displayed information about the calories used during physical activity. ACTM on the Caltrac was an acronym for activity mode. Three different modes were used on the Caltrac depending upon the activity done during the physical education class. The Pedal Mode (bicycle symbol on the display) was used during bicycling, weightlifting with short rest periods (less than a minute and a half), rowing, and using a stair climber. The weightlifting mode represented by the barbell on the display was used for weightlifting with rest periods of 1.5 minutes or more. Most class periods used the third setting (i.e. the normal setting) where the Caltrac measures calories burned by doing full body exercises such as walking, jogging, running, and playing various physical education games or other activities (Muscle Dynamic Fitness Network, 1998).

The Caltrac was placed on the waist of the student by clipping it to their shorts in the correct horizontal position. Each Caltrac unit was numbered and pre-set for each of
the students who participated in the study. Upon entering the class, the students picked up a numbered Caltrac that had been individually set by the researcher for that student. The students then clipped the units onto their shorts. The students participated in their regular physical education activity for the class period. At the end of the class, the researcher collected the Caltrac units and recorded the total number of calories burned and the total number of activity calories burned on a pre-designed chart by the student's name. The Caltracs were then re-set by the researcher for the next physical education class.

Heart Rate Monitor Data Collection

Participants in the research study also wore a heart rate monitor in conjunction with their Caltrac unit. The teacher used heart rate monitors in her physical education classes prior to the study so the students were used to wearing them. Students were required to wet down the transmitter and place it around their chest. The students then put on the wrist monitor or watch. The students were directed to come over to the researcher and the physical education teacher to start the watches and make sure the heart rate monitors were functioning properly. Students wearing the heart rate monitors were also required to wear a cloth wristband over the watch so they did not focus on their heart rate during class activity. The researcher and the teacher would periodically check the student's heart rate monitors and Caltracs during the class to determine if the equipment was functioning properly. At the end of the class, students placed their heart rate monitors (transmitters and watches) and Caltracs on the research cart before heading to the locker room. The researcher stopped the watches and set them for the next class. The researcher then recorded both the total calories and activity calories expended during the
class next to the student’s name on the designed chart. After leaving the middle school, the researcher downloaded the heart rate monitor watches by using the computer interface. In the computer program, file summary was brought up to determine how much time the students spent below, in, or above the 60 to 85 percent of maximum heart rate. The file summary and heart rate graph of the previous class was saved, printed, and filed for each student participating in the research study for the day. The class activity and date were also recorded on each student’s printout. Activity calories for each student were recorded by hand by the researcher on the bottom of the visual graph of the heart rate printout. The results of the printouts were analyzed and compared to the number of calories burned.

Fitness Testing Data Collection

In addition to the previously mentioned instruments, the researcher was provided with fitness testing information. The researcher calculated body mass index by taking the student’s weight in kilograms and dividing this number by the student’s height in meters squared. The body mass index provides an indication of the appropriateness of a student’s weight relative to their height (Leger & Lambert, 1988). The researcher recorded the students’ height and weight prior to the study. According to the Prudential FITNESSGRAM (CIAR, 1992), an appropriate range for 11 to 14 year old girls is 16.9 to 25, and 15.8 to 24.5 for 11 to 14 year old boys.

The physical education teacher had the students complete the PACER fitness test in the fall of the school year prior to the research study. PACER (Progressive Aerobic Cardiovascular Endurance Run) is a multistage fitness test adapted from the 20 meter shuttle run test published by Leger and Lambert (1982) and revised in 1988 (Leger,
Mercier, Gadoury & Lambert, 1988). The test is progressive from easy to more difficult. It is set to music and is a valid and fun alternative to the traditional distance runs to measure aerobic capacity. The objective of the test is to run as long as possible back and forth across a 20 meter distance at a specified pace which gets faster each minute. Usually the area is marked off by cones and students are required to run to each set of cones (20 meters) and touch the line before the beep in the music. Students must wait for the next beep to begin running the opposite direction. Students continue the test until they can no longer reach the line or cones before the beep has sounded. Students are allowed to try to catch up with the pace until he/she misses two beeps. The students are then instructed to go to a cool down area being careful not to interfere with other students still participating in the test. Students record the total number of laps, which indicates how many times a student completes the 20-meter distance. The tape contains 21 levels and is completed in 21 minutes (CIAR, 1992). An acceptable healthy fitness range for females ages 11 to 14 is nine to 44 laps, and for males 11 to 14 years is 23 to 80 laps.

In addition to the PACER test, students completed the push-up test with a partner. The students were required to perform a push-up to an elbow angle of 90 degrees. The teacher used a foam dice underneath the student to indicate how far they needed to bend their arms to complete a push-up. The student’s partner was to judge whether or not a student completed an acceptable push-up. The students’ attempted to complete as many push-ups as possible in one attempt. They then recorded the total number of push-ups on their fitness profile sheet. An acceptable healthy range for push-ups was seven to 15 for 11 to 14 year old girls, and eight to 30 for 11 to 14 year old boys.
Students also completed a sit-up test with a partner and recorded their own results on their fitness profile card. The students were required to complete as many sit-ups as possible within a one minute time period. The students needed to cross their arms across their chest and touch their elbows to their knees to perform a sit-up correctly.

A sit and reach test was completed in partners and the students recorded their results on their fitness profile card. This test was performed to determine flexibility of the hamstring muscles. The student removed his/her shoes and sat down with his/her legs straight out in front of him/her with his/her feet flat against the sit and reach box. The arms were straight and extended forward with one hand on top of the other and the palms down. The student reached directly forward along the scale four times and held the position of the fourth reach for at least one-second. The measuring apparatus was a twelve-inch high box with a slight overhang over the student’s feet. The measuring scale was on top of the box with the nine-inch mark even with the edge of the box nearest to the student. According to the Prudential FITNESSGRAM, standards for the healthy fitness zone (CIAR, 1992), girls ages 11 to 14 should have a minimum score of ten inches on the sit and reach test. Boys in the same age group should have a minimum score of eight inches on the sit and reach test.

Administration of the Survey Instrument

Towards the end of the study, time was set aside for the students to fill out the survey. At the end of a class period, the physical education teacher handed out the surveys to the students. Prior to completing the survey, students were asked to put their physical education number and their sex on the top right corner of the survey. The physical education code was a way to show which student filled out the survey. The
physical education teacher then read the directions of the survey to the students before they began responding to the questions. Students were provided with the survey and a pencil and were asked to complete the survey prior to leaving class. The researcher and the teacher collected the surveys at the end of the class period. Forty-nine students completed the survey.

Treatment of the Data

Descriptive and inferential statistical procedures were used to analyze the data to determine if there was a relationship between caloric expenditure and various physical education class activities, heart rate of students, sex of students, and fitness levels of students. In addition, the students’ perceptions and knowledge of physical activity and healthy behaviors were also statistically assessed. Statistical Program System Software (SPSS) for generating frequencies, descriptive statistics, analysis of variance, and correlation procedures was employed (SPSS, 1983).

To test research question number one, “Is there a difference between the caloric expenditure in the various physical activities taught in middle school physical education?” frequencies and percentages were calculated for caloric expenditure and the nine physical activities; a one-way ANOVA was performed to determine the differences between caloric expenditure and the various physical activities. The null hypothesis was as follows: There is no difference between caloric expenditure and the various physical activities taught in middle school physical education. An F value was calculated and interpreted for its probability under the terms of the null hypothesis.

To test research question number two, “What is the relationship between heart rate and caloric expenditure of students in middle school physical education?”
frequencies and percentages were calculated for heart rate and caloric expenditure; a two-tailed Pearson product-moment correlation test at the .01 level of significance was calculated to determine the degree of the relationship between heart rate and caloric expenditure.

To test question number three, "Is there a sex difference in caloric expenditure during middle school physical education classes?" frequencies and percentages were calculated for sex and caloric expenditure; a t-test which allows males and females to be compared on caloric expenditure was also calculated.

To test question number four, "Is there a difference between fitness levels and caloric expenditure in physical education classes?", frequencies and percentages were calculated for the pacer test, sit-ups, push-ups, pull-ups, sit and reach test, and caloric expenditure. In addition, the Pearson product-moment correlation procedure was utilized to examine the degree of the relationship between students' fitness levels and caloric expenditure.

To test question number five, "What are middle school students' attitudes and knowledge about physical activity and healthy behaviors?" frequencies and percentages were calculated for attitude and knowledge of the students who had taken the survey. A t-test was done to compare boys and girls on knowledge and attitude about physical activity and healthy behavior.

A description of the subjects and the data analysis are provided in Chapter IV and the results of the study. Each research question presented in Chapter I is answered using descriptive narration and illustrations as appropriate. Conclusions and recommendations are presented in Chapter V.
CHAPTER IV
PRESENTATION OF THE DATA

The purpose of this study was to analyze caloric expenditure of students in middle school physical education classes to determine if they were burning an adequate amount of calories to meet the daily recommendations for optimal health benefits. According to the Surgeon General’s Report (U.S. Department of Health and Human Services, 1996), and research by Paffenbarger and colleagues (1994, 1986) it is recommended that all people including children need to expend a minimum of 150 calories in daily physical activity. Specifically, this study was designed to collect data and answer the following questions:

1. Is there a difference between the caloric expenditure in the various physical activities taught in middle school physical education classes?

2. What is the relationship between heart rate and caloric expenditure of students in middle school physical education classes?

3. Are there sex differences in caloric expenditure during middle school physical education classes?

4. Is there a difference in students’ fitness levels and caloric expenditure in physical education classes?

5. What are middle school students’ attitudes and knowledge about physical activity and healthy behaviors?
This chapter includes a description of the demographic characteristics of the subjects; the percentage of time spent in the different physical activities and the results of the activities; results of the caloric expenditure during various physical activities; results of time in activity and mean heart rates; results of the mean heart rates and percentage of time spent above, in, and below the students' target heart rate zones; results of the mean heart rate and percentage of time spent above, in, and below the target heart rate during different physical activities; description of the results of the fitness tests; and description of the results of the survey. Through the above analysis the research questions are answered.

Demographic Characteristics of the Subjects

A total of 56 subjects in two middle school physical education classes participated in the study. Forty-five (81.7%) of the subjects were girls and eleven (18.3%) of the subjects were boys. The age range of the subjects was 11 to 14 years. There were eleven (20%) subjects who were eleven years old; twenty-four (44.5%) students who were twelve years old; nineteen (33.2%) thirteen year olds; and two (4.4%) fourteen year olds. The average age of the subjects was 12.2 years. The middle school students' height ranged from 33 to 69 inches. The mean height of the students was 61.6 inches. The students' weight range was 40 to 178 pounds. On the average, these middle school students weighed 106.6 pounds. Although the subject size was 56 students, multiple observations were conducted. N represents the number of observations or occurrences.
Table 1

Demographic Characteristics of the Subjects

<table>
<thead>
<tr>
<th>Demographic categories</th>
<th>N</th>
<th>%</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>11</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>45</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td>12.2</td>
<td>.8</td>
</tr>
<tr>
<td>11 years</td>
<td>11</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 years</td>
<td>234</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 years</td>
<td>19</td>
<td>33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 years</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height</td>
<td></td>
<td></td>
<td>61.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Weight</td>
<td></td>
<td></td>
<td>106.6</td>
<td>23.0</td>
</tr>
</tbody>
</table>

Percentage of Time Spent in Class Activities and Description of the Activities

The students in the middle school physical education classes participated in nine different activities: basketball, omnikin, fitness testing, kick boxing, fitness circuit, broom ball, badminton, weight lifting, and soccer. The percentage of the class periods that were spent in these activities included: 26.0% in badminton, 22.4% in the fitness circuit, 12.5% in fitness testing, 11.3% in basketball and Omnkin, 6.7% in broom ball, 4.8% in soccer, 3.1% in kick boxing, and 1.8% in weight lifting.
The students were observed in the basketball unit for three days during the research study. Each day students warmed up with a fitness activity to music, which took about five to ten minutes. The fitness activity incorporated exercises such as running, sit-ups, push-ups and mountain climber exercises. The first two days the class worked on ball handling skills such as dribbling and shooting. Shooting drills took place at three baskets in the gymnasium. The students were instructed to do lay-ups, jump shots and free throws. The last day of the basketball unit consisted of skill practice, shooting, and half court basket ball games at each basket. There were approximately 10 students on two teams at each basket.

The students played Omnikin two days during the research study. The students began class with warm-up exercises which consisted of running, sit-ups and push-ups. Omnikin was a cooperative game where students were divided into approximately six to eight teams with no more than four students. They were required to wear a jersey color that matched their teammates. A large cage ball was required to play this game. One team of students set the ball. Setting the ball included all the teammates getting down on one knee and supporting the ball above their heads. The standing teammate served the ball with a two-hand hit and called out a color of another team. The team whose color was called tried to retrieve and set the ball before it touched the ground. The teams proceeded to set and serve the ball while calling out the different colors. The team serving scored a point only if the ball hit the ground.

The students completed their fitness testing one day during the research study. During the fitness testing, stations were set up to do the sit and reach, sit-ups, pull-ups,
push-ups and other fitness tests. Students worked with partners and recorded their results on their fitness profile cards handed out by the teacher. After students finished their fitness testing they had free time to play basketball. One group of approximately eight students chose to play a half court basketball game. Other students practiced basketball shooting. In the other class, all students chose to practice basketball shooting.

One class on one of the days of the research was exposed to kick boxing. A certified instructor from one of the local clubs came into one of the physical education classes to teach a sample kick boxing class. The instructor demonstrated some of the basic moves and then the students participated in an aerobic kick boxing class.

During the study, students also participated in a fitness circuit for four class periods. Stations were set up in a circle in the gymnasium. Students rode bike, jumped rope, and did various weight lifting exercises. Student switched stations every 20 seconds.

The middle school students also participated in a broom ball activity at a nearby ice rink. The students either walked or ran to the ice rink, which was approximately three blocks from the school. They were then divided into two teams of approximately 14 players to play broom ball. Broom ball was a game played with sticks that had a plastic end and a ball. This game was played similar to hockey, where the object of the game was to shoot the ball into the opponent's goal to score a point.

The students participated in the badminton unit for four days. The first two days consisted of instruction and then practice in partners or groups of four. The last two days the students elected to play in a round robin tournament or practice with a partner.
On the day the students were to complete the survey, they could choose between playing a game of soccer in the gym or lifting weights in the weight room. These activities were without the direction of the teacher. Students organized their own teams or went to the weight room on their own. The majority of the students played soccer. There were two teams of approximately 12 to 14 students. Only eight students in both classes elected to go to the weight room to lift weights. Students completed the survey at the end of this class period.

Table 2

Percentage of the Time Spent in the Different Physical Activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>N</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Badminton</td>
<td>99</td>
<td>26.0</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>78</td>
<td>22.4</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>42</td>
<td>12.5</td>
</tr>
<tr>
<td>Basketball</td>
<td>40</td>
<td>11.3</td>
</tr>
<tr>
<td>Omnikin</td>
<td>44</td>
<td>11.3</td>
</tr>
<tr>
<td>Broom Ball</td>
<td>24</td>
<td>4.8</td>
</tr>
<tr>
<td>Soccer</td>
<td>17</td>
<td>3.1</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>8</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Description of Caloric Expenditure During Various Physical Activities

The average calories burned during all the class activities was 71.1 and the mean calories burned per minute was 2.6. The average number of calories that the students burned during the various physical activities was as follows: broom ball, 120.5 calories;
basketball, 92.0 calories; kick boxing, 79.0 calories; badminton, 69.8 calories; fitness circuit, 65.9 calories; Omnikin, 61.1 calories; soccer, 60.3 calories, fitness testing 55.1 calories; and weight lifting, 36.8 calories.

Total calories accounted for the calories a student burned according to their basal metabolic rate in addition to the calories burned in physical activity. The average total calories expended during the class were 108.6 calories. The average total number of calories burned during the various activities were as follows: broom ball, 170.9 calories; basketball, 131.3 calories; kick boxing, 126.8 calories; badminton, 106.2 calories, Omnikin, 100.8 calories; soccer, 98.7 calories; fitness circuit, 96.5 calories; fitness testing, 94.7 calories; and weight lifting, 66.0 calories.

The average number of calories burned per minute of activity were as follows: broom ball, 3.7 calories; basketball, 3.8 calories; kick boxing, 2.3 calories; badminton, 2.4 calories, Omnikin, 2.1 calories; soccer, 2.0 calories; fitness circuit, 3.0 calories; fitness testing, 2.1 calories; and weight lifting, 1.5 calories.

Description of the Activity Time and Mean Heart Rates

The students spent an average of 27 minutes and 48 seconds in physical activity. The average heart rate during the class activities was 134 beats per minute. The mean maximum heart rate was 183 beats per minute. Students were above their target heart rate zone (more than 85 percent of their maximum heart rate) for an average of 55 seconds. During class activities, students mean heart rate in their zone (60 to 85 percent of their maximum heart rate) was eight minutes and twenty-four seconds. Students were below
Table 3

Description of Caloric Expenditure During the Different Physical Activities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Mean Activity Calories Burned</th>
<th>Mean Total Calories Burned</th>
<th>Mean Calories Burned Per Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom Ball</td>
<td>120.5</td>
<td>170.9</td>
<td>3.7</td>
</tr>
<tr>
<td>Basketball</td>
<td>92.0</td>
<td>131.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Kick Boxing</td>
<td>79.0</td>
<td>126.8</td>
<td>2.3</td>
</tr>
<tr>
<td>Badminton</td>
<td>69.8</td>
<td>106.2</td>
<td>2.4</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>65.9</td>
<td>96.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Omnikin</td>
<td>61.1</td>
<td>100.8</td>
<td>2.1</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>55.1</td>
<td>94.7</td>
<td>2.1</td>
</tr>
<tr>
<td>Soccer</td>
<td>60.3</td>
<td>98.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>36.8</td>
<td>66.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Table 4

Description of Activity Time and Mean Heart Rates

<table>
<thead>
<tr>
<th>Heart Rate (HR)</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average HR</td>
<td>369</td>
<td>134</td>
<td>18</td>
</tr>
<tr>
<td>Maximum HR</td>
<td>378</td>
<td>183</td>
<td>19</td>
</tr>
<tr>
<td>Time HR Above Zone *</td>
<td>377</td>
<td>:55</td>
<td>2:28</td>
</tr>
<tr>
<td>Time HR In Zone *</td>
<td>379</td>
<td>8:24</td>
<td>7:06</td>
</tr>
<tr>
<td>Time HR Below Zone *</td>
<td>377</td>
<td>18:05</td>
<td>9:21</td>
</tr>
<tr>
<td>Activity Time *</td>
<td>385</td>
<td>27:48</td>
<td>5:09</td>
</tr>
</tbody>
</table>

* Time in Minutes
their target heart rate zone (under 60 percent of their maximum heart rate) for an average of 18 minutes and five seconds.

Description of Mean Percentage of Time Above the Target Heart Rate Zone During Different Physical Activities

Students' average time and percentage of time spent above their target heart rate zone (85 percent or above maximum heart rate) in these activities were as follows: broom ball, 78.8 seconds or four percent of time; basketball, 87.7 seconds or six percent of time; kick boxing, 102.3 seconds or five percent of time; fitness circuit 63.0 seconds or five percent of time; Omnikin, 48.3 seconds or three percent; fitness testing, 35.3 seconds or five percent of time; badminton, 35.1 seconds or two percent; weight lifting, 23.1 seconds or one percent; and soccer, 78.8 seconds or five percent. These percentages are presented in Table 5.

### Table 5

<table>
<thead>
<tr>
<th>Activity</th>
<th>N</th>
<th>% Above HR Zone</th>
<th>Mean Time *</th>
<th>SD *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom Ball</td>
<td>24</td>
<td>4</td>
<td>78.8</td>
<td>148.4</td>
</tr>
<tr>
<td>Basketball</td>
<td>43</td>
<td>6</td>
<td>87.7</td>
<td>116.0</td>
</tr>
<tr>
<td>Kick Boxing</td>
<td>11</td>
<td>5</td>
<td>102.3</td>
<td>150.6</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>85</td>
<td>5</td>
<td>63.0</td>
<td>186.0</td>
</tr>
<tr>
<td>Omnikin</td>
<td>36</td>
<td>3</td>
<td>48.3</td>
<td>130.9</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>45</td>
<td>2</td>
<td>35.3</td>
<td>90.4</td>
</tr>
<tr>
<td>Badminton</td>
<td>105</td>
<td>2</td>
<td>35.1</td>
<td>113.1</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>8</td>
<td>1</td>
<td>23.1</td>
<td>33.6</td>
</tr>
<tr>
<td>Soccer</td>
<td>20</td>
<td>5</td>
<td>78.8</td>
<td>149.4</td>
</tr>
</tbody>
</table>

* In seconds
two percent; badminton, 35.1 seconds or two percent; weight lifting, 23.1 seconds or one percent; and soccer 78.8 seconds or five percent.

Description of Percentage of Time in the Target Heart Rate Zone

During Various Physical Activities

Subjects’ average time and percentage of time in their target heart rate zone (60 to 85 percent of maximum heart rate) in the following activities were as follows: broom ball, 919.8 seconds or 47 percent; basketball, 548.7 seconds or 36 percent; kick boxing, 726.8 seconds or 35 percent; fitness circuit 528.4 seconds or 39 percent; Omnikin, 423.2 seconds or 25 percent; fitness testing, 301.0 seconds or 19 percent; badmington, 459.3 seconds or 27 percent; weight lifting, 118.1 seconds or six percent; and soccer 336.5 seconds or 20 percent of the time.

Description of Percentage of Time Below the Target Heart Rate Zone

During Various Physical Activities

Subjects’ average time and percentage of time spent below their target heart rate zone (below 60 percent of the maximum heart rate) in these activities were as follows: broom ball, 948.0 seconds or 49 percent of the time; basketball, 872.8 seconds or 58 percent of time; kick boxing, 1225.5 seconds or 60 percent of time; fitness circuit, 770.9 seconds or 56 percent of the time; Omnikin, 1196.0 seconds or 72 percent of the time; fitness testing, 1282.3 seconds or 79 percent of the time; badminton, 1228.3 seconds or 71 percent of the time; weight lifting, 1711.9 seconds or 93 percent of the time; and soccer 1271.2 seconds or 75 percent of the time.
Table 6

Mean Heart Rates and Percentage of Time In the Target Heart Rate Zone during Different Class Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>N</th>
<th>% Time In Zone</th>
<th>Mean Time *</th>
<th>SD *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom Ball</td>
<td>25</td>
<td>47</td>
<td>919.8</td>
<td>551.9</td>
</tr>
<tr>
<td>Basketball</td>
<td>43</td>
<td>36</td>
<td>548.7</td>
<td>269.5</td>
</tr>
<tr>
<td>Kick Boxing</td>
<td>11</td>
<td>35</td>
<td>726.8</td>
<td>379.9</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>85</td>
<td>39</td>
<td>528.4</td>
<td>273.1</td>
</tr>
<tr>
<td>Omnikin</td>
<td>37</td>
<td>25</td>
<td>423.3</td>
<td>390.0</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>45</td>
<td>19</td>
<td>301.0</td>
<td>337.7</td>
</tr>
<tr>
<td>Badminton</td>
<td>105</td>
<td>27</td>
<td>459.3</td>
<td>452.2</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>8</td>
<td>6</td>
<td>118.1</td>
<td>139.7</td>
</tr>
<tr>
<td>Soccer</td>
<td>20</td>
<td>20</td>
<td>336.5</td>
<td>336.5</td>
</tr>
</tbody>
</table>

* In seconds

Description of Results of the Physical Fitness Tests

The students completed these fitness tests: PACER, push-ups, sit-ups, and sit and reach. The researcher calculated body mass index. The mean body mass index for students was 19.4 with a standard deviation of 3.1. The mean score on the PACER test was 19.2 lengths with a standard deviation of 12.6. The average number of push-ups done by the students was 21.7 with a standard deviation of 13.2. The mean number of sit-ups performed by the students was 44.0 with a standard deviation of 15.8. The
students' average score was 25.3 inches on the sit and reach flexibility test with a standard deviation of 10.8 inches.

Table 7
Mean and Percentage of Time Below the Target Heart Rate Zone during Different Class Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>N</th>
<th>% Time Below Zone</th>
<th>Mean Time *</th>
<th>SD *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom Ball</td>
<td>25</td>
<td>49</td>
<td>948.0</td>
<td>674.1</td>
</tr>
<tr>
<td>Basketball</td>
<td>43</td>
<td>58</td>
<td>872.8</td>
<td>365.8</td>
</tr>
<tr>
<td>Kick Boxing</td>
<td>10</td>
<td>60</td>
<td>1225.5</td>
<td>374.2</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>84</td>
<td>56</td>
<td>770.9</td>
<td>367.1</td>
</tr>
<tr>
<td>Omnikin</td>
<td>37</td>
<td>72</td>
<td>1196.0</td>
<td>513.9</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>45</td>
<td>79</td>
<td>1282.3</td>
<td>403.1</td>
</tr>
<tr>
<td>Badminton</td>
<td>105</td>
<td>71</td>
<td>1228.3</td>
<td>533.0</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>8</td>
<td>93</td>
<td>1711.9</td>
<td>348.2</td>
</tr>
<tr>
<td>Soccer</td>
<td>20</td>
<td>75</td>
<td>1271.3</td>
<td>390.7</td>
</tr>
</tbody>
</table>

* In seconds

Description of the Survey Results

Forty-nine (40 girls and 9 boys) of the 56 subjects in the study completed the survey.

The mean score for attitude was 46.4 with a standard deviation of 7.9. The mean attitude score for males was 44.6 with a standard deviation of 9.3. For females, the mean score was 46.8 with a standard deviation of 7.6. Males’ mean score for knowledge was 44.7 with a standard deviation of 7.2. Females’ mean score for knowledge was 43.4 with a standard deviation of 4.0.
Table 8

**Description Mean Results of the Fitness Tests**

<table>
<thead>
<tr>
<th>Fitness Tests</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index</td>
<td>409</td>
<td>19.4</td>
<td>3.1</td>
</tr>
<tr>
<td>Pacer</td>
<td>363</td>
<td>19.2</td>
<td>12.6</td>
</tr>
<tr>
<td>Push-ups</td>
<td>401</td>
<td>21.7</td>
<td>13.2</td>
</tr>
<tr>
<td>Sit-ups</td>
<td>378</td>
<td>44.0</td>
<td>15.8</td>
</tr>
<tr>
<td>Sit &amp; Reach</td>
<td>401</td>
<td>25.3</td>
<td>10.8</td>
</tr>
</tbody>
</table>

Table 9

**Description of the Survey Results**

<table>
<thead>
<tr>
<th>Categories</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td>49</td>
<td>46.4</td>
<td>7.9</td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>44.6</td>
<td>9.3</td>
</tr>
<tr>
<td>Female</td>
<td>40</td>
<td>46.8</td>
<td>7.6</td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>44.7</td>
<td>7.2</td>
</tr>
<tr>
<td>Female</td>
<td>40</td>
<td>43.4</td>
<td>4.0</td>
</tr>
</tbody>
</table>
Table 10

One-way ANOVA for Mean Calories Burned by the Various Physical Activities and Heart Rates In, and Below the Target Heart Rate Zone for the Various Activities

<table>
<thead>
<tr>
<th>Activity</th>
<th>Calories Burned</th>
<th>Total Calories Burned</th>
<th>HR Above Target HR Zone (seconds)</th>
<th>HR In Target HR Zone (seconds)</th>
<th>HR Below Target HR Zone (seconds)</th>
<th>Calories Burned Per Minute of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broom Ball</td>
<td>120.5</td>
<td>170.9</td>
<td>78.8</td>
<td>919.8</td>
<td>948.0</td>
<td>3.7</td>
</tr>
<tr>
<td>Basketball</td>
<td>92.0</td>
<td>131.3</td>
<td>87.7</td>
<td>548.7</td>
<td>872.8</td>
<td>3.8</td>
</tr>
<tr>
<td>Kick Boxing</td>
<td>79.0</td>
<td>126.8</td>
<td>102.3</td>
<td>726.8</td>
<td>1225.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Fitness Circuit</td>
<td>65.9</td>
<td>96.5</td>
<td>63.0</td>
<td>528.4</td>
<td>770.9</td>
<td>3.0</td>
</tr>
<tr>
<td>Omnikin</td>
<td>61.1</td>
<td>100.8</td>
<td>48.3</td>
<td>423.3</td>
<td>1196.0</td>
<td>2.1</td>
</tr>
<tr>
<td>Fitness Testing</td>
<td>55.1</td>
<td>94.7</td>
<td>35.3</td>
<td>301.0</td>
<td>1282.3</td>
<td>2.1</td>
</tr>
<tr>
<td>Badminton</td>
<td>69.8</td>
<td>106.2</td>
<td>35.1</td>
<td>459.3</td>
<td>1228.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Weight Lifting</td>
<td>36.8</td>
<td>66.0</td>
<td>23.1</td>
<td>118.1</td>
<td>1711.9</td>
<td>1.5</td>
</tr>
<tr>
<td>Soccer</td>
<td>60.3</td>
<td>98.7</td>
<td>78.8</td>
<td>469.5</td>
<td>1271.3</td>
<td>2.0</td>
</tr>
<tr>
<td>F Ratio</td>
<td>22.1</td>
<td>24.1</td>
<td>1.1</td>
<td>7.5</td>
<td>11.1</td>
<td>19.6</td>
</tr>
</tbody>
</table>

*p < .001 < .001 < .346 < .001 < .001 < .001
Caloric Expenditure and Heart Rates In and Below the Target Heart Rate Zone During the Different Physical Activities

Research Question Number One

Research question number one asked if there were differences between caloric expenditure in the various physical activities taught in middle school physical education classes and was tested by using the SPSS procedures for one-way analysis of variance (ANOVA) and Tukey's multiple comparisons. Tukey's Test was done for multiple comparisons to determine where there were comparisons in the means of calories burned, total calories burned, heart rates in, and below the target heart rate zone and the different physical activities. Table 10 displays the results of the analysis of variance for the six variables.

In summary, there were significant differences on five different comparisons among the nine different physical activities and calories burned, total calories burned, heart rates in and below the target heart rate zone, and the calories burned per minute of activity. The null hypotheses regarding differences between heart rates above the target heart rate zone and the nine physical activities were not rejected. No significant differences were found between heart rates above the target heart rate zone in the physical activities.

Multiple comparisons for the five significant variables are presented in Table 11. Students participating in the weight training activity burned the least amount of calories (36.8), total calories (65.6) and calories burned per minute of activity (1.5). Moreover,
students participating in weight training spent the most time below their target heart rate zone at 1711.9 seconds.

Table 11

**Multiple Comparisons of Calories Burned, Total Calories Burned, Heart Rates In and Below the Target Heart Rate Zone, and Calories Burned Per Minute in the Different Physical Activities**

<table>
<thead>
<tr>
<th>Multiple Comparison of Activities</th>
<th>Calories Burned</th>
<th>Total Calories Burned</th>
<th>HR In Target HR Zone (seconds)</th>
<th>HR Below Target HR Zone * (seconds)</th>
<th>Calories Burned Per Minute of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>3, 9, 2</td>
<td>3, 5, 9, 2</td>
<td>3</td>
<td>2, 4, 7, 9, 3</td>
<td>9, 3, 2</td>
</tr>
<tr>
<td></td>
<td>5, 7</td>
<td>7</td>
<td>2, 7, 9, 5, 1</td>
<td>5, 1, 6</td>
<td>4, 7,</td>
</tr>
<tr>
<td></td>
<td>4, 1</td>
<td>4, 1</td>
<td>4, 6</td>
<td>5, 6, 1</td>
<td></td>
</tr>
<tr>
<td>Highest</td>
<td>6</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Reversed, highest to lowest

This was the code for the following activities: basketball (1), Omnikin (2), fitness testing (3), kick boxing (4), fitness testing (5), broom ball (6), badminton (7), weight lifting (8), and soccer (9).

On the other hand, students participating in the broom ball activity burned the largest amount of activity calories (120.5), total calories (170.9) and had the second highest amount of calories burned per minute of activity (3.7). Only basketball burned more calories per minute of activity (3.8). In addition, broom ball was one of the three activities in which students spent the least amount of time below their target heart rate zone. Students burned the second highest amount of activity calories, and total calories in kick boxing (79.0 & 126.8) and basketball (92.0 & 131.3). Therefore, students spent...
more time in their target heart rate zone in kick boxing (726.8 seconds) and basketball (548.7 seconds). The following activities were found to be in the middle between the lowest and highest values in regards to calories burned, total calories, heart rate in and below the target heart rate zone, and calories burned per minute of activity: Omnikin, fitness circuit, badminton, and soccer.

In summary, there were significant differences in caloric expenditure and the different physical activities. Based on Tukey's Test for multiple comparisons, there were differences found among the various activities and the calories burned, total calories burned, and heart rates in and below the target heart rate zone. Moreover, comparisons indicated that there were differences in the calories burned each minute and the various activities.

Research Question Number Two

Research question number two asked if there was a relationship between heart rate and caloric expenditure of students in middle school physical education classes. To test for the relationship between heart rate and caloric expenditure, Pearson product-moment correlations were calculated. The correlations between heart rate and the variables of average heart rate, heart rate above the target heart rate zone, heart rate in the target heart rate zone, heart rate below the target heart rate zone and maximum heart rate and caloric expenditure variables of calories burned, total calories burned and calories burned and time in activity are summarized in Table 12. In summary, there were positive correlations between calories burned and average heart rate, calories burned and heart rates above and in the target heart rate zone, calories burned and maximum heart rate and
an inverse relationship or negative correlation between calories burned and heart rates below the target heart rate zone. Moreover, there were positive correlations between total calories burned and average heart rate, total calories burned and heart rates above and in the target heart rate zone, total calories burned and maximum heart rate and an inverse relationship or negative correlation between total calories burned and heart rates below the target heart rate zone. There were also positive correlations between the calories burned per minute of activity and average heart rate, calories burned per minute of activity and heart rates above and in the target heart rate zone, and calories burned per minute of activity and maximum heart rate. Again, there was a negative correlation or inverse relationship between calories burned per minute of activity and heart rates below the target heart rate zone.

Table 12

<table>
<thead>
<tr>
<th>Heart Rate Variable (HR)</th>
<th>Calories Burned</th>
<th>Total Calories Burned</th>
<th>Calories Burned and Time in Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average HR</td>
<td>.490 *</td>
<td>.424 *</td>
<td>.537 *</td>
</tr>
<tr>
<td>HR Above Zone</td>
<td>.211 *</td>
<td>.194*</td>
<td>.156 *</td>
</tr>
<tr>
<td>HR In Zone</td>
<td>.436 *</td>
<td>.392 *</td>
<td>.381 *</td>
</tr>
<tr>
<td>HR Below Zone</td>
<td>-.327 *</td>
<td>-.243 *</td>
<td>-.523 *</td>
</tr>
<tr>
<td>Maximum HR</td>
<td>.215 *</td>
<td>.211 *</td>
<td>.185 *</td>
</tr>
</tbody>
</table>

* Significant beyond the .001

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Research Question Number Three

Question number three asked whether there were sex differences in caloric expenditure measured as the three variables of calories burned, total calories burned, and calories burned and time in activity in middle school physical education. To test for differences, t-values, means, and standard deviations were calculated for males and females. The mean activity calories burned for males were 79.8 with a standard deviation of 30.1 calories, in comparison to females who burned an average of 69.1 calories with a standard deviation of 29.1 calories. The t-test was 2.72 with a $p = <.007$; therefore the null hypothesis was rejected. There were differences between the calories burned by males in comparison to females. The mean total calories burned were 121.8 for males with a standard deviation of 38.6 calories. The mean total calories burned were 105.6 with a standard deviation of 33.5 calories. The t-test was 3.5 with a $p = <.001$; therefore the null hypothesis was rejected. There were differences between the total calories burned by males in comparison to females. The mean calories burned per minute of activity were 2.9 calories with a standard deviation of 1.0 calories for males and 2.6 calories for females with a standard deviation of 1.1 calories. The t-test was 1.61 with a $p = .108$; therefore the null hypothesis was accepted. There were no differences between the calories burned per minute of activity and the sex variable. In summary, the t-test revealed that calories and total calories burned were significantly different for males in comparison to females with males burning approximately 10 more activities calories and 16 more total calories than girls.
Table 13

Means, Standard Deviations, and T-values for Caloric Expenditure Variables by Sex

<table>
<thead>
<tr>
<th>Calories</th>
<th>Male Mean</th>
<th>SD</th>
<th>Female Mean</th>
<th>SD</th>
<th>t-test</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories Burned</td>
<td>79.8</td>
<td>30.1</td>
<td>69.1</td>
<td>29.2</td>
<td>2.72</td>
<td>.007 *</td>
</tr>
<tr>
<td>Total Calories Burned</td>
<td>121.8</td>
<td>38.6</td>
<td>105.6</td>
<td>33.5</td>
<td>3.50</td>
<td>.001 *</td>
</tr>
<tr>
<td>Calories Burned Per Minute of Activity</td>
<td>2.9</td>
<td>1.0</td>
<td>2.6</td>
<td>1.1</td>
<td>1.61</td>
<td>.108</td>
</tr>
</tbody>
</table>

* Significant beyond .01

Research Question Number Four

Research question number four asked if there was a relationship between students’ fitness levels and caloric expenditure variables of calories burned, total calories burned, and calories burned per minute of activity in physical education classes. To test for the relationship between students’ fitness level assessed by fitness testing and caloric expenditure Pearson product-moment correlations were calculated. The correlations between students’ fitness levels and caloric expenditure are summarized in Table 14. In summary, there were significant positive correlations between a student’s body mass index and calories burned, total calories burned, and calories burned per minute.
Table 14

Correlations Between the Fitness Testing Variable and Caloric Expenditure Variable

<table>
<thead>
<tr>
<th>Fitness Tests</th>
<th>Calories Burned</th>
<th>Total Calories Burned</th>
<th>Calories Burned Per Minute of Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body Mass Index</td>
<td>.365*</td>
<td>.415*</td>
<td>.366*</td>
</tr>
<tr>
<td>Pacer</td>
<td>.027</td>
<td>-.005</td>
<td>-.003</td>
</tr>
<tr>
<td>Push-ups</td>
<td>-.005</td>
<td>-.035</td>
<td>-.038</td>
</tr>
<tr>
<td>Sit-ups</td>
<td>.047</td>
<td>.036</td>
<td>.007</td>
</tr>
<tr>
<td>Sit &amp; Reach</td>
<td>.019</td>
<td>.057</td>
<td>.038</td>
</tr>
</tbody>
</table>

* Significant beyond the .001

Research Question Number Five

Research question number five asked what are the students’ attitudes and knowledge about physical activity and healthy behaviors. To determine the students’ attitudes and knowledge about physical activity and healthy behaviors, the survey instrument was utilized. The questions that reflected a student’s attitude were numbered one, two, three, four, five, six, seven, eight, nine, 17, 21, 22, and 23 on the survey. A score between 59 and 65 points indicated a very favorable attitude towards physical activity. A score of 46 to 58 points indicated that students had favorable attitudes towards physical activity. A score between 33 to 45 suggested that students had a neutral or uncertain attitude about physical activity. A score of 20 to 32 points implied that a student had unfavorable attitude towards physical activity, and if they scored below 20 points on the survey it indicated that they had very unfavorable attitude towards physical activity.
activity. Table 15 represents the mean percentage of attitude scores from the survey. There were two students or four percent who scored between 59 and 65 points, which indicated that they had a very favorable attitude towards physical activity. Twenty-eight or 57 percent of students scored between 46 to 58 points, which indicated that they had a favorable attitude towards physical activity. Fifteen students or 31 percent scored between 33 and 45 points, which suggested that they had neutral or uncertain attitude about physical activity. Four students or eight percent scored between 20 to 32 points, which indicated that they had unfavorable attitudes towards physical activity. There were no scores below 20 points. The mean score for attitude about physical activity was 46.4, which indicated that on the average students had favorable attitudes towards physical activity.

Table 15

Mean Percentage of Attitude Scores from the Survey

<table>
<thead>
<tr>
<th>Attitude Scores</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Favorable Attitude</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59 – 65 points</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Favorable Attitude</td>
<td>28</td>
<td>57</td>
</tr>
<tr>
<td>46 – 58 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Attitude</td>
<td>15</td>
<td>31</td>
</tr>
<tr>
<td>33 – 45 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfavorable Attitude</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>20 – 32 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Unfavorable Attitude</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Below 20 points</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The questions reflecting the students' knowledge were numbered 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, and 24. Students that were very knowledgeable about physical activity and healthy behaviors scored in the range of 50 to 59 points. Students who were knowledgeable scored between 39 and 49 points. A score of 28 to 38 points reflected a neutral knowledge about physical activity and healthy behaviors. A score of 17 to 27 suggested that students had very little knowledge about physical activity and healthy behaviors, and students who scored below 17 points were not knowledgeable about physical activity and healthy behaviors. Table 16 represents the mean percentage of knowledge scores from the survey. Three students or six percent scored 50 to 59 points, which indicated that they were very knowledgeable about physical activity and healthy behaviors.

Table 16

<table>
<thead>
<tr>
<th>Knowledge Scores</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Knowledgeable</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>50 - 59 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledgeable</td>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td>39 - 49 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral Knowledge</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>33 - 45 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very Little Knowledge</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>28 - 38 points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not Knowledgeable</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Below 28 points</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
behaviors. Forty students or 82 percent scored between 39 and 49 points, which indicated that they were knowledgeable about physical activity and healthy behaviors. Six students or 12 percent scored between 28 and 38 points, which suggested they had neutral knowledge about physical activity and healthy behaviors. There were no scores below 28 points. The mean score for knowledge about physical activity and healthy behaviors was 43.6, which suggested that students on the average were knowledgeable about physical activity and healthy behaviors.

To test for the relationship between age, attitude, and knowledge about physical activity and healthy behaviors Pearson product-moment correlation was calculated. To test for differences, t-values, means and standard deviations were calculated for males and females. The correlations between attitude, knowledge, and age were summarized in Table 17. There were significant correlations between attitude and knowledge ($r = .389$)

Table 18 represents the mean score of attitude for males was 44.6 with a standard deviation of 9.3. The mean score of attitude for females was 46.8 with a standard deviation of 7.6. The t-test was -7.70 with a $p = < .445$; therefore, the null hypothesis

<table>
<thead>
<tr>
<th>Correlations Between Attitude, Knowledge, and Age About Physical Activity and Healthy Behaviors (N = 49)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>----------</td>
</tr>
<tr>
<td>Attitude</td>
</tr>
<tr>
<td>Age</td>
</tr>
</tbody>
</table>

* Significant beyond .001
was accepted. There were no differences between attitudes of physical activity and healthy behaviors and sex. The mean score of knowledge for males was 44.7 with a standard deviation of 7.2. The mean score of knowledge for females was 43.4 with a standard deviation of 4.0. The t-test was .726 with a $p = .472$; therefore the null hypothesis was accepted. There were no differences between knowledge of physical activity and healthy behaviors based on the gender variable.

In summary there was a correlation between knowledge and attitudes about physical activity and healthy behaviors. There was not a correlation based on age and knowledge and attitude of physical activity and healthy behaviors. There were no sex differences within knowledge, attitude and healthy behaviors.

Table 18

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male Mean</th>
<th>SD</th>
<th>Female Mean</th>
<th>SD</th>
<th>t-test</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td>44.6</td>
<td>9.3</td>
<td>46.8</td>
<td>7.6</td>
<td>-.770</td>
<td>.445</td>
</tr>
<tr>
<td>Knowledge</td>
<td>44.7</td>
<td>7.2</td>
<td>43.4</td>
<td>4.0</td>
<td>.726</td>
<td>.472</td>
</tr>
</tbody>
</table>

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CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

According to the recent Surgeon General's Report guidelines, all Americans including children need to burn a minimum of 150 calories in daily physical activity or approximately 1,000 calories a week to meet minimal healthy activity standards (U.S. Department of Health and Human Services, 1996). The purpose of this study was to assess the caloric expenditure of students in middle school physical education classes to determine if they were expending a sufficient amount of calories in physical education classes to meet these healthy activity recommendations. The following research questions were used to guide the study.

1. Is there a difference between the caloric expenditure in the various physical activities taught in middle school physical education classes?

2. What is the relationship between heart rate and caloric expenditure of students in middle school physical education classes?

3. Are there sex differences in caloric expenditure during middle school physical education classes?

4. Is there a difference in students' fitness levels and caloric expenditure in physical education classes?

5. What are middle school students' attitudes and knowledge about physical activity and healthy behaviors?
The subjects for the study consisted of 56 students (11 males and 45 females) in two middle school physical education classes taught by the same instructor. The age range of the subjects was 11 to 14 years. The research took place over a ten-week period. Data were collected over 19 days or 38 total class periods. Height, weight, age, and sex data was collected the first day of the research. These instruments were used to collect data: the Caltrac accelerometer, which measured calories burned, and total calories burned; the Vantage XL heart rate monitor, which measured average heart rates, maximum heart rates, heart rates above, in, and below the target heart rate zone; and a survey instrument designed to measure knowledge and attitude of physical activity and healthy behaviors. To answer the research questions, additional information such as the students’ fitness test results was obtained by collecting the students’ individual fitness profile cards. The results of this study provided answers to the previously stated research questions.

Summary

Research Question One

There were significant differences found among the nine different physical activities and the calories burned, total calories burned, calories burned per minute of activity, and heart rates in and below the target heart rate zone. There were no significant differences found between heart rates above the zone and the various physical activities. Based on Tukey’s test for multiple comparisons, there were differences found among the various activities and the calories burned, total calories, calories burned per minute of activity and heart rates in and below the zone.
Students participating in broom ball expended the largest amount of activity calories (120.5) and total calories (170.9), the second largest amount of calories burned per minute (3.7) and spent the most amount of time (919.8 seconds) in their target heart rate zone. Only in basketball did students burn more calories per minute of activity (3.8) and spent the least amount of time (872.8 seconds) below their target heart rate zone. In addition to broom ball and basketball, students participating in the fitness circuit spent the least amount of time below their target heart rate zone. Students expended the second and third highest amount of calories and total calories in basketball (92.0 & 131.3) and kick boxing (79.0 and 126.8). Therefore, in addition to broom ball, students spent more time in their target heart rate zone in kick boxing (726.8 seconds) and basketball (548.7 seconds). The following activities were found to be in the middle between the highest and lowest values in regards to calories burned, total calories burned, heart rate in and below the target heart rate zone, and calories burned per minute of activity: soccer, badminton, fitness circuit, and Omnikin. Students participating in weight training expended the least amount of calories (36.8), total calories (65.6), and calories burned per minute of activity (1.5). Furthermore, students participating in weight training spent the most time below their target heart rate zone at 1711.9 seconds.

The results of this study indicated that there were significant differences among the various physical activities are consistent with Strand and Reeder's (1993) findings. They found differences among various physical activities and the time students spent in their target heart rate zone. Heart rates in the students' target heart rate zone varied from 7.9 to 17.4 minutes among four different physical activities (Strand, et al., 1993). In
comparison to the research from this study, heart rates in the students’ target heart rate zone varied from approximately two to 15.3 minutes among nine different physical activities.

Research Question Two

There were positive correlations between calories burned and average heart rate, calories burned and heart rates above and in the target heart rate zone, calories burned and maximum heart rate, and a negative correlation or an inverse relationship between the calories burned and heart rates below the target heart rate zone. In addition, there were positive correlations between calories burned per minute of activity and average heart rate, calories burned per minute of activity and heart rates above and in the target heart rate zone, and calories burned per minute of activity and maximum heart rate. Again, there was a negative correlation or inverse relationship between calories burned per minute of activity and heart rates below the target heart rate zone.

Time in physical activity along with time spent in the target heart rate zone may indicate the amount of calories burned. In this research study, a 50 minute class period had an average of 27 minutes and 50 seconds in physical activity, in comparison to a study done by Strand and Reeder (1993) which indicated students were involved in physical activity for an average of 34.63 minutes a day. In addition, students spent between 49 and 93 percent of time below their target heart rate zone in the various physical activities, which is consistent with Stand and Reeder’s (1994) findings of 62 percent of time is spent below their target heart rate zone. The results of this study indicate that time in activity increases the amount of calories burned.
In agreement with Coleman's study in 1997, this research indicates that there was a significant correlation between heart rate and caloric expenditure. Students who increase their average heart rate, maximum heart rate, and time spent in their target heart rate zone would burn more calories during activity. The heart rate monitors can provide an indication of calories burned due to the intensity of the activity. A parallel finding of this study indicates that there was an inverse relationship between calories burned and heart rate below the zone. If students are spending a significant amount of time below their target heart rate zone they would burn less calories.

**Research Question Three**

The results indicated that there were significant differences in calories burned and total calories burned between males (79.8 and 121.8) and females (69.1 and 105.6) with males expending more calories than females. The calories burned per minute of physical activity were not significantly different for males (2.9) in comparison to females (2.6). The review of literature suggests that males are more active than females (Brustad, 1996; Garcia, 1994; McKenzie, 1997; Thorne, 1993; & Trost, 1996). Although this may be demonstrated statistically, other factors may affect the participation of females in physical education. According to McKenzie (1997), boys receive 29 percent more prompts for physical activity than girls. This unequal number of prompts may encourage boys to participate while discouraging girls to participate. Moreover, the research by Welk (1999) and Jacobs and Eccles (1992) have indicated that parents, especially mothers, have a significant influence on activity levels of children. The research indicates that children are more likely to participate if parents show interest and
encourage their children to be active (Eccles, et al., 1991, Jacobs, et al., 1992, & Welk, 1999). Children are more likely to participate in physical activity if they have access to programs, and the equipment needed to participate (Welk, 1999).

It may be interesting to know why, and in what particular activities there is the most difference in caloric expenditure. It may be fair to conclude that because males expend more calories during physical activities, the charts that define caloric consumption for males and females should differ not by age, but by sex. Because males are more active, they can consume more calories to equalize the energy balance equation.

Research Question Four

The results revealed that there were significant positive correlations between the students' body mass index and the calories burned, total calories burned, and the calories expended per minute of activity. Students with a higher body mass index tended to expend more calories, total calories, and calories per minute of activity in comparison to students with a lower body mass index. There were no significant differences between calories burned and the other fitness test components. This is consistent with Pangrazi, Corbin and Welk (1996) finding that suggests that there is very little evidence to indicate that high levels of fitness may be necessary for good health. Fitness levels of adolescents do not affect the amount of calories burned during physical activity.

Research Question Five

There was a positive correlation between attitude and knowledge regarding physical activity and healthy behaviors. Students with higher attitude scores tended to be more knowledgeable about physical activity and healthy behaviors. On the other hand,
there was not a correlation between age or sex, and attitude and knowledge towards physical activity and healthy behaviors. According to Ferguson (1989), students who had positive attitudes towards physical activity and physical education were more likely to indicate that they planned to be active or exercise in the future.

Conclusions

Since there were differences in the various activities in physical education and the calories burned, we can conclude that not all activities will burn the same amount of calories. It may be possible to put activities on a continuum from low level physical activities that burn fewer calories, to activities that burn a significantly greater amount of calories. In light of this information, students in physical education need to be educated about what activities burn an adequate amount of calories to be beneficial to their health. Strand and Roesler (in press) have created a concept termed calorie education. This concept not only educates students by use of the Caltrac accelerometer, but also teaches them about standards to reduce health risks.

The average number of calories burned in physical education over the period of the research study was approximately 71 calories a day. This is consistent with Anderson’s study (1999) which indicated that students burned an average of 60 to 80 calories in physical education class. Since the recommended standard set by the Surgeon General’s Report is a minimum of 150 calories in daily physical activity, the results of this study demonstrate that students participating in physical education classes, are, in most cases, not meeting 50 percent of the minimum standard of recommended caloric expenditure during physical education classes. Even during the activity of broom ball
which had the highest mean caloric expenditure of 120.5 calories, the students did not
meet the minimum caloric expenditure recommendation. In addition, most middle school
physical education classes meet only two to three days a week. This means that students
may expend approximately 210 calories a week in physical activity in physical education
classes, which is far lower than the 1,000 calorie recommended standard of calories per
week of energy expenditure in physical activity.

Since there were positive correlations between calories burned, total calories
burned and time in activity, in addition to the heart rate information such as average heart
rate, heart rates above and in the target heart rate zone, maximum heart rates and a
negative correlation or inverse relationship between calories burned and heart rate below
the target heart rate zone, it is fair to conclude that the intensity of heart rate and time
spent in physical activity had an effect on the amount of calories expended. Thus, heart
rate monitoring is another effective indication of whether students are burning a sufficient
amount of calories during physical activity.

The results of Research Question Number Three indicate that there were sex
differences between males and females in caloric expenditure during physical activity.
This tends to suggest that males burn more calories than females participating in the same
physical activities.

The results of Research Question Four revealed that there was a positive
relationship between the students’ body mass index and calories expended, but not in
relationship to the other fitness tests. This tends to suggest that a student’s fitness level
may not be a strong indicator of how many calories they will burn during physical

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activity. It does indicate that those students with a higher body mass index, in comparison to students with a lower body mass index, may burn more calories during physical activity.

There was a significant positive correlation found between attitude and knowledge about physical activities and healthy behaviors. It is fair to conclude that students who are more knowledgeable about their bodies and healthy behaviors are more likely to have a positive attitude towards physical activity and adhere to positive lifestyle behaviors.

Recommendations

It is clear that physical education classes can not meet the minimum recommended caloric expenditure standard without assistance. The limited length and frequency of physical education classes makes this standard impossible. To expend more calories in physical education classes the following recommendations should be implemented:

1. Increase the number of days and perhaps the amount of time physical education is offered in the school. On the average, middle school physical education classes meet two to three days a week for approximately 50 minutes a day. In that time frame, students are to change in and out of gym clothing and participate in physical activities. According to McKenzie (1993), the amount of time children spend in physical activity, or energy expended, may be one of the most important health outcomes and national standards, which need to be further defined.
2. Implement activities that promote health-related fitness and skill development (McKenzie, et al., 1993). From the research, we can conclude that some activities burn a significantly higher amount of calories than other activities. The focus of the curriculum may need to be re-evaluated. In particular, the goals of middle school physical education need to be defined. Are the goals to teach sport skills, to increase health-related fitness, or both? In answering this question, we need to view the health implications of what to promote as far as physical activity. If the goal is to increase health-related fitness and teach sports skills, teachers need to incorporate health-related fitness concepts into physical activities that burn a higher amount of calories. Allocating more curricular time to include the activities that burn a larger amount of calories may need to be a priority over activities that expend significantly less calories.

3. Educate students on the minimum standards of physical activity and caloric expenditure needs to be implemented into the physical education curriculum. According to this study, students who are more knowledgeable about their bodies and physical activities and healthy behaviors are more likely to have a positive attitude towards physical activity. Providing an educational component such as calorie education in the physical education curriculum may enhance a student’s knowledge, which in turn could initiate increased participation in all physical activities.

4. Encourage the involvement of all school and community programs in promoting and encouraging physical activity (U.S. Department of Health and Human Services, 1996a). Because physical education is not the only place that children can experience physical activity, there needs to be additional support from the parents and the
community. A balance between healthy dietary patterns and adequate physical activity has shown to decrease future health problems (Health Reference, 1996). This involvement may take additional effort on the part of the school, physical educators, and health education teachers. Developing curricular materials and encouraging students to discuss and practice nutritional and physical activity concepts with their parents is one way to encourage parental involvement. The key point remains; physical education classes alone can not meet the minimal physical activity standards without a significant base of support. Students need to participate in physical activity outside of physical education classes.

5. Continue to implement technology in teaching physical activity and fitness concepts. The Caltrac motion sensors and heart rate monitors are valuable assessment tools of students’ physical activity or caloric expenditure in physical education classes. In conjunction with the educational component, the technological assessment tools can provide individual feedback to students in relation to the time and intensity of their activity.

6. Be aware of sex differences in regards to participation in physical activities, and in particular, physical education. I believe that it is important to educate current teachers about their behaviors of discrimination and expectations of boys and girls based on the stereotypes of gender. Although it may not be possible to educate all teachers who are currently teaching, I believe that all college education majors need to be exposed to a class about gender issues in education, which includes physical education and participation in physical activity. I believe that parents should also be educated on
gender issues and differential treatment of children. Sharing this information with parents during conferences or through workshops may be a way of educating parents in becoming aware of their sex-stereotyped behaviors and beliefs.

7. It is recommended that this research be repeated with more subjects and possibly more male subjects. It may be of interest to conduct this research in an all boys’ class compared to what was done in the all girls’ class and the co-educational class. Furthermore, it may be of interest to repeat this study at the elementary or high school level to determine if there is a difference in the number of calories burned based on the age or grade level of the subjects. The research indicates that there is a decline in physical activity in relationship to age and sex (U.S. Department of Health and Human Services, 1991). If this statement is true, it would be of interest to pin point the age and sex differences of where and when the decline in physical activity occurs.

8. It is recommended that an additional study be done to address the curricular debate on what should be the focus of physical education.

9. It is recommended that this study be repeated to observe how different teaching methods and styles may affect caloric expenditure of children participating in physical education classes.

Surveys have been shown to be an inexpensive and reliable way to assess attitudes, knowledge, and physical activity levels. The survey used for this study needs to be given to a larger sample population to determine if the responses were relatively typical for the age and sex of the students.
Final Thoughts

I believe this research reflects the growing trend towards the use of technology and the use of various assessment techniques in physical education. By promoting the physical education of children, incorporating technology, and integrating health-related concepts and activities, I believe we are moving forward in educating our youth to become active and knowledgeable healthy adults.
APPENDIX A

PERCEPTIONS AND KNOWLEDGE ABOUT PHYSICAL ACTIVITY
AND HEALTHY BEHAVIORS STUDENT SURVEY
AND SURVEY KEY
Perceptions and Knowledge About Physical Activity and Healthy Behaviors

**Directions:** Please CIRCLE the appropriate letter or letters that indicate how will the statements describe *your thinking or feelings most of the time*. There are no right or wrong answers. Physical activity includes all individual sports, all team sports, and individual exercises. Examples of these activities may include: aerobics, badminton, basketball, bike riding, cross country skiing, dancing, football, racquetball, running, softball/baseball, swimming, tennis, volleyball, weight training, and physical fitness activities. Healthy behaviors are those actions that help maintain your well-being.

<table>
<thead>
<tr>
<th></th>
<th>SD = STRONGLY DISAGREE</th>
<th>D = DISAGREE</th>
<th>U = UNCERTAIN</th>
<th>A = AGREE</th>
<th>SA = STRONGLY AGREE</th>
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<tbody>
<tr>
<td>1</td>
<td>I look forward to physical activity.</td>
<td></td>
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<td>2</td>
<td>I wish there were more enjoyable ways to stay fit than vigorous exercise.</td>
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<td>3</td>
<td>I do not enjoy physical activity.</td>
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<td>4</td>
<td>Physical activity is very important to me.</td>
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<td>5</td>
<td>Life is much richer as a result of physical activity.</td>
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<td>6</td>
<td>I dislike the thought of doing physical activity.</td>
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<td>7</td>
<td>I have to force myself to participate in physical activity.</td>
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<td>8</td>
<td>To miss a day of physical activity is a relief.</td>
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<td>9</td>
<td>Physical activity is important in my day.</td>
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<tr>
<td>10</td>
<td>Competing in sports will make a person healthier.</td>
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<tr>
<td>11</td>
<td>People should warm-up before they exercise.</td>
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<tr>
<td>12</td>
<td>Exercise slows the circulation of the blood.</td>
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<tr>
<td>13</td>
<td>Any type of exercise is good for a person's health.</td>
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</tbody>
</table>
14. The older a person is, the less important it is to exercise. SD D U A SA
15. Vigorous physical activity is necessary for good health. SD D U A SA
16. People should spend 20 to 30 minutes a day doing vigorous physical activity. SD D U A SA
17. I would choose vigorous physical activity over light physical activity. SD D U A SA
18. Eating healthy is just as important as participating in physical activity. SD D U A SA
19. Being overweight is harmful to a person's health. SD D U A SA
20. Exercise habits formed in childhood carry over into adulthood. SD D U A SA
21. Being strong and physically fit is not the most important thing in my life. SD D U A SA
22. I look forward to physical education class. SD D U A SA
23. I generally do worse in physical education class than in any other class. SD D U A SA
24. People will live longer if they exercise. SD D U A SA
Dissertation Survey Key

Perceptions and Knowledge about Physical Activity and Healthy Behaviors

Positive Attitude Questions – 1, 4, 5, 9, 17, 22 (score 1 to 5)

Negative Attitude Questions – 2, 3, 6, 7, 8, 21, 23 (score 5 to 1)

Knowledge Questions – 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24

Positive Knowledge Questions – 10, 11, 13, 15, 16, 18, 19, 20, 24 (score 1 to 5)

Negative Knowledge Questions – 12, 14 (score 5 to 1)

Attitude Questions only: 1, 2, 3, 4, 5, 6, 7, 8, 9, 17, 21, 22, 23

59 – 65 Very favorable feelings about physical activity
46 - 58 Favorable feelings towards physical activity
33 – 45 Neutral feeling
20 – 32 Unfavorable feelings
13 – 19 Very unfavorable feelings about physical activity

Knowledge Questions only: 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 24

50 – 55 Very knowledgeable about physical activity and healthy behaviors
39 – 49 Knowledgeable about physical activities and healthy behaviors
28 – 38 Neutral knowledge
17 – 27 Not knowledgeable about physical activity and healthy behaviors
11 – 16 Very limited knowledge about physical activity and healthy behaviors
APPENDIX B

PASSIVE CONSENT LETTER TO THE PARENTS

AND

REQUEST FOR THE CHILD NOT TO PARTICIPATE IN THE STUDY FORM
Dear Parent/Guardian:

I am an instructor at Moorhead State University working on my doctoral program at the University of North Dakota in Grand Forks. My advisor is Dr. Lynne Chalmers, Associate Professor and Chair of Teaching and Learning at UND. I am conducting a research study by using a device called a Caltrac, which is programmed based on the students' age, height, weight and gender to analyze their caloric expenditure during various activities in physical education. The research will attempt to determine if the students are burning an adequate amount of calories to meet the daily recommendations for optimal health. The Caltrac is a device the size of a small pocket calculator that is clipped on the students' shorts and measures the amount of calories expended during normal physical education activities. In addition, a survey will be administered to determine the students' perceptions of physical activity and knowledge of healthy behaviors. This research is being conducted with the support of the principal, Mr. Brad Larson, and with the assistance of the physical education teacher, Lois Mauch.

Information using the Caltrac device will be collected in your child's physical education class for approximately seven weeks during the remaining school year. A survey will be issued once during the research study. All data collected will remain confidential. The school and the participants in the study will remain unidentifiable.

Your child will wear a Caltrac device during some physical education classes throughout the rest of the school year. They will also be asked to fill out a survey. If you do not want your child to participate in the study, please sign and return the second page of this letter to your child's teacher.

Thank you for your cooperation.

Sincerely,

Wendy Frappier
Doctoral Student at the University of North Dakota
1005 118th Ave. S.
Horace, ND 58047
Phone: (701) 293-7720

Dr. Lynne Chalmers
Box 7189
University of North Dakota
Grand Forks, ND 58202
Phone: (701) 777-3189
I do not want my child to participate in the Analyzing Caloric Expenditure study.

Parent Name: 

Child's Name: 
APPENDIX C
PRINCIPAL CONSENT LETTER
December 21, 1998

Dear

I am an instructor at Moorhead State University in Moorhead, Minnesota working on my doctoral program at the University of North Dakota in Grand Forks. I am conducting research by using a device called a Caltrac to analyze caloric expenditure of students' physical education classes to determine if they are burning an adequate amount of calories to meet the daily recommendations for optimal health benefits. The Caltrac device is clipped on the students' shorts and it measures the amount of calories expended during physical activity. Along with using the Caltrac, I would like to use a survey instrument, to determine the students' perceptions about physical activity and their knowledge of healthy behaviors.

To complete this study, I am asking that you allow me to go into two middle school physical education classes and collect data. Approximately seven weeks is needed to conduct the research. All data collected will remain confidential. Your school and participants in the study will remain unidentifiable.

I would like to begin the collection of data during the week of January 4th, 1999. I will discuss this with the cooperating teacher, to determine what type of schedule would be acceptable for her.

Thank you for your assistance and cooperation.

Sincerely

Wendy Frappier
Doctoral Student
University of North Dakota
1005 118th Ave. S.
Horace, ND 58047
Phone: (701) 293-7720

Dr. Lynne Chalmers
Box 7189
University of North Dakota
Grand Forks, ND 58202
Phone: (701) 777-3187
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