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FACTORS THAT INFLUENCE THE PHYSICAL FITNESS
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By

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ABSTRACT

FACTORS THAT INFLUENCE THE PHYSICAL FITNESS OF DEAF CHILDREN

By

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Maintaining appropriate fitness levels and participating in regular physical activities are associated with many positive health benefits, including improved stamina, ability to complete daily physical tasks, and reduction of risk factors related to various diseases and disabilities (Rowland, 1999). These particular healthy lifestyle behaviors are important to deaf children, given the general consensus that this group has demonstrated lower physical fitness levels than their hearing peers (Goodman & Hopper, 1992). However, the reasons why deaf children, as a group, have performed lower on physical fitness tests have not been researched or identified.

The purpose of this study was to investigate factors that influence the physical fitness of deaf children. A group of 51 deaf children in grades first through fourth from *regular* and *special* schools participated in this study. Participants had a minimum hearing loss of 55 dB in the better ear and did not possess any multiple disabilities. A modified version of the Fitnessgram test was used to measure physical fitness. Parents/ guardians and school personnel completed surveys related to the child's school placement, participation in physical activity, and physical education participation, as well as hearing loss/status information for both the parent and the child. Analysis of variance (ANOVA) and multiple regression procedures were used to identify relationships

between independent and physical fitness variables, and to determine which factors most strongly predicted the physical fitness performance of deaf children.

The results indicated that participation in regular physical activities and parents' hearing status influenced the overall physical fitness of deaf children. Children who participated in at least three regular physical activities per week performed significantly better on all physical fitness measures with the exception of the trunk lift, than did children who participated in fewer activities per week. Parents' hearing status was determined to be an influential factor in that 80% of the children with two deaf parents participated in three or more regular activities per week, compared to 37% of those with at least one hearing parent.

The primary implication of this study is that parents of deaf children should be educated about their influence as role models for healthy lifestyle behaviors. Education should be targeted to those parents who are sedentary and those who may have apprehensions about the child's participation in physical activities, with the focus being on getting the deaf children involved in regular physical activity participation.

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CHAPTER 1

Introduction

Deaf[1] children, like their hearing counterparts, benefit from participation in regular physical activity and concomitant physical fitness in several ways. Compared to an unfit individual, a person who is physically fit is more likely to be able to complete daily and leisure activities such as dressing, walking, and shopping without undue fatigue, as well as effectively handling mental challenges, such as stress (Harris, 1996; McArdle, Katch, & Katch, 2001). Children who are physically fit and active are more likely than less active and unfit children to experience situations involving socialization; whereas, poor fitness may discourage involvement in socialization and physical activities (Rowland & Freedson, 1994). Additionally, appropriate fitness and activity levels may reduce the onset of risk factors leading to many hypokinetic diseases (Rowland, 1999). Risk factors associated with hypokinetic diseases include those leading to heart disease (narrowing of the arteries); bone, joint, and muscle problems (decreased bone mineral density); diabetes (inactivity and diet); and obesity (inactivity and diet). These risk factors have been identified in children as young as six years of age, making physical fitness and activity participation an important strategy in the reduction of hypokinetic diseases (Payne & Isaacs, 1999; Rowland, 1999).

Children and adults need to maintain at least minimal levels of physical fitness in order to experience the many benefits associated with adequate fitness. Minimal acceptable fitness for school-aged children is defined as having levels of

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[1] For the purpose of this study, deaf with a lowercase "d" refers to an individual with a hearing loss exceeding 55dB in the better ear. Deaf with an uppercase "D" refers to individuals who identify themselves as being a member of the Deaf community. As many individuals do not perceive deafness as a disability, but rather an identity (Moores, 1996; Stewart, 1991), person-first terminology was not used within this study.

cardiorespiratory endurance, upper body and abdominal strength/endurance, and percent body fat which rank at or above the 20th percentile for each measure (Cooper Institute of Aerobic Research, 1999). Exercise physiologists recommend participation in vigorous physical activities either vigorous activity 20 minutes per session for three days per week or moderate activity 30 minutes per session for 5 days per week (Public Health Service, 1990; 2000).

Even with the importance placed on healthy fitness levels, deaf children have demonstrated lower fitness levels than their hearing peers. Goodman and Hopper (1992) completed a review of five studies (Bresett, 1971; Campbell, 1983; Pender & Patterson, 1982; Wiegersma & Van Der Velde, 1983; Winnick & Short, 1986) evaluating the physical fitness of deaf and hearing children, and noted that the results were generally favorable to hearing children. Given that almost 70% of all hearing school-aged children have not reached one or more of the national healthy fitness and activity goals, the lower physical fitness levels of deaf children are especially alarming (Public Health Service, 1980; 1990; 2000).

The reasons why deaf children, as a group, demonstrate lower fitness levels are unknown. Deafness is not a physical disability, but rather a sensory disability defined as a hearing loss so severe, generally greater than 55 dB in the better ear, that difficulties in communication exist even with the use of amplification devices. In some cases, deaf children may have multiple disabilities, including various physical disorders, such as ataxia, which could affect fitness and activity levels. However, for most deaf children there are no physical reasons which would explain the occurrence of these lower fitness levels.

Deaf children may exhibit low levels of physical fitness for the same reasons as do hearing children. The fitness levels of school–aged children, especially upper elementary and older, are influenced by the amount of physical activity participation within the community and school physical education settings (Lehnhard, Lehnhard, Butterfield, Beckwith, & Marion, 1992; Ross & Pate, 1987; Sallis, McKenzie, & Alcaraz, 1993). A child with many opportunities to be physically active and fit at a young age and remain active during his/her school years, is more likely to become a fit and active adult than is a child with fewer opportunities. Children with physically fit and active parents who model these behaviors are six times more likely to demonstrate similar healthy lifestyle patterns than children with more sedentary and less fit parents (Bona, Schwartz, Spain, & Natchipolsky, 1995; Stucky-Ropp, & DiLorenzo, 1993). The child's motor skill level may also influence physical activity participation, with inadequate skill levels potentially leading to lower activity participation and fitness levels (Payne & Isaacs, 1999). Regardless of the child's hearing status, the extent to which each factor influences physical fitness and activity levels vary from individual to individual (Hastad & Lacy, 1998; Moores, 1996).

There may also be some unique factors specifically related to deafness that influence the physical fitness of deaf children. Etiology and level of hearing loss are potential influential factors, as both relate to the outcome of communication. Communication problems are more prevalent among children with profound and acquired deafness, especially when deafness is due to meningitis or involve sensorineural hearing losses (Moores, 1996). This may influence the child's understanding and participation in activities leading to the attainment of fitness. Parents may behave differently regarding their deaf child's involvement in fitness and other activities depending on their own hearing status. Hearing parents may be apprehensive of their deaf child's participation in physical activity settings and may limit his/her involvement in some activities; whereas, deaf parents may not be overprotective due to a greater understanding of the disability (Moores, 1996). School placement may also influence the physical fitness and activity levels of deaf children. Deaf children are placed in either *regular* or *special* school settings. Deaf students in *special* schools typically have opportunities to participate in activities, interact, and socialize with other deaf students; whereas, deaf students in *regular* schools may or may not have similar opportunities. However, the factors that influence the physical fitness and activity levels of deaf children will likely remain unknown until an investigation that focuses on these factors is completed.

Statement of the Problem

The purpose of this study is to identify factors that may influence the physical fitness levels of deaf children. Factors being investigated include: (a) school physical education; (b) physical activity participation; (c) etiology of hearing loss; (d) level of hearing loss; (e) parents' hearing status; and (f) type of school placement.

Need for the Study

Many deaf children have demonstrated lower fitness levels than their hearing peers (Goodman & Hopper, 1992). The reasons for lower fitness levels are unknown, as the literature provides very little information about the factors that influence the physical fitness levels of this group (Goodman & Hopper, 1992). Information about factors that influence the physical fitness levels of deaf children would benefit approximately 200,000 school-aged deaf children in the United States, their parents, teachers, and other individuals who are most likely to influence the attainment of fitness by deaf children (United States Department of Education, 1996). The importance of this information lies in knowing if factors that affect the physical fitness of deaf children are similar to those that affect hearing children, more disability-specific, or a combination of both. This study will provide baseline data regarding demographic, school, and/or deafness related factors which should be evaluated more closely with respect to deaf children's fitness. Presently, there is no research on the factors that affect the physical fitness of deaf children (Goodman & Hopper, 1992), leaving the profession to guess why deaf children have demonstrated lower fitness levels than their hearing peers.

Research Questions

1. Does level of hearing loss, in decibels, influence the physical fitness levels of deaf children?
2. Does etiology of hearing loss influence the physical fitness of deaf children?
3. Is parents' hearing status related to the physical fitness levels of deaf children?
4. Does placement in *regular* or *special* school settings influence the physical fitness of deaf children?
5. Does the amount of weekly physical education influence the physical fitness of deaf children?
6. Does the amount of physical activity participation influence the physical fitness levels of deaf children?

Assumptions

1. Fitness test instructions were presented in the student's desired mode of communication, mainly contact signing and spoken/oral communication; therefore, each participant understood these instructions.
2. Each participant had the necessary prerequisite skills (i.e., running) to perform individual fitness tests.
3. There were no differences in the physical capabilities of the deaf students within *special* and *regular* schools to perform the fitness tests.
4. Each participant gave his/her best effort on all fitness measures.
5. Each participant's parents/guardians understood and were able to completely answer the questionnaire items relating to themselves and their child.

Limitations

1. The sample size in this study was relatively small, limiting generalization of the findings to the general population of deaf children.
2. Students in this study participated in physical education programs which ranged from 20 minutes to 90 minutes per week. This wide class time range limits generalization to other school systems across the country in that some classes met once a week for 40 minutes, other classes met twice a week for 20 minutes each time, and still others met daily for 45 minutes. This type of information may be difficult to generalize unless schools have similar physical education class meeting times.
3. Schools were selected from one state, limiting geographical representation.

Definitions

Acquired deafness. A hearing loss which occurred after birth that may be due to illness, infection, or various other causes (Batshaw, 1997).

Congenital deafness. A hearing loss that was present at birth and may be caused by prenatal illnesses, genetics, or unknown reasons (Sherrill, 1998).

Deaf. Deaf, both with an uppercase and lowercase "d," refers to any hearing loss greater than 55 dB in the better ear. The term Deaf using the uppercase "D" refers to an individual or group of individuals who identify with the Deaf culture (Moores, 1996; Stewart, 1991).

Decibel (dB). A measurement of intensity of sound that is commonly used to categorize severity of hearing loss (Moores, 1996).

Physical fitness. With respect to the Healthy People Goals for a Nation (Public Health Service, 2000) and various field test batteries (Cooper Institute of Aerobic Fitness, 1999; Payne & Isaacs, 1999), children's physical fitness levels are categorized by components of health-related physical fitness. Health-related physical fitness includes body composition, cardiovascular endurance, flexibility, muscular strength, and muscular endurance (Hastad & Lacy, 1998; U.S. Department of Health and Human Services, 1996).

Regular school. A public school where both deaf and hearing children are educated, with deaf children being placed in self-contained classrooms, regular classes, or a combination of the two.

Sign language. A visual-spatial communication mode that uses manual symbols representing concepts and ideas through use of fingerspelling and manual signs (Schein

& Stewart, 1995). The primary mode of communication used within the Deaf community, in *special* schools, and self-contained classrooms.

Special school. A school where the majority of students are deaf and the primary mode of communication is sign language. Students either return home at the end of the day or reside at the school and return home on the weekends.

CHAPTER 2

Review of Literature

The purpose of this study was to identify factors that influence the physical fitness levels of deaf children. The following topics are discussed in this review of literature: (a) background information on physical fitness; (b) the immediate and long-term benefits of physical fitness; and (c) factors that may influence the attainment of fitness of deaf children.

What is Physical Fitness?

Physical fitness includes several components related to the ability of the body to function effectively physiologically, and is categorized as being either skill-related or health-related (Hastad & Lacy, 1998). Skill-related physical fitness involves components more closely related to sports and athletic performance, such as balance, agility, coordination, and power. Health-related physical fitness refers to components of everyday functional fitness, such as cardiorespiratory endurance, muscular strength/ endurance, body composition, and flexibility. While both types of fitness are important, it is health-related physical fitness that has generated the most emphasis from medical professionals due to its connection with various diseases and disabilities (Public Health Service, 1990). In general terms, health-related physical fitness is defined as the physiological functions which offer protection from diseases and disabilities associated with inactive, sedentary habits (Wilmore & Costill, 1994). In order to experience such protection from disease and disability, minimally appropriate fitness levels are required, which are defined as performing at or above the 20th percentile on individual measures of health-related physical fitness (Cooper Institute of Aerobic Fitness, 1999).

Each category of health-related physical fitness plays a role in the overall health and well-being of an individual. Cardiorespiratory endurance is the component of fitness concerned with the ability of the heart and lung systems to provide the body with oxygen during continuous movement (Wilmore & Costill, 1994). Individuals who possess appropriate levels of cardiorespiratory endurance are able to exercise the entire body over a period of time without undue stress or fatigue. Poor levels of cardio-respiratory endurance have been found to be one of the main precursors for heart disease (Hastad & Lacy, 1998; Francis, 1999). Individuals who demonstrate poor cardiorespiratory endurance experience difficulties when moving their bodies from one point to another, requiring periods of rest before able to continue movements. A healthy cardiorespiratory system allows the heart to have strong cardiac output, decreased build-up of plaque and deposits along the arteries, and efficient pumping action (Wilmore & Costill, 1994).

Body composition refers to the relative amounts of bone, fat, muscle, and other vital tissues and parts within the body (Wilmore & Costill, 1994). Body composition is generally evaluated in terms of percentage body fat, and is the only health-related physical fitness component that is not a performance measure. The ratio between lean body mass and fat mass is important in an individual's ability to perform functional movements, as body fat has been connected with performance on many weight-bearing activities (Rowland, 1999). Many of the problems with percent body fat come from overfatness, rather than overweight (Hastad & Lacy, 1998). An individual could have larger muscle mass leading to a classification of overweight on general height/weight scales, but could still be within normal limits when body fat is evaluated. High body fatness may cause an individual to have difficulty in moving their body efficiently. This is one of the reasons why many children and adults drop out of physical activity, as it becomes difficult and cumbersome to move the additional fat. High body fat is associated with sedentary lifestyles, a precursor for many hypokinetic diseases and disabilities (Rowland & Freedson, 1994).

An individual could also either be underweight or underfat (Wilmore & Costill, 1994). An individual who has been classified as being underweight demonstrates a body weight that is lower than the mean for his/her height, age, and gender. This individual may have a percentage body fat within normal limits accompanied by a lean body build. An individual who has been classified as underfat may demonstrate body weight within acceptable limits for age, height, and gender, but possess lower than recommended amounts of body fat. This individual could have higher muscle mass or a leaner than normal body build. Low body fatness does not necessarily mean that the individual is physically fit; it can sometimes be an indication of malnutrition and below normal ranges of fat storage which protect the body from injury; and can sometimes negatively affect the growth and maturation of the child (Malina & Bouchard, 1991).

Muscular strength and endurance refer to the abilities of the upper and lower body to exert muscular force initially and continually over a prolonged period (Cooper Institute of Aerobic Research, 1999). In many tests, these two factors are evaluated concurrently and are reported as either upper body or abdominal strength and endurance (Hastad & Lacy, 1998). Muscular strength and endurance allow an individual to exert enough force to perform functional everyday activities with ease. An individual who has low muscular strength and endurance may have difficulties performing activities of daily living such as carrying books, climbing stairs, doing laundry, or completing tasks around the house or yard. As with body fatness, low muscular strength and endurance lead to many movements being arduous, possibly leading to sedentary habits and an increased risk of hypokinetic diseases and disabilities compared to individuals who demonstrate adequate levels of muscular strength and endurance (Rowland & Freedson, 1994).

Flexibility is concerned with the movement of body joints through their functional range of motion, and relates to the elasticity of muscles, ligaments, and tendons (Rowland, 1999). Individuals who possess an adequate level of flexibility are more likely to demonstrate appropriate posture and are less susceptible to injury during physical activities, including injuries associated with the lower back and body joints. An individual with poor flexibility may be prevented from participating in physical activities where agility is necessary, due to an increased potential for injury (Hastad & Lacy, 1998).

Why is Physical Fitness Important to Deaf Children?

Fitness is important to deaf children, just as it is to children who do not have hearing losses. There are several reasons why fitness is important to deaf children, including reasons directly related to their hearing loss (specific to deafness) and those which are important to hearing children as well.

Reasons Important to Hearing Children

Health-related physical fitness plays an important role in the daily life of an individual, regardless of hearing status. There are several reasons why physical fitness is important to all children, including both immediate and long-term benefits.

Immediate benefits. Appropriate fitness levels can lead to many immediate benefits. One such benefit is in the performance of everyday activities, easily and without undue stress and fatigue, thus, promoting overall quality and enjoyment of life (Kohl & Hobbs, 1998; Pate, Baranowski, Dowda, & Trost, 1996; Wilmore & Costill, 1994). Participation in leisure activities within the exercise and recreational arena, such as walking, bicycling, and swimming, can be very enjoyable for individuals who have attained appropriate fitness levels (Heyward, 1990).

Interaction and socialization with others in physical activity and recreational settings is another immediate benefit of physical fitness. Individuals who have appropriate fitness levels and are involved in sport and recreational activities participate in a setting where interaction with others is a foremost objective (Stucky-Ropp & DiLorenzo, 1993). Participation in physical activity promotes socialization and cooperation among participants, an experience that is very important for children (Ramsey & Rank, 1997). Successful interaction and socialization with others encourages participation in physical activity, increases self-worth, promotes learning of socialization and teamwork skills, and generates friendships among participants (Stucky-Ropp & DiLorenzo, 1993).

Maintaining appropriate fitness levels increases one's overall quality of life, both physically and psychologically (Ford, Puckett, Blessing, & Tucker, 1989; Leith & Taylor, 1991). Children feel better about themselves and their abilities when they are more capable of performing even the most basic tasks without great effort (Fox, 1992; Martinsen, & Stephens, 1994). Increases in overall physical activity performance and fitness measures lead to enhanced self-concept in children (Faigenbaum, Zaichkowsky, Westcott, & Long, 1997; Salokum, 1994). This enhancement of self-concept is especially strong when connected with positive changes in body fat (Marsh & Redmayne, 1994). Psychological well-being is critical in a world with increasing daily stressors. Coping with situations that tend to promote stress and anxiety is a positive outcome from physical fitness and activity participation (Harris, 1996).

Long-term benefits. One of the most important long-term benefits of fitness and physical activity participation is the potential to decrease the risk of hypokinetic diseases and disabilities. Hypokinetic diseases are those associated with poor fitness and inactive lifestyles (Rowland, 1999). Some of the risk factors associated with hypokinetic diseases have surfaced in children as early as six years of age, including narrowing of the arteries and increased blood pressure. The risk factors associated with hypokinetic diseases can be reduced through participation in physical activities and maintaining appropriate fitness levels (Rowland & Freedson, 1994). In addition, the same healthy lifestyle behaviors promote an increase in overall bone mineral density leading to stronger bones (Heyward, 1990) reduce the prevalence of diabetes, and increase an individual's psychological capability to handle stress, depression, and anxiety (Rowland & Freedson, 1994; Stucky-Ropp & DiLorenzo, 1993).

Compared to other life-altering diseases, cardiovascular disease has one of the highest correlations with low fitness levels, resulting in more than one million deaths per year (Wilmore & Costill, 1994). According to present Public Health Service reports (2000), more than 13.5 million individuals in the United States have coronary heart disease, and 1.5 million individuals experience a heart attack each year. Not only does poor fitness place an individual at risk for cardiovascular disease, but also for dying prematurely from disease complications (Public Health Service, 1990; 2000). Children and adults who demonstrate low cardiorespiratory endurance on fitness tests, such as through endurance runs or the PACER protocol (Cooper Institute of Aerobic Research, 1999), are at increased risk for heart disease (Cooper Institute of Aerobic Research, 1999; Ross & Pate, 1987).

Diabetes is another life-altering disease which is triggered by poor fitness, inactivity, and obesity (Albright, Franz, & Hornsby, 2000). Diabetes is the inability of the body to produce or use insulin, a necessary agent in glucose metabolism (Wilmore & Costill, 1994). Type II diabetes usually surfaces in young and middle aged adults and affects more than 8 million individuals in the United States (Public Health Service, 2000). Diabetes drastically increases an individual's risk of heart disease, with affected individuals having an 80% mortality rate from cardiovascular disease (Albright, Franz, & Hornsby, 2000). The alarming fact is that many cases of type II diabetes could have been prevented through maintenance of healthy fitness levels and daily physical activity participation (Public Health Service, 2000). The main prescriptions for controlling diabetes include maintaining appropriate fitness levels, participating in regular physical activity, adherence to a specialized diet, and, in some cases, medication.

Appropriate fitness and activity levels promote strong bones and joints, thus reducing the chance of fractures and debilitating injury caused by decreased bone and joint stability (Heyward, 1990). Physical fitness allows for greater participation in weight-bearing activities, which in turn leads to increased bone mineral density and flexibility of joints (Harris, 1996; Heyward, 1990). Increased bone mineral density allows the skeletal system to withstand greater weights and more pressure during weight-bearing activities without the occurrence of injuries (Heyward, 1990). Flexibility allows for uninhibited movement of body parts through joint range of motion, decreasing chances of injury during physical activities and normal everyday movements (Harris, 1996). Additionally, physical fitness and participation in physical activities promotes not only increased muscular strength and endurance, but also improved muscle tone (Rowland & Freedson, 1994). Improved muscle tone promotes smooth contraction of muscles and decreased chance of injury and muscle soreness due to improper or imbalanced movements. Thus, poor fitness and sedentary activity levels can lead to reduced bone mineral density, flaccid muscle tone, and rigid joints, increasing the risk of injury and limitations during movement (Harris, 1996; Heyward, 1990; Rowland & Freedson, 1994).

Physical fitness and activity participation provide several long-term benefits, namely reducing the risk factors associated with various hypokinetic diseases and disabilities. Maintaining appropriate fitness levels and participating in regular physical activities reduces the risk and onset of such diseases as cardiovascular disease, diabetes, and bone and joint problems. This in itself is an important reason for all children to be introduced to participation in regular physical activities leading to attainment and maintenance of appropriate physical fitness levels from a young age.

Reasons that are Specific to Deafness

Physical fitness is important to deaf children for the same reasons as for hearing children. However, there are some additional deafness-specific reasons that must be considered for children who are deaf.

Readiness for Deaf sport. One of the most important mainstays of Deaf culture is Deaf sport (Stewart, 1991). Readiness for Deaf sport not only entails participation in sports and physical activities, but also being physically capable of participation by demonstrating appropriate physical fitness levels. An individual who is not physically fit may be less likely to become involved in any form of physical activity (Francis, 1999). Not being involved in any form of physical activity reduces the chance of the deaf individual participating in Deaf sporting events. It is within the Deaf sport arena that great pride and self-concept can be gained by participating with individuals who share similar communication abilities and cultural experiences (Stewart, 1991). Through Deaf sport, deaf children can learn about opportunities for participation as athletes, coaches, officials, volunteers, and spectators. Therefore, the deaf individual not only fails to benefit from physical activity participation, but also the socialization and interaction opportunities with other deaf individuals that are associated with Deaf sport.

Social status among hearing peers. Social status among peers is a great source of pride and self-worth (Williams & White, 1983). Increased pride and self-worth lead to positive feelings toward oneself and in one's belief that he/she can successfully attempt and accomplish things that would otherwise have been avoided (Coakley, 1990; Williams & White, 1983). Participation in sporting events and attainment of physical fitness can lead to popularity among peers and improved personal appearance, both which are important to school-aged children (Chase & Dummer, 1992). This importance of social status increases with age, with social status through sports participation more important to males and personal appearance more important to females. For many individuals, acceptance and social status among peers rolls over into other settings such as academics and other school-related activities and involvement in physical fitness and activity participation tend to increase this acceptance among peers, both active and inactive (Coakley, 1990).

Socialization and social status among peers are critical factors for deaf children, especially with the barriers to communication that are present for deaf children in many settings (Moores, 1996). Barriers to communication can and do prevent deaf children from complete participation in many activities, mainly in the school settings, and affect success in both learning and socialization (Moores, 1996; Stewart, 1991). Physical activity is a setting that typically offers a level playing field for deaf and hearing individuals, where deaf children should not be at a disadvantage (Stewart, 1991). Deaf children who are physically fit and active are likely to experience the same benefits as hearing children including increased social status among their peers, feelings of pride, and self-worth (Coakley, 1990). Individuals with poor fitness, regardless of hearing status, are more susceptible to isolation from their peers, leading to decreased socialization opportunities (Coakley, 1990; Greenberg & Kusche, 1989). From a sociological standpoint, it is important for deaf children to demonstrate physically fit and active habits in order to promote the benefits of socialization and the attainment of social status among their peers.

What are the Fitness Levels of Deaf Children?

The focus of this study was on the health-related physical fitness of deaf children, therefore, this review of literature will be limited to health-related physical fitness rather than skill-related physical fitness. Goodman and Hopper (1992) completed a review of studies evaluating the physical fitness of deaf children. Of all the studies reviewed, only five met the criteria for evaluating health-related physical fitness (Table 1). According to Goodman and Hopper (1992), the results of these studies generally indicated that deaf children demonstrate lower physical fitness levels than their hearing peers.

Bresett (1971) measured cardiorespiratory endurance using several methods of evaluation. A total of 100 subjects, 50 males and 50 females, between the ages of 12 to 14 years participated in this study. The deaf participants (n = 50) were students at a residential school for the deaf and the hearing participants (n = 50) were students at local public schools. No information was provided regarding distribution of genders across hearing groups. The author defined deafness as "that condition in which the sense of hearing is non-functional for the ordinary purpose of life with or without amplification of sound" (p. 3). Age at onset was categorized as either congenital or acquired before the age of two; however, participants were not grouped based on differences in age at onset. In addition, level of hearing loss and communicative preferences were not reported.

In the Bresett (1971) study, physical fitness was evaluated using breathing capacity, expiratory volume, leg strength, and arm strength. Breathing capacity and forced expiratory volume were measured through use of manual spirometers. Arm strength was evaluated based on push-up performance adjusted by the weight of the subject. Leg strength was evaluated using one rep-max performance on a leg dynanometer. Hearing participants performed significantly higher than deaf participants on both forced expiratory volume and breathing capacity. Female hearing participants demonstrated significantly higher leg strength than female deaf participants. Hearing participants performed better on measures of arm strength; however, results were not statistically significant. From these results, the author postulated that the differences in fitness between hearing and deaf participants may have been due to differences in opportunities to participate in physical activities outside the school setting.

Table 1

Research and Descriptive Statistics from Studies Evaluating Health-Related Physical Fitness of Deaf Children

		Component of Fitness				
Study	*n*	Cardiorespiratory Endurance	%Body Fat	Flexibility	Abdominal Strength/Endurance	Upper Body Strength/Endurance
Bresett (1971)	100	Max Breathing Cap (in^3) H > D 209.68 >173.60* M 178.40 > 127.84* F FEV (in^3) H > D 157.04 > 130.24* M 133.68 > 92.72* F	DNT	DNT	Leg Strength (lbs) via dynanometer H > D 768.40 > 722.80 M 656.80 > 545.20* F	Push-Ups Adjusted for weight (lbs) H < D 170.81 < 220.26 M H > D 411.36 > 347.74 F
Pender & Patterson (1982)	120	Harvard Step Test (index) H < D 56.35 > 63.42*	DNT	DNT	60-sec Sit-Ups (#) H > D 16.71 > 14.95*	Push-Ups (#) H > D 11.78 > 8.78*
Campbell (1983)	94	9-minute run (laps) H > HH > D* 14.27 > 13.03 > 12.88*	DNT	DNT	60-sec Sit-Ups (#) H = D > HH 26.53 = 24.50 > 19.44* M H > HH > D 29.00 > 20.00 > 12.20* F	Flexed Arm Hang (sec) H = HH = D 9.39 = 8.50 = 7.81

H = Hearing; HH = Hard of Hearing; D = Deaf F = Females; M = Males DNT = Did Not Test
*$p < .05$
**$p < .01$

Table 1 (continued)

Study	*n*	Component of Fitness: Cardiorespiratory Endurance	%Body Fat	Flexibility	Abdominal Strength/Endurance	Upper Body Strength/Endurance
Wiegersma & Van Der Velde (1983)	57	DNT	DNT	Sit, Bend & Reach (no data recorded) H = D	Total Sit-Ups (#) H > D 8.42 > 6.27**	DNT
Winnick & Short (1986)	1731	1-Mile or 9-Min Run (yards/min) H > D > HH 206.67>197.33>186.00 M H > D = HH 164.67>162.67=162.67 F	Sum of Skinfolds calf & tricep D = H = HH 23.33>22.67>22.00 M HH > D > H 31.33>30.67>24.33* F	Sit-and-Reach (cm) H > D = HH 26.00>23.30>22.67 M H > D > HH 31.67>27.33>26.00*F	60-sec Sit-Ups (#) H > D = HH 42.33>36.33=35.67* M H > D = HH 34.67>30.67>29.00* F	DNT
Ellis (2001)	73	Timed One-Mile Run All below 40th Percentile *M* = 19th percentile	Skinfolds calf & tricep All below 40th *M* = 20th percentile	Sit-and-Reach Range = 30th to 90th Percentile *M* = 58th percentile	60-sec Sit-Ups (#) All below 40th Percentile *M* = 33rd percentile	Pull-Ups (#) All below 40th Percentile *M* = 23rd percentile

H = Hearing; HH = Hard of Hearing; D = Deaf F = Females; M = Males DNT = Did Not Test
*$p < .05$
**$p < .01$

Pender and Patterson (1982) evaluated three aspects of fitness, namely cardiorespiratory endurance, abdominal strength/endurance, and upper body strength/ endurance. A total of 120 subjects between the ages of 6-11 years participated and were classified as either hearing (n = 60) or deaf (n = 60). Deafness was defined as having a congenital hearing loss of 60 to 110 dB in the better ear. Hearing participants were students at a local public school, and deaf participants were students at the state residential school for the deaf. Fitness was measured via a timed step test in which heart rate was monitored (HR > 180 beats per minute led to cessation of the test), as well as the total number of push-ups and sit-ups completed. Information on gender and specific test administration used to measure upper body and abdominal strength/endurance were not disclosed.

Hearing participants demonstrated significantly higher performance for measures of upper body and abdominal strength/endurance; whereas, for the step test, deaf participants showed superior performance (Pender & Patterson, 1982). The authors did mention, however, that the deaf participants, while their performances were higher the hearing participants, had greater difficulties maintaining pace on the step test. No information was provided as to how directions or step-test cadence were presented to the deaf participants. Additional in-depth information pertaining to deafness (level, other etiologies, communication preferences) was not reported.

Campbell (1983) evaluated three fitness variables for 47 hearing, 23 hard of hearing, and 24 deaf children between the ages of 6-13 years. Gender information was not provided. Hard of hearing was defined as a hearing loss of less than 90 dB, and deaf was defined as any hearing loss at or greater than 90 dB. All participants attended the same public school and were integrated within classes. Fitness was evaluated by the 9-minute walk/run as a measure of cardiorespiratory endurance, 60-second flexed knee sit-ups for abdominal strength/endurance, and a timed flexed arm hang for upper body strength/endurance. This study did not identify the methods used for presenting test directions to hard of hearing and deaf participants. Additional information pertaining to deafness (age at onset, level of hearing loss, communication) was not reported.

Hearing and hard of hearing participants performed significantly better than deaf participants on the cardiorespiratory endurance test (Campbell, 1983). No significant differences were evident between the groups on the measure of upper body strength/endurance. Deaf and hard of hearing participants performed significantly lower than hearing participants on the measure of abdominal strength/endurance, with hearing females performing significantly higher than deaf females, and hard of hearing males performing significantly higher than deaf males. Overall, deaf and hard of hearing participants performed significantly lower than did hearing participants on all measures, with the exception of the performances of males on abdominal strength/endurance which was not significantly different and upper body strength/endurance which was similar across groups. The results of this study were generally in favor of the hearing participants.

Wiegersman and Van Der Velde (1983) evaluated the physical fitness levels of 25 hearing and 32 deaf children aged 6-8 years. No information was provided pertaining to gender, the classification method used for deafness, school placement, age at onset of hearing loss, or of the communication modality used during testing procedures. The fitness measures included flexibility (sit-and-reach), abdominal strength/endurance (60-

second flexed knee sit-ups), and agility (squat thrust). The conclusions of this study indicated deficiencies in fitness by deaf children across all ages, except for flexibility where negligible differences were found for the 8-year-old group. The authors postulated that the smaller gap in fitness seen with the 8-year-old group may have been due to the greater number of activities offered through the residential school setting as compared to the non-residential or public school settings. Other than the preceding statement, no further information on school placement was provided, but from this, it was presumed that the deaf participants were students at a school for the deaf.

Winnick and Short (1986) completed a large scale study evaluating the physical fitness of deaf and hearing children, with a sample size of 686 hearing, 153 hard of hearing, and 892 deaf children aged 10-17 years. This sample size was further consisted of 873 females and 858 males. Individuals with hearing losses in the 27 dB to 90 dB range were classified as hard of hearing, and those with hearing losses exceeding 90 dB were classified as deaf. All of the hearing students attended public schools and the hard of hearing and deaf students attended either public schools or residential schools for the deaf. No information was provided regarding age at onset of hearing loss. The test administration procedures for presenting test directions to the deaf students were not discussed.

Winnick and Short's (1986) study evaluated the physical fitness variables of cardiorespiratory endurance (timed 1.0 mile for children aged 10 to 12 years and timed 1.5 mile for children aged 13 to 17 years), percent body fat (tricep and subscapular skinfolds), abdominal strength/endurance (60-second sit-ups), and flexibility (sit-and-reach). Only the exclusion of upper body strength/endurance prevented this study from being a complete fitness assessment. Hearing children performed at higher levels on all fitness measures than both the hard of hearing and deaf children. Statistical significance was indicated between the hearing and non-hearing children on abdominal strength/endurance and flexibility. The deaf participants demonstrated significantly higher percentage body fat than both the hard of hearing and hearing participants. In addition, the deaf participants performed slightly higher than the hard of hearing participants on cardiorespiratory endurance, flexibility, and abdominal strength/endurance tests; however, none of these performances were statistically significant.

Ellis (2001) evaluated the health-related physical fitness performance of 73 deaf children aged 6-16 years and compared these results to the AAHPERD national standard norms (AAHPERD, 1984; Hastad & Lacy, 1998). All participants had at least a 55 dB hearing loss in their better ear. Directions were presented using a combination of sign language and verbal communication. Physical fitness components measured included cardiorespiratory endurance (timed one-mile run), percentage body fat (calf and tricep skinfolds), flexibility (sit-and-reach), abdominal strength/endurance (60-second sit-ups), and upper body strength/endurance (pull-ups).

The results of this study indicated that this group of deaf children demonstrated physical fitness performances below the 40th percentile on national standard norms for all tests with the exception of flexibility (Ellis, 2001). A number of the results fell below the 20th percentile, mainly with cardiorespiratory endurance (M = 19th percentile) and percent body fat (M = 20th percentile). Performances on the sit-up (M = 33rd percentile) and pull-ups (M = 23rd percentile) were well below the 40th percentile. The results of this study would indicate that deaf children performed below the median on standard national norms for health-related physical fitness measures, with the exception of flexibility (M = 58th percentile). This information suggests agreements with the literature that deaf children demonstrate below average fitness levels when compared to norms formulated for hearing children.

Taking into account those studies that evaluated health-related physical fitness variables, the general consensus remains that deaf children, as a group, demonstrate lower fitness levels than their hearing peers. However, when evaluating the research completed in this area, only one component of physical fitness was evaluated using the same fitness measure (the 60-second sit-up test) in all six studies (Table 1). Even with the variability in fitness measures used between studies, the outcome of each remained consistent in that deaf children were found to perform lower on many of the physical fitness tests than their hearing peers.

Factors Affecting the Fitness Levels of Deaf Children

While deaf children as a group have demonstrated lower fitness levels than their hearing peers, the factors that contribute to the lower fitness levels by deaf children are generally unknown. It is logical to consider that some of the factors that influence the physical fitness of deaf children may be those that affect the fitness levels of hearing children. However, in addition to factors that are similar for hearing children, there may be factors that are deafness-specific and unique to children with hearing losses.

Same Factors as for Hearing Children

Some of the factors that affect the physical fitness levels of deaf children may be those that are influential for hearing children. The main factors that have been found to influence the physical fitness of hearing children are those related to parental influence, school physical education, and physical activity participation.

Parental influence. Several investigations have reported that parents' involvement in physical activity and their encouragement of similar behaviors for their children may increase the chances that the child will become physically active as well (Biddle & Armstrong, 1992; Pate, et al., 1997). Pate et al., (1997) evaluated the influence of activity patterns of family members on their children's fitness levels. A total of 739 sixth grade children, 387 males and 352 females, and their families participated in this study. A questionnaire was used to determine the child's perception of the family's physical activity habits. The questionnaire required the participant to indicate activity levels for each family member using a 5-point Likert scale (1=not active to 5=most active). In addition, each child indicated whether both parents are equally active, the mother is most active, the father is most active, sibling(s) is most active, or no one in the family is active. There was no mention of the directions given to the participants in how to determine which family member(s) was the most active. Each participant completed the health-related physical fitness measures of cardiorespiratory endurance (1.0 mile run/walk), abdominal strength/endurance (number of sit-ups), upper body strength/endurance (number of pull-ups), flexibility (sit-and-reach), and body composition (skinfolds). Locations for the skinfolds and the sit-up protocol used were not described.

The results of the Pate, et al., (1997) study indicated that children demonstrated significantly higher fitness scores when the mother or both parents were perceived by the child to be active. No significant gender interaction was found for family activity habits and children's physical fitness levels. Further analysis indicated that flexibility scores were the greatest for the group of children who reported that the mother was most active. When the father was identified as the most active family member cardiorespiratory endurance performance was the highest, but flexibility scores were the lowest. The authors suggested that mothers encourage more stretching and moderate activity participation; whereas, fathers encourage more vigorous activity habits. Among all of the participants, the lowest performances on all fitness measures were demonstrated by the children who identified no family members as being physically active. The results indicated that when parents were not active and influencing their children to be active as well, other influential factors must play greater roles in getting children active. For example, where family members are not active themselves, factors such as school physical education may become especially important in getting children to become involved in physical activity.

School physical education. Schools offer many opportunities for children to become involved in various school and extracurricular activities, including physical activity. The frequency, duration, and quality of physical education programs have significant effects on the physical fitness of school-aged children (McKenzie, et al., 1996; Sallis, et al., 1997). A program that meets for more minutes during the week and focuses on continuous activity will likely have more positive outcomes than a program that meets on fewer occassions and does not provide opportunities for the children to be continuously active during class (Sallis, et al., 1997). However, there is the question of whether children are participating in sufficient moderate to vigorous physical activity during physical education classes. Pate, et al., (1996) reported that approximately 92% of elementary and middle schools require physical education classes; however, only 27% of these same school children participated in physical activity of a sufficient intensity to produce fitness benefits. Similar results were reported by Ross and Pate (1987). In their study, 97% of elementary level children were enrolled in physical education classes; however, less than 30% of their physical education class time was spent on actual vigorous physical activity.

Sallis, et al., (1997) implemented a two-year physical education program specifically designed to increase physical activity and fitness levels. Seven elementary schools and 955 fourth grade physical education students in those schools participated in this study. Schools were assigned one of three groups: (a) physical education taught by a specialist; (b) physical education led by a trained classroom teacher; (c) and physical education led by an untrained classroom teacher (control group); however, no discussion was provided on whether the assignment of schools to treatment groups was random. Health-related physical fitness included measures of cardiorespiratory endurance (1.0 mile run), abdominal strength/endurance (60-second bent knee sit-ups), upper body strength/endurance (pull-ups), flexibility (sit-and-reach), and body fatness (calf and tricep skinfolds). Trained observers used the System for Observing Fitness Instruction Time (SOFIT) protocol to evaluate the physical education program at each school (McKenzie, Sallis, & Nader, 1991).

Physical education classes led by specialists met for an average 79.7 minutes per week, while those with trained classroom teachers met 64.6 minutes per week, and the control classes 38.0 minutes per week. Through observation, it was indicated that during these classes, the control group students were moderately to vigorously active 17.8

minutes/week, trained teacher-led classes 32.7 minutes/week, and specialist-led 40.2 minutes/week. Significant positive contrasts were indicated for both the amount of physical education per week and the activity level of the students. The outcome of the observations indicated that not only was the duration of physical education classes important in participating in sufficient levels of physical activities, but also that the leadership within these classes played a role in the type and duration of activity participation.

All participants, regardless of group, demonstrated similar performance on each of the fitness measures during the pretest at the beginning of the two-year program, with the exception of the mile run, where the trained teacher-led group performed significantly higher than the specialist-led and control groups (Sallis, et al., 1997). At the conclusion of the two-year period, the specialist-led group performed significantly better on all fitness measures, with the exception of upper body strength/endurance and flexibility for males only. For the male participants, body composition remained relatively stable; whereas, for females there was a non-significant increase in percent body fat for the specialist-led group and decrease for the teacher-led and control groups. The authors suggested that the combination of the duration of physical education classes and leadership within these classes most likely led to the improvements in health-related physical fitness of children. Several investigations have reported similar results regarding the influence of frequency of physical education participation on the physical fitness of children (Centers for Disease Control and Prevention, 1997; McKenzie, et al., 1996).

For some children, physical education classes provide the only opportunity during the day to be physically active, making the duration of each session important to the attainment of physical fitness (McKenzie & Sallis, 1997; Strand, Scantling, & Johnson, 1997). This was evident in Ignico's study (1994) which followed a group of 434 students through grades 1-5 in two physical education programs, one meeting twice per week for 30 minutes (60 minutes total per week) and the other five times per week for 30 minutes (150 minutes total per week) per session. The hypothesis was that children in the twice per week program would not participate in sufficient moderate to vigorous physical activity in order to achieve health benefits.

Each participant was evaluated thrice yearly on four measures of fitness, namely cardiorespiratory endurance (1.0 mile run), percent body fat (skinfolds), flexibility (sit-and-reach), and abdominal strength/endurance (sit-ups) (Ignico, 1994). The results indicated that participants in the daily physical education programs demonstrated superior performance across grades on all measures of fitness. Additionally, all of the participants in the daily physical education group performed at or above the 50th percentile, and in many cases above the 75th percentile, on all measures. In comparison, all participants in the twice weekly program performed at or below the 50th percentile, with many below the 25th percentile, on all fitness measures, with minimal improvement seen over the course of the study. Follow-up testing revealed that when the students in the daily physical education program entered middle school and began a two times per week program, cardiorespiratory measures decreased slightly.

In summary, physical education programs provide children with opportunities to improve important health-related benefits. However, the literature indicates that this is only true where the programs are characterized by sufficient fitness related activities and are taught by qualified professionals.

Physical activity participation. Participation in regular physical activity has been found to influence the physical fitness of children (Colchico, Zybert, & Basch, 2000). There has been a decline in the support generated for and frequency in which physical education is being offered within schools, and this has led to an increase in the emphasis placed on participation in physical activities within the community (Ross, Dotson, Gilbert, & Katz, 1985). Dale, Corbin, and Dale (2000) reported that when children are not physically active in the school setting through physical education or recess, they typically do not compensate for this inactivity outside of the school setting.

Colchico, Zybert, and Basch (2000) completed a study using a small sample of 30 female students between the ages of 11 and 14 years. Each student participated in a physical activity program designed specifically to increase activity and fitness levels three times a week for a period of 12 weeks. Fitness was evaluated using cardiorespiratory endurance (1.0 mile run/walk), upper body strength/ endurance (60-second push-ups), abdominal strength/endurance (60-second curl-ups), flexibility (sit-and-reach), body mass index, and percentage body fat (tricep and calf skinfolds). Additionally, self-perceptions were evaluated by the Self-Perception Profile for Children using a modified 5-point Likert scale (Harter, 1985). The results indicated significant improvements on all fitness measures, as well as self-perception scores. The improvements in fitness measures of cardiorespiratory endurance, abdominal strength/endurance, upper body strength/endurance, and flexibility were significant at the $p < .00$ level. Body mass index improved significantly at the $p < .01$ level, and percentage body fat at the $p < .05$ level. The greatest changes in self-perception ($p < .01$ and $p < .00$) were for social acceptance, athletic competence, behavioral conduct, and global self-worth. This conclusion lends support to the importance and value of participation in structured after school sports and recreational activities for enhancing children's physical fitness levels and psychological well-being.

Factors Specific to Deafness

Some factors that influence physical fitness may be specifically related to deafness. These factors include the age at onset and level of hearing loss, parents' hearing status, and school placement.

Age at onset of hearing loss. Age at onset of hearing loss is classified as being congenital or acquired (Batshaw, 1997). The most common cause of congenital deafness is an inherited autosomal recessive genetic disorder, accounting for approximately 70% of cases of deafness present at birth. Spinal meningitis is the most common cause of acquired deafness, accounting for approximately 20% of all cases of acquired hearing loss. None of the reported studies that have evaluated health-related physical fitness has indicated type and cause of hearing loss of the participants (Goodman & Hopper, 1992).

Age at onset of hearing loss has not been evaluated relative to health-related physical fitness measures. Generally, the studies that have evaluated age at onset have focused on skill-related fitness (Boyd, 1965; Brace, 1936; Long, 1932; Myklebust, 1964). The results of these studies indicated that, as a group, participants with congenital deafness performed better than the acquired deafness group on skill-related fitness variables of balance, speed, coordination, power, and coordination. However, within each study, hearing participants performed higher on all measures than all deaf participants. There is the possibility that age at onset may affect health-related physical fitness due to the affects found between age at onset and motor skill performances. For example, many physical activities require adequate levels of balance in order to perform movements efficiently (Payne & Isaacs, 1999). The majority of investigations that evaluated balance of deaf children have indicated this to be a common problem for children with acquired deafness, especially that caused by meningitis (Goodman & Hopper, 1992). This could indicate a potential indirect relationship between age at onset of hearing loss and physical fitness performance of deaf children.

Levels of hearing loss. The degree of hearing loss basically refers to the decibel (dB) loss in the better ear, with higher severity losses having some communication implications (Sherrill, 1998). Levels of hearing loss are described in Table 2. Still, many children with severe to profound hearing losses are educated in residential school settings. The moderate to severe level is of importance because it is the minimal baseline (>55 dB) for eligibility to participate in Deaf sport (Stewart, 1991).

Existing research regarding the physical fitness of deaf children with respect to degree of hearing loss share several commonalities including how hearing status is reported within the literature. First, most of those studies have not evaluated degree of hearing loss and age at onset separately, rather combining the two as groups (i.e., acquired, hard of hearing = 27 dB to 90 dB and congenital, deaf = exceeding 90 dB). Secondly, the studies that have evaluated degree of hearing loss as an independent variable have focused on skill-related physical fitness and fundamental motor skills rather than health-related physical fitness (Butterfield, 1983; Campbell, 1983; Goodman & Hopper, 1992; Morsh, 1936). Other more recent studies that investigated the health-

Table 2

Levels of Hearing Loss

Decibel Loss (dB)	Category or Degree of Hearing Loss	Communication Skills
26 – 40 dB	Mild	Likely no difficulties
41 – 55 dB	Moderate	Can benefit from amplification
56 – 70 dB	Moderate to Severe*	Can benefit from amplification
71 – 90 dB	Severe	Some can benefit from amplification and speech therapy
Over 90 dB	Profound	Communication deficiencies likely even with use of amplification Speech therapy necessary

*Important level due to hearing losses exceeding 55 dB required for participation in Deaf sport

Adapted from Sherrill (1998)

related physical fitness of deaf children have not reported age at onset and level of hearing loss information. Because of this, the amount of information regarding the effects of age at onset and degree of hearing loss on health-related physical fitness of deaf children is limited.

Since age at onset and degree of hearing loss have not been evaluated in any study focusing on the health-related physical fitness of deaf children, these variables cannot be eliminated as potential influential factors. There are several hypotheses that can be speculated regarding the effect, if any, that age at onset and degree of hearing loss have on a deaf child's physical fitness levels. One such hypothesis could be that a child with an acquired hearing loss due to meningitis may demonstrate lower fitness levels due to potential underlying balance deficiencies related to meningitis. Another possible hypothesis may be that an individual with a hearing loss of more than 90 dB may have greater communication barriers which affect physical fitness levels through reduction in the opportunities to participate fully in physical activities. However, these hypotheses are highly speculative until evidence is available regarding the effect of age at onset and degree of hearing loss on the physical fitness of deaf children.

Parents' hearing status. Stewart (1991) indicated that deaf parents are more likely than hearing parents to be aware and knowledgeable of sports opportunities for their deaf children. This evidence was generated from years of experience within the Deaf community rather than an empirical study. However, Stewart's (1991) postulation was supported by a study completed by Ellis (2001). Using a sample of 73 deaf students between the ages of 6-16 years, physical fitness was evaluated using a combination of the Fitnessgram and AAHPERD fitness tests. A short questionnaire was used to evaluate parents' hearing status and physical activity levels in order to determine the probability that the child would be introduced into Deaf sport by family members. Parents' hearing status was divided into three groups: (a) both deaf; (b) both hearing; and (c) one deaf/one hearing. Data analysis indicated that not only did deaf students with two deaf parents demonstrate better performances on all fitness measures than children with one or both hearing parents, but also greater participation in physical activity as well. Deaf students with two hearing parents demonstrated the lowest frequency of community sports participation, lowest overall fitness scores, and highest percentage body fat. These results support the notion that hearing parents may not only have less awareness of physical activity opportunities for their deaf children, but also may be apprehensive in allowing their children to be involved in physical activities (Moores, 1996; Stewart, 1991, Vernon & Andrews, 1990).

School placement. Prior to the implementation of the Individuals with Disabilities Education Act (IDEA) (Federal Register, 1977), the majority of deaf children attended schools for the deaf, an educational placement which was explicitly designed to meet the educational, communicative, and social needs of deaf children (Moores, 1996; Stewart, 1991). Now more than 75% of school-aged deaf children attend public schools, with educational placements ranging from total integration in regular classes to total segregation in deaf education, or self-contained, classes (Moores, 1996). There may be differences in educational, communication, and social opportunities in different educational placements, including physical education classes and extracurricular activities.

Winnick and Short (1988) evaluated the fitness levels of deaf children attending various school placements using the deaf and hard of hearing sample from their 1986 study. The participants were divided based on their educational placement which consisted of 599 residents of deaf schools, 318 non-residents of deaf schools, and 128 public school students. No information was provided about the class placement of deaf students within the public schools, communication modality used, or of any additional demographic characteristics pertaining to parents, activity, schools, or deafness.

The results indicated that deaf residential students performed significantly better on measures of cardiorespiratory endurance and abdominal strength/ endurance than non-residents and public school students. The residential students also demonstrated higher flexibility scores and lower percentage body fat; however, these results were not statistically significant (Winnick & Short, 1988). The overall conclusion from this study indicated that deaf children educated in residential schools demonstrated higher fitness levels than deaf and hard of hearing students who were placed in other educational settings. No comparisons were made to the hearing children from the Winnick and Short (1986) sample to determine how the residential students measured up, neglecting a valuable piece of information.

Ellis (2001) measured the health-related physical fitness of 73 deaf children aged 6-16 years who were categorized as either residents or non-residents of the school for the deaf in which they were students. Fitness measures included cardiorespiratory endurance (timed 1.0 mile run), flexibility (back saver sit-and-reach), abdominal strength/endurance (60-second bent knee sit-ups), upper body strength/endurance (modified pull-ups), and percentage body fat (tricep and calf skinfolds). Directions to all fitness tests were presented via spoken communication and contact sign language, and were supplemented by demonstrations. The residential group performed significantly better on all measures of fitness. There were no gender differences among fitness variables up through 10 years of age; however, after the age of 10, males performed significantly higher on all measures than did females. When compared to age- and gender-specific national norms developed for hearing children, as indicated by AAHPERD standard norm scales (AAHPERD, 1994; Hastad & Lacy, 1998), the deaf children demonstrated performances which fell below the 40th percentile on all measures, with the exception of flexibility. There were also a number of cases where performances fell below the 20th percentile, mainly on cardiorespiratory endurance and percent body fat. This indicated that the deaf participants as a group performed below median norms on nationally recognized fitness protocols.

From the few studies that evaluated school placement and physical fitness levels of deaf children, the general consensus is that residential students have demonstrated higher fitness levels than non-residential and public school students. Residential schools have historically promoted social and cultural education as part of their overall curriculum and also tend to have smaller student populations leading to increased opportunities for participation in school-wide activities, an opportunity which could positively influence the physical fitness levels of deaf children (Moores, 1996; Schirmer, 2001).

Summary

Studies which have investigated the physical fitness level of deaf and hard of hearing children have reported this group to demonstrate lower fitness levels than their hearing peers. There are no obvious reasons why deaf children should demonstrate lower physical fitness than hearing children. In fact, there is no information within the literature which evaluates the factors which may affect the physical fitness of deaf children. Potential factors may be those which have been found to influence the physical fitness of hearing children, namely physical activity participation, parents, and school physical education. In addition, other factors may be more specific to deafness and include school placement, age at onset of hearing loss, and level of hearing loss.

CHAPTER 3

Methods

The purpose of this study was to investigate factors that influence the physical fitness levels of deaf children. Physical fitness was evaluated using the Fitnessgram test battery, and information regarding demographic and school variables was obtained from questionnaires completed by school personnel and parents/guardians.

Research Design

The study design can be characterized as ex post facto in that participants had already been categorized or placed within a certain group through natural selection prior to this study. Independent variables consisted of level of hearing loss, etiology of hearing loss, parents' hearing status, school placement, school physical education, and physical activity participation. Dependent variables included the health-related physical fitness measures of cardiorespiratory endurance, body fatness, flexibility, abdominal strength/endurance, upper body strength/endurance, and overall Healthy Fitness Zone scores.

The independent variables such as etiology and level of hearing loss were stable and not changed by this study. The investigator had no control over the outcome of the independent variables, i.e., could not decide school placement for a student or hearing status for a parent. Therefore, using the causal-comparative method, the influence that each ex post facto independent variable had on the dependent variable (fitness measures) was determined. Cause and effect was not be determined using this method, but rather the potential of each factor to influence, along with other factors, the outcome of each fitness variable. The influence of independent variables on the dependent variables was determined through group comparisons. As an example, students were grouped based on their school placement in *regular* or *special* schools and then compared on fitness variables.

Minimizing Threats to Internal Validity

Threats to internal validity included time, selection, and mortality threats. Group threats (e.g., control versus experimental) did not apply to this study because there is only one experimental group. The methods undertaken for minimizing the remaining threats to internal validity are discussed in the following paragraphs.

Threats to internal validity due to time included those related to history, maturation, test reactivity, and instrumentation. History may be a threat when an unintended event occurs during the testing period or during the individual's life that affects only specific individuals and not other participants. This threat was difficult to minimize as incidents or events may vary from day to day. For example, students may become ill or experience an injury. Threats to internal validity due to history were minimized by completing all fitness tests on one testing date. Using this short testing period also reduced the chance of threats to internal validity caused by maturation, or the occurrence of growth and development during the testing procedure that could lead to changes in performance. Fatigue is a maturation threat that was more likely within this study, and was reduced by having the exhausting tests (PACER, curl-ups) interspersed within the less demanding tests (flexibility, skinfolds). The fitness tests included the PACER which was a measure of cardiorespiratory endurance, the curl-ups and push-ups were measures of muscular strength/endurance, the trunk lift and back-saver sit-and-reach were measures flexibility, and skinfolds were a measure of percent body fat. This scheduling allowed students to rest both between tests and during the less exhausting tests.

Some students may have already participated in the fitness tests through their physical education classes and were more familiar with them than students who had no prior experience with the testing protocol. This posed a threat to internal validity due to testing effects. Practice trials were allowed for the fitness tests to ensure that participants were familiar with the expectations of each test. This also increased the chance that the participant demonstrated his/her best performance when tested, thereby minimizing testing effects.

Instrumentation refers to unintended changes to testing procedures or equipment that could have affected test results. However, problems associated with instrumentation were reduced by using a standardized fitness test battery, calibrating and checking equipment (e.g., stopwatch, weight scale, calipers) before each testing session, and following the same test administration procedures during each evaluation period.

Another threat to internal validity was subject mortality. Students may have indicated that they wanted to participate only to later change their minds, have an injury, or absence that might prevent participation. This threat was minimized by the organization and administration of the study. First, all tests were performed on the same day, reducing any chance that a student would drop out due to the short time interval. Additionally, experienced investigators administered all test procedures and provided close supervision of each student's participation, decreasing the chances of injury. Although subject mortality was a possibility, in fact, no participants were injured or withdrew during the testing procedures.

Minimizing Threats to External Validity

External validity referred to the potential for the results of the study to be generalized to other settings. A representative sample of deaf children in first through fourth grades participated in this study. Limitations were not placed on school settings; therefore, this study can be generalized to deaf children in the first through fourth grades in both *special* and *regular* schools. This study employed the Fitnessgram (Cooper Institute of Aerobic Research, 1999) a common school-based field test for measuring physical fitness of school-aged children, increasing the generalizability to school systems using this protocol.

Another threat to external validity was that the students' behavior in the experimental setting may have been different than their behavior in their regular physical education class or classroom setting This study involved having other individuals (the investigator, teacher, classmates) observe each participant's performances, with the exception of individual measures of skinfolds, height, and weight. This may have caused the students to perform better or worse than they would have in their regular physical education class due to placing them on a "grandstand" when performing in front of other individuals. These results may not generalize to deaf children in real-life situations. Most tests were completed during their regular physical education classes, which made this threat to external validity difficult to minimize. Consistent adherence to the standardized Fitnessgram administration procedures assisted in reducing this threat to external validity by administering fitness tests exactly the way they would be by others using the same test protocol.

Participants

The sample included students from *regular* and *special* schools in a midwestern state. *Regular* schools consisted of public schools from various sized school districts and within rural, suburban, and urban locations. The *special* school setting was represented by the state school for the deaf. Deaf students in grades first through fourth from these schools participated in this study.

Selection Criteria

Students satisfied the following criteria in order to participate in this study:

1. Participants were deaf with no multiple disabilities.
2. Participants were students within the first through fourth grades.
3. Participants had at least a 55 dB hearing loss in the better ear.

Recruitment of Participants

Information letters were sent to school administrators at public schools across the midwestern state, as well as the state school for the deaf. School administrators completed a survey pertaining to demographic information about their school and students, and a consent form granting permission to contact students' parents/guardians and allow use of the school facilities. A self-addressed stamped envelope was provided for the return of completed materials to the investigator.

Information packets were sent to parents/guardians of all deaf children in the first through fourth grades at each participating school. Information packets were sent home to parents/guardians by the child's classroom teacher or Hearing Impaired Coordinator for the school district. The packets consisted of a letter describing the study, request for the child's participation, demographic survey, and a consent form. As with school administrators, self-addressed stamped envelopes were provided for the return of completed materials to the investigator.

Follow-up letters were sent to school administrators and parents/ guardians if information was not received within three weeks after mailing the information packets. In several cases, follow-up emails were conducted to ask the teacher to encourage parents to submit the consent form, allowing the investigator to know if the child would participate.

Sample Size

Fifty-one deaf children (*n*=30 males; *n*=21 females) in grades first through fourth participated in this study. The potential eligible sample size given the criterion and grade level was identified to be in excess of 208 students from the schools who were asked to participate. This was a small sample size in terms of statistical power (Cohen, 1982), but nevertheless, large for a group of deaf children from one state. After completion of this study the investigator contacted all of the Hearing Impaired Coordinators to discuss potential reasons why there was a low number of students participating. Several coordinators indicated that it was not unusual to have low parent approval within their home school district, while others were unsure why more parents did not give permission. However, all agreed that the short timeline allocated by this study may have hindered getting some consent forms back from the parents and if given a second round of consent forms may have had more participants. While the exact reasons are unknown why more students did not participate in this study, possible reasons for low participation include parents forgetting to return consent forms, disinterest in information that testing would provide both to the parent and school, not wanting their children to be considered "subjects" of a study, and/or lack of time to return consent information to parents and schools.

Informed Consent Procedures

The informed consent process was initiated by obtaining approval from the Michigan State University Committee on Research Involving Human Subjects (UCRIHS). School administrators and parents/guardians of students in the first through fourth grades at each participating school were asked to give written informed consent. After being presented with signed/spoken directions and demonstrations of each test and expectations, each student gave spoken and/or signed assent to participate. UCRIHS approval is documented in Appendix A.

Instrumentation

Physical fitness was evaluated using the Fitnessgram test battery. Fitness measures included cardiorespiratory endurance, percent body fat, flexibility, abdominal strength/endurance, and upper body strength/endurance. The results of pilot studies evaluating the reliability and validity of a modified Fitnessgram test battery for evaluating fitness of deaf children are shown in Appendix B. Two surveys were used to obtain information relating to school, child, and parent factors (Appendix C). A school administrator completed the survey relating to school physical education, location, and number of deaf students enrolled. The parents/guardians completed a survey regarding their child's hearing loss and physical activity participation, as well as their own hearing status.

Fitnessgram

The Fitnessgram test battery was used to determine the health-related physical fitness of deaf children in grades first through fourth (Cooper Institute of Aerobic Research, 1999). The Fitnessgram focuses on the components of fitness that are most important to overall health and well-being. In contrast to many older fitness tests, such as the AAHPERD physical fitness tests (AAHPERD, 1984), Fit Youth Today (American Health and Fitness Foundation, Inc., 1986) and the President's Challenge Physical Fitness Test (President's Council on Physical Fitness and Sports, 1993), the Fitnessgram does not employ guidelines of reaching above a certain normative baseline level (i.e., above the 85th percentile) or performance criterion (i.e., complete at least 30 sit-ups in one-minute). The Fitnessgram uses a Healthy Fitness Zone that represents "lower" and "upper" performance levels associated with sufficient physical fitness to help prevent hypokinetic disease. The lower and upper performance levels are criterion referenced standards; however, research has shown that they correspond approximately to the 20th and 60th percentile levels for most age and gender groups (Cooper Institute of Aerobic Research, 1999). Blair, Kohl, Gordon, and Paffenbarger, (1989) reported that the greatest increases in optimal health occur when an individual moves above the 20th percentile level, with performances anywhere above this point considered sufficient. The purpose of the Healthy Fitness Zone was to establish a range of "good" fitness associated with protection against hypokinetic diseases. The area above the "upper" limit was termed "better" fitness and was suggested as a motivation factor for improving fitness levels (Cooper Institute of Aerobic Fitness, 1999). The Fitnessgram consists of valid and reliable tests that have been recommended to measure physical fitness of children aged 5 years and older.

Cardiorespiratory endurance. The authors of the Fitnessgram provide three choices for the measure of cardiorespiratory endurance, namely the PACER, one-mile run, and the walk test. The PACER was chosen because it was more appropriate than the longer endurance runs for testing younger children (Cooper Institute of Aerobic Research, 1999). The PACER consists of a 20 m shuttle run in which the pace becomes progressively quicker. Additionally, the PACER is an indoor test that can be performed in any location that is flat and at least 30m in length.

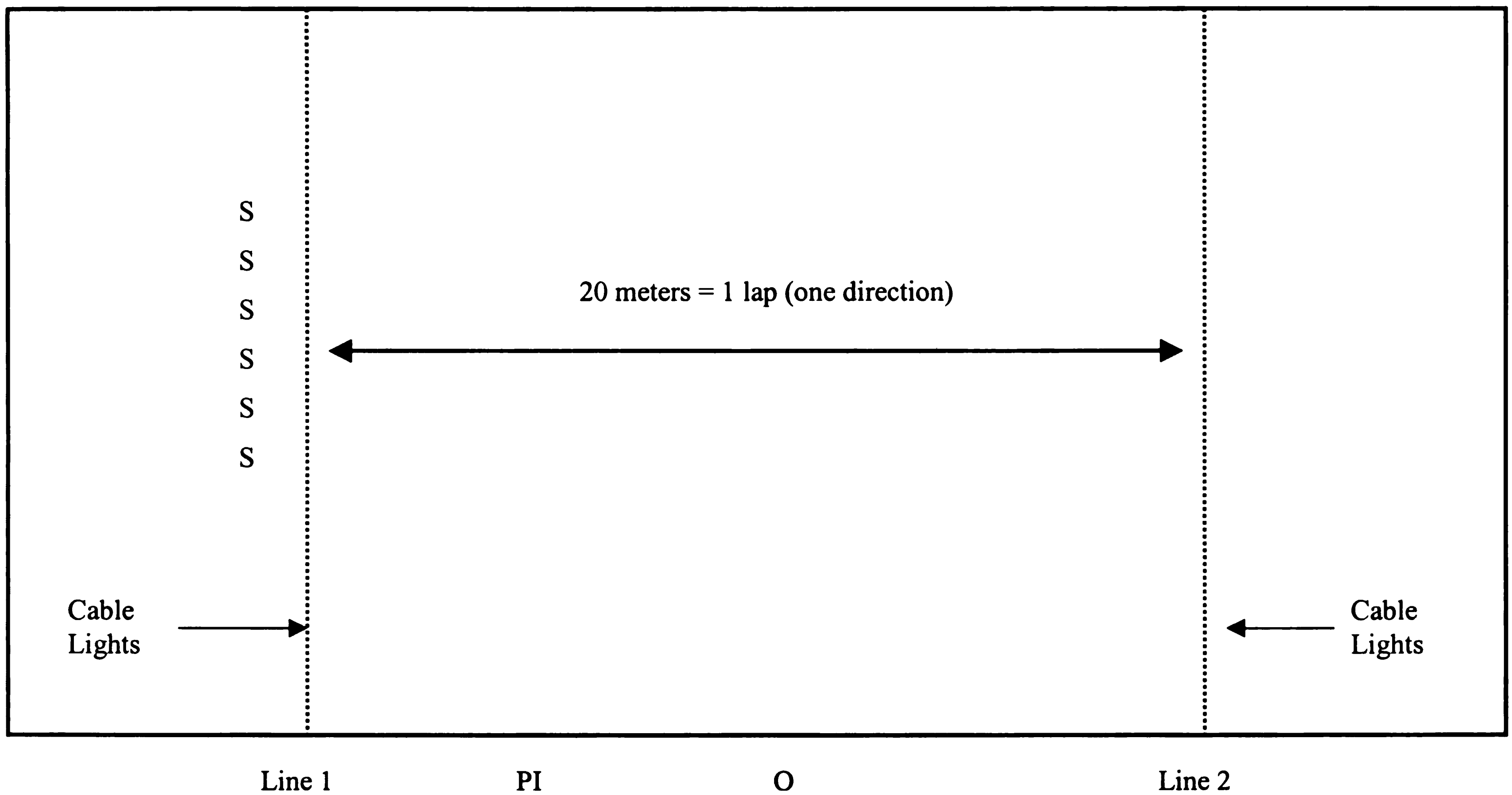
Directions for administering the PACER were followed according to the Fitnessgram test administration manual (Cooper Institute of Aerobic Fitness, 1999). The PACER uses an auditory compact disc (CD) that beeps to inform students when to start running. Two parallel lines 20m apart are marked by cones, chalk, or marking tape. Students line up at the first line, wait for the beep, and then run the 20m distance to the second line, turn and wait for the next beep before running back to the first line. Students continue this running pattern until they are unable to reach the line before the beep occurs. However, students are allowed one “miss” if they are not able to reach the line before the beep the first time. When this happens, students are instructed to immediately turn and run to the next line in an attempt to catch up with the pace. The PACER is officially over when the student, for the second time, is unable to reach the end of the 20m distance before the beep occurs. This test is scored based on the total number of 20m laps that the student is able to complete before being unable to continue performing at the increasing pace.

The PACER starts slow and becomes progressively faster with each passing minute. During the first minute, cues are given every nine seconds, with a half-second pace increase every minute (second minute: one lap/8.5 s; third minute: one lap/8 s, and so forth). After the end of each minute, a rapid succession of three beeps occurs to warn participants that the pace will be increasing. Using this pace, the range of performance would be from zero laps to a maximum of 305 laps total. However, given the quick pace and the young age of the participants, a realistic performance for an individual with very high cardiorespiratory endurance would be the ability to complete one lap in 5 seconds (consistent with the 9 minute level), or a maximum of 80 laps.

Because the auditory cue was inappropriate for deaf children, a 24-foot string of cable lights were used to mark each starting line, substituting visual cues for the auditory beeps (Figure 1). The two lines of cable lights separated the 20 m distance (Figure 2). These lights were activated by a hearing assistant each time a beep was heard on the CD recording. After each minute, the lights flicked rapidly to warn students that the pace was increasing. The deaf children completed the PACER using these visual cues as a hearing child would the auditory cues.

The PACER has been determined to have acceptable validity for use with hearing children. In fact, the PACER is the preferred method for evaluating cardiorespiratory endurance in prepubescent children, as many forms of distance runs have demonstrated low reliability and validity among this population (Cooper Institute of Aerobic Research, 1999). This could be due to the difficulty of motivating children for completion of the distance run and lack of comparative information for shorter distances (i.e., half-mile run). A pilot test was conducted to determine the feasibility of the PACER as a measure

Figure 1. The PACER Test.



PI = Project Investigator
O = Hearing person activating cable lights
S = Students

Figure 2. The PACER Test.

of cardiorespiratory endurance for deaf children using the visual light cues. Twenty-one deaf children between the ages of 6-11 years completed a one-mile timed run and two measures of the PACER, with tests being performed one week apart (Appendix B). Pearson correlations were found to be $r = -.70$ between the mile and the first PACER test and $r = -.74$ between the mile run and the second PACER. These results indicated moderately high concurrent validity for the PACER run using the cable lights. Validity has been reported to be between $r = .52$ to $r = .93$ when compared to maximal oxygen consumption measured via a treadmill stress test (Safrit, 1995; Vincent, Barker, Clarke, & Harrison, 1999).

The Fitnessgram authors have reported the PACER to have strong reliability (Cooper Institute of Aerobic Fitness, 1999). A pilot test was conducted by the investigator to determine reliability between two measures of the PACER test using 21 deaf children between the ages of 6-11 years (Appendix B). A moderately high test-retest correlation of $r = .79$ was reported between the first PACER and the second PACER. The results of this pilot study indicated that the visual cues were suitable for this test, and that the PACER was an appropriate measure of cardiorespiratory endurance for this sample of deaf children. Reliability has been reported between $r = .89$ to $r = .98$ for hearing children of both genders and between the ages of 6-12 years (Safrit, 1995; Vincent, et al., 1999).

Body composition. The Fitnessgram authors offer two options for measuring body composition, skinfold measures and body mass index (BMI). Percent body fat was evaluated by the recommended tricep and calf skinfolds measured in millimeters using Lange skinfold calipers. BMI could have been used as it only requires knowledge of an individual's height and weight. However, skinfold measures have higher validity when compared to laboratory measures of percent body fat (Rowland, 1999), and were therefore selected instead of BMI.

Tricep skinfolds were measured by a vertical fold on the back of the right upper arm, halfway between the elbow and the acromion process. This location was identified by the investigator using a piece of string or ruler to determine the midpoint (Cooper Institute of Aerobic Research, 1999). The vertical fold was grasped just above the marked location to ensure that the measurement was taken at the midpoint. Subjects were instructed to relax their arms during this skinfold measurement.

Vertical calf skinfolds were taken on the inside right calf at the location of maximum circumference. Each participant flexed his/her leg to a 90° angle with the foot on an elevated, flat surface, such as a step or stool. The participant was instructed to keep the foot flat on the surface so not to flex the leg muscles during measurement. Maximum circumference was visually identified, marked, and the skinfold grasped just above this location in order for measurement to occur at the specified site (Cooper Institute of Aerobic Research, 1999).

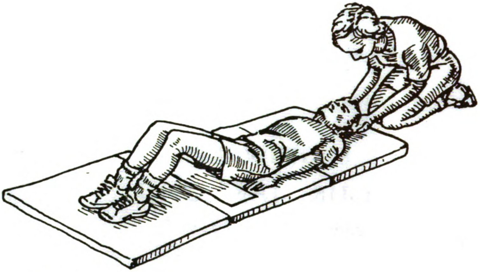
Each skinfold was grasped and pulled slightly away from the body by the investigator's thumb and pointer finger (Cooper Institute of Aerobic Research, 1999). Skinfolds were re-grasped for every successive measurement. At each location, three consistent measures, with each skinfold rounded to the nearest 0.5 mm, were taken with the median (middle score) value being recorded for investigative purposes. To ensure consistency of measures, the triceps or calf skinfold readings did not vary by more than 3 mm among readings (Hastad & Lacy, 1998). If individual skinfold measures varied by more than 3 mm among the three trials, the investigator ceased that round of measurement and repeated all measures. Median skinfold measure values were entered into the Fitnessgram computer program, and percent body fat was calculated automatically for each participant using the Slaughter et al. (1988) equations.

Estimating percent body fat from tricep and calf skinfolds is recommended for the field-testing of children aged 6-11 years (Lohman, 1987). Use of these two anatomical sites has been reported to have a good level of validity, with a 3% to 5% error rate when compared to underwater weighing (Cooper Institute of Aerobic Research, 1999). Hastad & Lacy (1998) defined *good* validity as being between $r = .60$ and $r = .80$. Validity for hearing children has been reported between $r = .70$ and $r = .90$ when compared to underwater weighing procedures (Safrit, 1995). Pilot testing indicated a reliability coefficient of $r = .98$ for measuring the percent body fat of 21 deaf children aged 6-11 years on two occasions scheduled one week apart (Appendix B). For male and female hearing children (age not reported), reliability has been reported to be $r = .95$ (Safrit, 1995).

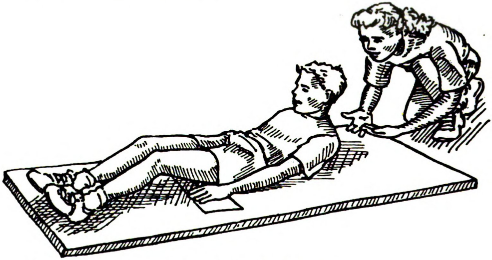
Muscular strength, endurance, and flexibility. The Fitnessgram authors describe several tests for measuring muscular strength, endurance, and flexibility. For abdominal strength and endurance, the curl-up was the only recommended choice. For the measure of trunk extensor flexibility and strength, the trunk lift was the only recommended choice. Four choices were suggested for upper body strength and endurance, namely push-ups, modified pull-ups, pull-ups, and the flexed arm hang. The push-up test was recommended. For flexibility, the choices of the back-saver sit-and-reach and shoulder stretch were given, with the back-saver sit-and-reach being recommended.

Abdominal strength and endurance was measured using the recommended curl-up test. This test has been found to be a more valid measure of abdominal strength/ endurance than the sit-up test where performance is assisted by the hip flexors (Hastad & Lacy, 1998). Participants lay in a supine position on a gym mat, with feet flat on the floor, knees flexed at approximately 140°, and arms placed to the sides with palms face down on the mat. A 3.0- or 4.5-inch measuring strip was placed under the participant's bent legs so that the tips of the fingers touched the top of the strip when the participant was lying on his/her back in a stationary position (see Figure 3). The 3-inch strip was used for participants up through 9 years of age and the 4.5-inch strip for participants 10 years and older.

Each participant raised the upper body and shoulders in a "crunch" fashion so that the hands moved passively over and touched the bottom of the measuring strip and then returned to the starting position. This movement was performed in a slow, deliberate manner of one curl-up every three seconds. Cadence is usually maintained by having subjects listen to beeps recorded on a compact disc (CD). The auditory recording of the cadence is inappropriate for deaf children. Modifications were provided by the investigator in the form of visual hand cues. She raised her hand on the 1- and 2-second count, and lowered it on the 3-second count (Figure 4). Participants were instructed to begin movement when the hand was raised, and then lower the trunk to the starting position when the arm was lowered. Participants continued this sequence until they reached a maximum of 75 curl-ups or were unable to continue the pace. The number of curl-ups performed ranged from zero to a maximum of 75.



Starting position for the curl-up test.



Position of student in the "up" position for the curl-up test.

Figure 3. The Curl-Up Test

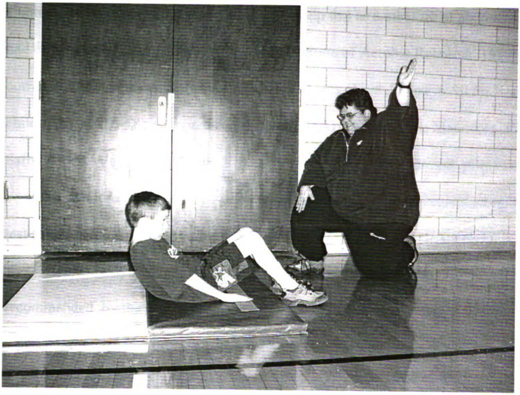


Figure 4. The Curl-Up Test.

Content validity has been assumed for the curl-up test as a measure of abdominal strength and endurance of hearing children (Cooper Institute of Aerobic Research, 1999). Pearson correlation has indicated test-retest reliability values of $r = .78$ to $r = .90$ for hearing children ages of 6-18 years on the curl-up test (AAHPERD, 1994; Massicote, 1990; Safrit, 1995). Validity for use with deaf children was reported through pilot testing to be $r = .90$ for children for ages 6-11 years when compared to the 60-second sit-up test and test-retest reliability was reported to be $r = .88$ for the same group (Appendix B).

Upper body strength and endurance was evaluated using the push-up test as recommended by the Fitnessgram authors (Cooper Institute of Aerobic Fitness, 1999). Participants began in a prone position with the palms of the hands placed on the mat directly under their shoulders, toes touching the mat, and legs slightly apart and straight. The body was lowered as a unit until the arms reached a 90° angle, then returned to the starting position for the completion of one push-up. According to the Fitnessgram manual, participants performed the push-ups to a auditory three-second cadence similar to that used for the curl-ups. Because the auditory cues were inappropriate for use with deaf children, the investigator substituted visual cues. She kneeled directly in front of the participants, lowered her hand onto the floor during the 1- and 2-second count, and raised her hand on the 3-second count (Figure 5). Participants were instructed to reach the point where their arms were bent at 90° angles when the hand reached the floor, and move their bodies back to the starting position when the hand was raised. The total number of push-ups completed before the subject was unable to continue or keep up with the pace was recorded, with the range being zero to an unlimited maximum number.

Figure 5. The Push-Up Test.

Reliability coefficients for the push-up test have been reported to be $r = .87$, with the assumption of face validity for hearing participants aged 6 years and older (Johnson & Nelson, 1986; Massicote, 1990). Through the pilot test, validity was determined to be $r = .95$ for hearing children aged 6-12 years comparing the 3-second cadence push-ups with the regular, no cadence, push-ups test. The pilot studies indicated reliability and validity data of the 3-second cadence push-ups for evaluating deaf children to be $r = .92$ for children aged 6-11 years (Appendix B).

The back-saver sit-and-reach was used to measure flexibility of the lower back and thighs. This test was recommended by Fitnessgram authors instead of the regular sit-and-reach because it prevents hyperextension of the knees and back by testing one side at a time (see Figure 6). The back-saver sit-and-reach protocol consists of a box with a measuring stick or ruler placed on the top. The zero measure on the ruler was at the end facing the student and extending outward, with the nine-inch point marking the location where the student places his/her foot. Each participant sat on the floor placing the right foot (no shoe) at the base of the box and bending the left knee, keeping the sole of the left foot flat on the ground. The student then bent forward, moving the hands along the measurement scale on the top of the sit-and-reach box.

Forward movement was performed four times with the fourth attempt held for one to two seconds for measurement to be recorded to the nearest half inch. Each participant completed the back-saver sit and reach with the left foot at the box and the right knee bent. Scoring consisted of the maximum distance, in inches, that the student was able to reach forward without bending the straight leg or bouncing. Distance ranged from a minimum of zero to a maximum of 12 inches.

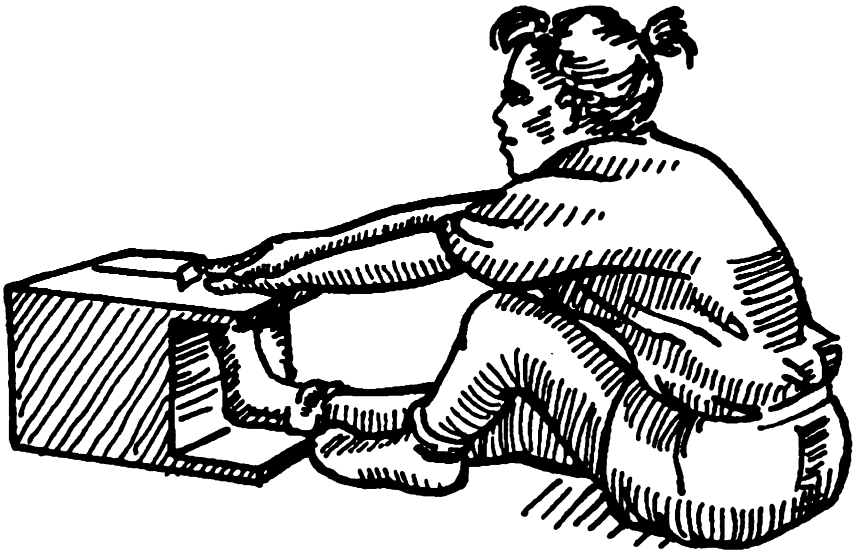


Figure 6. The Back-Saver Sit-and-Reach Test.

Content validity has been reported for hearing individuals for the back-saver sit-and-reach as an appropriate measure of back and hamstring flexibility; however, reliability values have not been reported (Hastad & Lacy, 1998; Safrit, 1995). A pilot test on two measures of flexibility completed one week apart indicated a reliability coefficient of r = .88 for ages 6-11 years for right sit-and-reach performance and r = .89 for ages 6-11 years for left sit-and-reach performance (Appendix B).

Trunk extensor flexibility and strength was measured using the trunk lift as recommended by the authors of the Fitnessgram (Cooper Institute of Aerobic Research, 1999). Participants lay face down on a gym mat with the chin resting on the mat, hands placed under the hips, and toes pointed (Figure 7). Students focused on a quarter-sized marker (poker chip) placed at the edge of the mat and directly within the line of vision. Students began by raising the upper body as far as possible without bouncing or jerking. The distance from the gym mat to the participant's chin was measured with a ruler and reported in inches. Two trials were allowed with the highest score being recorded. The distance for the trunk lift ranged from zero to a maximum of 12 inches. Content validity has been assumed for the trunk lift when evaluating hearing children; however, reliability has not been reported (Cooper Institute of Aerobic Research, 1999; Hastad & Lacy, 1998). Test-retest reliability and validity for use with deaf children was reported to be r = .96 for ages 6-11 years and r = .97 for ages 12-16 (Appendix B).

Overall physical fitness. Overall physical fitness was determined through the number of Fitnessgram tests in which performance was in or above the Healthy Fitness Zone (Cooper Institute of Aerobic Research, 1999). The lower end of the Healthy Fitness Zone does not indicate a high level of fitness, but rather the level at which significant

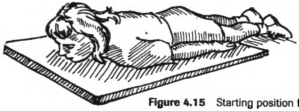


Figure 4.15 Starting position for the trunk lift.

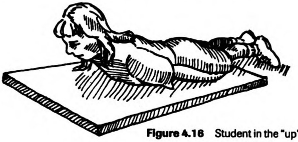


Figure 4.16 Student in the "up" position for the trunk test.

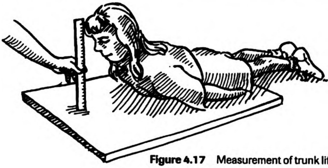


Figure 4.17 Measurement of trunk lift.

Figure 7. The Trunk Lift Test.

improvements in health occur leading to lower susceptibility of hypokinetic diseases and ease in everyday and leisure activities (Blair, et al., 1989). The Fitnessgram authors recommend that children demonstrate levels within or above the Healthy Fitness Zone in at least four of the six areas, including cardiorespiratory endurance and percent body fat. Individuals who demonstrate this requirement are deemed to have overall healthy fitness levels (Cooper Institute of Aerobic Research, 1999). No information has been reported concerning the reliability and validity of the overall Fitnessgram test.

Surveys

Three surveys were used to collect information pertaining to each school, physical education program, parent, and student (Appendix C). School administrators completed a survey about numbers and placements of deaf students within their schools. Parents completed a survey about the child's deafness (level, age at onset, etiology), child's school placement (years at present school, disability accommodations), child's physical activity participation (out of school activities), parents' hearing status (hearing or deaf), and parents' participation in Deaf community activities. The physical education teacher completed a survey regarding the school's physical education program, including days and minutes per week that the classes meet and type of communication used with deaf students.

Data Collection Procedures

Testing Schedule

Collection of fitness data occurred during one regularly scheduled physical education class period with additional time arranged as needed. At the beginning of their physical education class, students were introduced to the investigator and data collection team, and had each test explained through signed and spoken directions and demonstrations. After describing and demonstrating the tests, the investigator requested assent from each child. Students who wished to participate signed and/or spoke their intent to be a participant in the study. Written informed consent was obtained previously from parents/guardians. The testing set-up for this study turned out to be very unique. Specific testing dates and times were arranged with the schools and on scheduled testing periods school personnel brought only those children whose parents had given consent to the gymnasium, at which time all children gave their assent to participate.

After assent was obtained from the participants, students moved onto the gymnasium floor allowing enough room for stretching and warm-ups. After warming up, students lined up behind the cable lights at line #1 for the PACER test. All students completed four 20m laps as a practice trial, running from line 1 to line 2, waiting for the visual cue, and then running another lap. After completion of the practice trial, students were given several minutes to rest and cool down. Students then completed the PACER test in groups of no more than six. When performing the PACER test, participants lined up behind line #1 and began at the first visual cue, continuing as long as they are able to keep up with the increasing pace. For this aspect of the data collection period, a hearing individual, usually being the physical education or classroom teacher, activated the cable lights.

During the remainder of the physical education class, the other Fitnessgram test items were administered. Students were divided into two groups for administration of the remaining Fitnessgram tests. Group #1 completed the back-saver sit-and-reach, push-ups, and trunk lift in that specified order. Group #2 completed height and weight measures, followed by curl-ups and skinfold evaluation. After completion of the tests within their specified group, the students then rotated to the next group to complete the remaining fitness measures. Height, weight, and skinfolds were measured individually and in a private area away from other participants. This order allowed the more fatiguing endurance tests to be interspersed between one or more less tiring tests that offered rest periods. Any test items not completed after the physical education classes were conducted during a time mutually convenient to the students and teacher, usually immediately following the physical education class.

Communication Modality

Stewart, Dummer, and Haubenstricker (1990) reported that using only spoken communication was unsuitable when testing deaf students and may lead to misunderstanding of directions, inappropriate performances, and increased error with data collection procedures. Therefore, the communication modality used during group presentations included both spoken and signed communication to ensure that students were receiving the information in a way that they understood the directions. When addressing a participant during testing procedures, the communication modality of the student's choice, as identified by the parent/child survey, was used. The child's name or sign name was implemented when addressed in order to personalize the instructions. General positive feedback and encouragement was given for each test to enhance best effort performance.

Personnel

All Fitnessgram tests were administered by the investigator and trained assistants. The investigator had extensive experience and familiarity in using the Fitnessgram protocol for evaluating fitness of deaf children, most recently within grades K-12 at a school for students who are deaf, as well as with hearing and deaf children aged 6-12 years during recently conducted pilot tests. Several assistants aided with the fitness data collection. The investigator met with each assistant individually, as well as assigned and trained them on specific tests, e.g., curl-ups and the sit-and-reach to maintain consistency in testing. Directions for each test were described and demonstrated and then the assistant had to demonstrate testing competency on three consecutive measures prior to testing any of the participants. In addition, when the physical education teacher and/or classroom teacher was present, they were asked to assist with recording of data recording and general control of the class.

Timeline

Using the previously described data collection procedures, approximately 45 minutes were necessary for each individual to complete the Fitnessgram test battery, including assent, warm-up, and cool-down (Table 3). Most tests were completed within the students' regularly scheduled physical education classes. There were only three instances where additional testing time was needed to complete the tests due to the large number of students being tested during those particular sessions. Since several activities (assent, warm-up, the PACER, and cool-down) could be completed as a group, only 15 minutes were required to test each person on individual measures (e. g., skinfolds, height, weight, curl-ups). However, in the final analysis, approximately 14 testing hours (7 schools X 2 hours) were needed to evaluate the 51 study participants.

Table 3

Testing Time

Test	Time needed (min)	Grouping
Assent Procedures	10	All students together
Warm-Up & Stretching	5	All students together
PACER Test	8	Groups of 6 or fewer
Curl-Up Test	5	Partnered, 2 at a time
Push-Up Test	3	Partnered, 2 at a time
Skinfolds	2	Individually
Trunk Lift Test	2	Individually
Back-Saver Sit-and-Reach Test	2	Individually
Height/Weight	1	Individually
Cool-Down	5	All students together
Total Time	43	

Data Analyses

Data analyses consisted of descriptive statistics of each dependent (measure, correlations of independent variables and analysis of variance procedures, followed by appropriate planned contrasts via Scheffe' and multiple regression procedures. The small sample size prevented the use of the more appropriate statistical technique of MANOVA, even when two variables were highly correlated with one another. For example, parents' hearing status and school placement were found to correlate significantly; however, there were only 6 subjects in the two deaf parents/regular school cell and 4 subjects in the two deaf parents/special school cell, disallowing MANOVA computations. Therefore, ANOVA procedures were used to answer all research questions. This is a major study limitation since interactions between independent variables could not be evaluated. The use of repeated ANOVA procedures led to concern about increased family error rate. This is a limitation in that the significance level for all data analysis procedures was set at .05 and the repeated ANOVAs (a total of eight per independent variable) would reduce the significant alpha level to approximately .005. in addition to family error rate, the use of multiple ANOVAs computed for each individual independent variable also caused concern regarding the occurrence of type I error.

Research Question #1: Level of Hearing Loss

Level of hearing loss ranged from 55 dB to 100+ dB. Participants were classified into three nominal scale groups, moderate (55 dB to 70 dB), severe (71 dB to 90 dB) and profound (> 90 dB). ANOVA methods were used to determine differences between level of hearing loss groups and each individual fitness measure Where significant differences ($p < .05$) were found through ANOVA procedures, the Scheffe' technique was used to determine differences among specific groups. The Scheffe' test was recommended because of its conservative nature in identifying significant differences and the ability to use with unequal cell sizes.

Research Question #2: Etiology and Age at Onset

Etiology and age at onset of hearing loss was categorized in two ways: (a) based upon age at onset of deafness, namely congenital, acquired, or unknown; and (b) based upon the cause of deafness such as meningitis, other illness, drug administration, etc. The nominal scale categories of congenital, acquired, or unknown were used to conform to previous studies that evaluated etiology (Goodman & Hopper, 1992). Cause and onset of hearing loss were evaluated because some of the existing literature reported these variables to be potential influencers of skill-related physical fitness; therefore, these factors were evaluated to determine if the same was true for health-related physical fitness. ANOVA methods were used to determine relationships between etiology of hearing loss and each individual fitness measure. Where ANOVA procedures indicated significant differences ($p < .05$), the Scheffe' technique was used to determine differences between groups.

Research Question #3: Parents' Hearing Status

Parent's hearing status was categorized as either both deaf (D/D), both hearing (H/H), or one deaf and one hearing (D/H). Thus, parents' hearing status was measured using a nominal measurement scale. In this case, ANOVA methods were used to determine if relationships were present between parents' hearing status and individual fitness variables. Where significant differences ($p < .05$) were found, follow-up testing was through use of the Scheffe' technique.

Research Question #4: School Placement

School placement factors were evaluated based on the type of school that each student attended. School placement was categorized as either in a *regular* or *special* school. School factors were categorical measures. ANOVA procedures were followed to determine relationships between school placement and individual fitness variables, followed by the Scheffe' tests when significant differences ($p < .05$) were found.

Research Question #5: Physical Education

Physical education classes were evaluated based on the duration in minutes per week that the children participated in classes. ANOVA methods were used to determine if a relationship existed between physical education and each fitness variable. When ANOVA procedures indicated significant differences ($p < .05$), the Scheffe' technique was computed to identify the differences between groups.

Research Question #6: Physical Activity Participation

Physical activity participation was evaluated based on the number of regular physical activities in which the student had participated during the two months prior to the actual test date. Physical activity participation was grouped as either 0-2 activities per week or 3+ activities per week, an ordinal scale measurement. ANOVA methods were used to determine if a relationship existed between frequency of participation and individual fitness measures. Follow-up testing consisted of using the Scheffe' technique to identify the differences between groups.

CHAPTER 4

Results

The purpose of this study was to identify factors that influence the physical fitness levels of deaf children. Fitness levels were evaluated through administration of the Fitnessgram, a field-based test for measuring health-related physical fitness of school-aged children (Cooper Institute of Aerobic Research, 1999). Demographic and school variables were evaluated through questionnaires completed by parents and school administrators. The results of this study are presented in this chapter.

Descriptive Statistics

Descriptive statistics for participant characteristics and Fitnessgram test results are provided in Tables 4 and 5. The resulting information is discussed relative to age, gender, and individual fitness and demographic variables.

Sample Characteristics

A total of 51 subjects (30 male, 21 female) participated in this study. Of these participants, almost half reported having a congenital hearing loss (n = 25), followed by unknown (n = 18) and acquired hearing loss (n = 8). The majority of the participants attended *regular* schools (n = 32) compared to *special* school settings (n = 19). Almost three-fourths of the participants were from families with two hearing parents (n = 38), followed by two deaf parents (n = 10), and one hearing/one deaf parents (n = 3). Nineteen participants were categorized as participating in more than 90 minutes per week of physical education class (n = 19), with the remaining subjects being evenly split between less than 45 minutes/week (n = 16) and 45-90 minutes per week (n = 16) of participation in physical education classes. The majority of participants engaged in 0-2

Table 4

Sample Characteristics in Frequencies by Age Group

	Male (n = 30)			Female (n = 21)			Overall
	6-7 (n=8)	8-9 (n=13)	10-11 (n=9)	6-7 (n=8)	8-9 (n=9)	10-11 (n=4)	6-11 (n=51)
Age at Onset							
Congenital	4	4	5	5	4	3	25
Acquired	2	3	1	1	1	0	8
Unknown	2	6	3	2	4	1	18
School Placement							
Special	4	8	3	3	1	0	19
Regular	4	5	6	5	8	4	32
Parents Hearing Status							
Both Hearing	6	9	6	6	8	3	38
Both Deaf	1	4	3	1	1	0	10
One Hearing/ One Deaf	1	0	0	1	0	1	3
Physical Education							
<45min/wk	3	2	3	3	5	0	16
45-90min/wk	1	3	3	2	3	4	16
90+min/wk	4	8	3	3	1	0	19
Physical Activity Participation							
0-2 times/wk	6	7	5	4	4	2	28
3+ times/wk	2	6	4	4	5	2	23

Table 5

Means and Standard Deviations of Fitnessgram Test Results

Gender/Age (years)		*n*	HFZ (# tests)	% Body Fat	PACER (laps)	Curl-Ups (number)	Push-Ups (number)	Trunk Lift (inches)	Sit & Reach Right (inches)	Sit & Reach Left (inches)
Males										
6-7	*M*	8	5.50	18.81	10.63	16.75	7.75	8.75	11.13	10.94
	SD		.76	2.70	3.50	9.18	6.78	2.13	2.76	2.71
8-9	*M*	13	5.46	21.63	14.62	30.62	9.62	9.50	9.73	9.58
	SD		.78	8.29	6.63	20.21	6.34	1.63	1.56	2.07
10-11	*M*	9	5.11	21.31	14.22	25.89	8.89	10.11	9.44	9.39
	SD		1.05	6.04	12.70	12.85	5.25	1.73	1.74	2.23
Female										
6-7	*M*	8	5.13	21.27	9.50	20.63	9.00	8.31	13.31	11.63
	SD		1.13	5.01	3.74	14.22	5.81	2.14	4.49	2.39
8-9	*M*	9	5.33	18.52	13.56	23.67	8.00	9.72	13.61	10.61
	SD		.87	1.82	6.33	20.92	7.45	2.20	2.25	1.93
10-11	*M*	4	4.50	22.26	13.75	20.75	1.25	9.63	7.25	7.63
	SD		1.91	4.54	10.75	16.21	1.26	1.70	3.20	4.19
Overall Sample	*M*	51	5.25	20.58	12.86	24.04	8.16	9.35	10.42	10.11
	SD		1.00	5.53	7.57	16.54	6.23	1.93	2.98	2.55

activities per week (n = 28) compared to those who participated in 3+ activities per week (n = 23). Table 4 provides a description of overall sample characteristics.

Fitnessgram Test Results

The Fitnessgram test battery included measures of body composition (percent body fat/skinfolds), cardiorespiratory endurance, flexibility, and muscular strength/endurance. Scores above the 20th percentile and below the 60th percentile on a given test were associated with the Healthy Fitness Zone (HFZ). In addition, the total number of tests within the Healthy Fitness Zone for each individual was tabulated.

Overall results. Across the entire sample of 51 deaf children, the number of tests within the Healthy Fitness Zone was ($M \pm SD$) 5.25 ± 1.00 out of six tests. This indicates that the deaf children in this sample demonstrated healthy fitness levels. However, an extension of this observation is that the Fitnessgram indicates children must score within the Healthy Fitness Zone on at least 4 of 6 tests, with percent body fat and cardiorespiratory endurance being included. In this case, 82.4% of the deaf children scored within the Healthy Fitness Zone for percent body fat and 88.2% on the scores on the PACER were within this range. Percentages within the Healthy Fitness Zone were high for all tests, ranging from 78.4% for the left sit-and-reach test, 80.4% for the right sit-and-reach test, 88.2 % for push-ups, 90.2% for curl-ups, and 92.2% for the trunk lift. This information on overall results is provided in Table 5 and Figure 8.

Analyses of Research Questions

Research Question #1: Level of Hearing Loss.

The influence of level of hearing loss on the physical fitness of deaf children could not be determined because parents did not provide sufficient information when

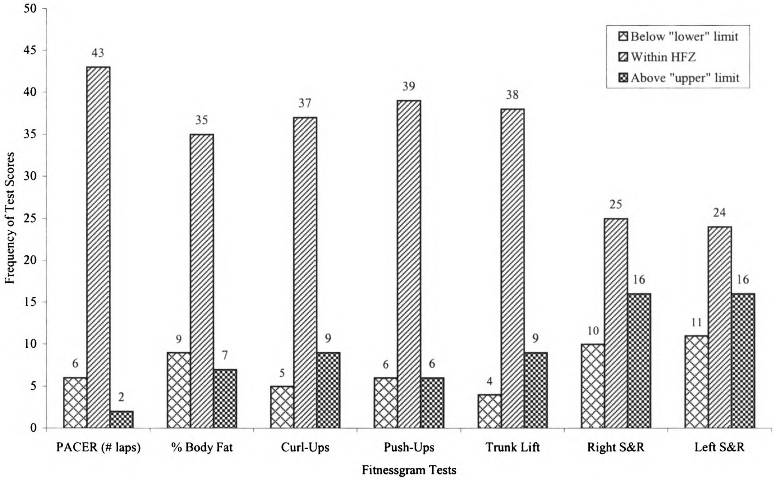


Figure 8. Tests Below, Within, and Above Healthy Fitness Zone.

responding to the questionnaires. Of the 51 completed questionnaires returned, 48 did not provide information about decibel hearing loss, with most parents leaving the question blank or writing in "don't know." Of the three respondents who did provide this information, all three (two were twins) indicated similar level hearing losses (90-100 dB), nullifying any potential between-subject comparisons.

Research Question #2: Age at Onset of Hearing Loss

Age at onset of hearing loss was categorized as being congenital ($n = 25$), acquired ($n = 8$), or unknown ($n = 18$). Of the eight cases of acquired hearing losses, seven specified that the loss was due to an illness, with three cases caused by meningitis, one caused by high fever, and three providing no indication of the type of illness.

ANOVA procedures indicated no significant differences among the three age at onset groups for overall scores in the Healthy Fitness Zone, $F(2,48) = 1.09, p < .35$. Non-significant differences were revealed for each of the physical fitness variables of percent body fat, $F(2,48) = 2.14, p < .13$, PACER performance, $F(2,48) = 1.61, p < .21$, curl-ups, $F(2,48) = .56, p < .58$, trunk lift, $F(2,48) = .35, p < .71$, right sit-and-reach, $F(2,48) = .71, p < .50$, and left sit-and-reach, $F(2,48) = .25, p < .78$. The closest any group test performances came to being significantly different were push-ups, $F(2,48) = 3.17, p < .06$.

The group with acquired deafness not only demonstrated fewer scores within the Healthy Fitness Zone and lower performances on the strength and endurance tests, but also higher percent body fat, when compared to the groups with congenital and unknown age at onset. The congenital group demonstrated the best overall performance on all tests, with the exception of a slightly lower performance on the push-up test compared to the unknown age at onset group. However, no differences were statistically significant. Overall fitness scores by age at onset group are presented in Table 6.

Research Question #3: Parents' Hearing Status

Parents' hearing status was classified as either hearing or deaf. Therefore, a child could have two deaf parents ($n = 10$), two hearing parents ($n = 38$), or one deaf and one hearing parent ($n = 3$). ANOVA procedures indicated significant differences among the parent hearing status groups for the physical fitness variables of percent body fat, $F(2, 48) = 3.89, p < .03$, PACER performance, $F(2, 48) = 5.57, p < .01$, and scores within the Healthy Fitness Zone, $F(2, 48) = 4.02, p < .03$. No significant differences were found for curl-ups, $F(2,48) = 2.32, p < .11$, push-ups, $F(2,48) = 1.69, p < .20$, trunk lift, $F(2,48) = 1.23, p < .30$, right sit-and-reach, $F(2,48) = 1.69, p < .20$, or left sit-and-reach, $F(2,48) = .95, p < .40$. Descriptive information is presented in Table 7.

Scheffe' post hoc procedures indicated that participants with two hearing parents had significantly higher, $p<.03 = 7.41$, percent body fat than did those with two deaf parents, with no significant difference involving participants with one hearing/one deaf parent. Participants with two deaf parents demonstrated significantly higher, $p<.01 = 9.84$, PACER performances than did children with two hearing parents, with no difference found involving children with one hearing/one deaf parent. All participants with two deaf parents performed within the Healthy Fitness Zone on all six fitness tests, with the Healthy Fitness Zone scores being significantly higher, $p<.03 = 1.33$, when compared to children with two hearing parents only. No other significant differences were found for any of the other physical fitness variables. These data must be interpreted with caution. While responses from parent surveys revealed that each of the participants

Table 6

Fitnessgram Performances by Age at Onset of Hearing Loss

	Congenital		Acquired		Unknown	
	n=25		*n*=8		*n*=18	
Fitness Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
Scores in Healthy Fitness Zone (#)	5.44	.96	4.88	1.13	5.17	.99
Percent Body Fat (%)	19.40	4.31	23.93	6.85	20.72	6.09
PACER (laps completed)	14.04	8.32	8.63	3.46	13.11	7.43
Curl-Ups (total)	25.88	17.54	18.75	14.19	23.83	16.39
Push-Ups (total)	8.56	6.35	3.50	3.96	9.67	6.15
Trunk Lift (inches)	9.56	1.99	9.38	1.66	9.06	2.01
Right Sit-and-Reach (inches)	10.88	3.47	10.44	3.18	9.78	2.08
Left Sit-and-Reach (inches)	10.34	2.72	10.13	3.19	9.78	2.07

Table 7

Fitnessgram Performances by Parents' Hearing Status

	Parents Both Hearing n=38		Parents Both Deaf n=10		One Hearing Parent/ One Deaf Parent n=3	
Fitness Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
Scores in Healthy Fitness Zone (#)	5.05	1.06	6.00	.00	5.33	.58
Percent Body Fat (%)	21.49	5.75	16.48	3.01	22.68	2.57
PACER (laps completed)	11.08	5.12	19.30	11.68	14.00	7.94
Curl-Ups (total)	21.34	13.99	33.60	21.28	26.33	23.97
Push-Ups (total)	7.24	5.92	10.90	6.37	10.67	8.74
Trunk Lift (inches)	9.13	1.95	9.80	1.90	10.67	1.26
Right Sit-and-Reach (inches)	10.03	2.75	11.95	3.82	10.33	1.53
Left Sit-and-Reach (inches)	9.83	2.75	11.05	1.76	10.50	1.32

had two parents, information was not obtained about whether the children actually resided in a two-parent or single-parent household.

Research Question #4: School Placement

Deaf children attended either *special* (n = 19) or *regular* (n = 32) schools. Six schools participated in this study. School A was a state school for the deaf located in an urban location with a total student body of 120 students. School B was located in a suburban area and consisted of a total student body of 58 students, including 6 deaf students. Schools C and D were both located in rural areas and had approximately 60 total students, including 14 deaf students at each school. Schools E and F were situated in suburban locations with school E having 58 total students, including 38 deaf students, and school F having 26 deaf students within a total student population of 50 children.

Students who attended *special* and *regular* schools demonstrated nearly identical scores within the Healthy Fitness Zone, $F(1, 49) = .00, p < .96$. Students from *special* schools performed significantly better, $F(1, 49) = 6.95, p < .01$, on the curl-up test than did students from *regular* schools. However, this significant difference could have been influenced by the two high performance outliers (range = 10 to 75) demonstrated by students at the *special* schools resulting in a high standard deviation compared to students at *regular* schools (range = 5 to 45). There were no significant differences for percent body fat, $F(1, 49) = 3.48, p < .07$, PACER performance, $F(1, 49) = .80, p < .38$, push-ups, $F(1, 49) = .44, p < .51$, trunk lift, $F(1, 49) = .89, p < .36$, right sit-and-reach, $F(1, 49) = .76, p < .39$, and left sit-and-reach, $F(1, 49) = .55, p < .46$, between the two school placements. Overall physical fitness performance and descriptive statistics for school placement are presented in Table 8.

Table 8

Fitnessgram Performances by School Placement

	Regular $n = 32$		Special $n = 19$	
Fitness Variable	*M*	*SD*	*M*	*SD*
Scores in Healthy Fitness Zone (#)	5.25	1.14	5.26	.73
Body Fat (%)	19.50	4.39	11.63	3.35
Curl-Ups (total)	19.59	9.27	31.53	22.75
Push-Ups (total)	7.72	6.23	8.89	6.33
Trunk Lift (inches)	9.55	1.94	9.03	1.91
Right Sit-and-Reach (inches)	10.70	3.52	9.95	1.74
Left Sit-and-Reach (inches)	10.31	2.88	9.76	1.89

The results of this study indicate that school placement does not have an influence on children's overall physical fitness performance within the Healthy Fitness Zone. Given the similarity of scores across fitness measures and the overall scores within the Healthy Fitness Zone, the results suggest that placement in *regular* and *special* schools do not influence the physical fitness of deaf children.

Research Question #5: School Physical Education Participation

Physical education classes were categorized according to the number of minutes that the children participated per week; namely <45 minutes/week (n=16) , 45-90 minutes/week (n=16) , and 90+ minutes/week (n=19). Scores within the Healthy Fitness Zone were similar across physical education groups, $F(2, 48) = .25, p < .78$. Significant differences among groups were indicated for PACER, $F(2, 48) = 4.59, p < .02$, and curl-ups, $F(2, 48) = 4.01, p < .03$, performances, but not for the physical fitness variables of percent body fat, $F(2, 48) = 1.91, p < .16$, push-ups, $F(2, 48) = .41, p < .67$, trunk lift, $F(2, 48) = 1.95, p < .15$, right sit-and-reach, $F(2, 48) = .61, p < .55$, or left sit-and-reach, $F(2, 48) = 1.36, p < .27$. Scheffe' post hoc analysis revealed that the 45-90 minutes/week physical education group performed higher on the PACER test than did the <45 minutes/week group, p<.02 = 7.08. The group that had physical education more than 90 minutes/week performed higher on the curl-up test than did the group that had physical education less than 45 minutes/week, p<.03 = 15.62. Descriptive statistics and overall fitness performance are presented in Table 9.

The results suggest that physical education participation does not influence the overall physical fitness performance of deaf children. These results may also provide some anecdotal evidence on the importance of having a trained specialist lead the classes.

Table 9

Fitnessgram Performances by School Physical Education

	<45 min/wk n=16		45-90 min/wk n=16		90+ min/wk n=19	
Fitness Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*
Scores in Healthy Fitness Zone (#)	5.13	1.15	5.38	1.15	5.26	.73
Body Fat (%)	20.15	4.78	18.85	4.02	22.39	6.80
PACER (laps completed)	10.00	4.75	17.19	11.14	11.63	3.35
Curl-Ups (total)	16.75	6.71	22.44	10.74	31.53	22.75
Push-Ups (total)	7.06	5.20	8.38	7.23	8.89	6.33
Trunk Lift (inches)	10.13	1.95	8.97	1.80	9.03	1.91
Right Sit-and-Reach (inches)	11.06	2.91	10.34	4.11	9.95	1.74
Left Sit-and-Reach (inches)	10.97	2.53	9.66	3.13	9.76	1.89

The physical education group that met for more than 90 minutes/week consisted only of the students from a *special* school. Their physical education classes were led by a teacher with no physical education background. Even with the greater frequency participation, this group only performed significantly higher than the other groups on one fitness measure. In all the *regular* schools, physical education classes met less frequently, but were taught by certified physical education teachers.

Research Question #6: Physical Activity Participation

Physical activity participation was recorded as the number of activities that the children participated in on a regular basis of three or more times per week for at least 30 minutes per session. For this study, physical activity participation was identified as the number of activities in which the deaf children participated in on a regular basis during the two months preceding the fitness test date. Physical activity participation was divided into two groups: 0-2 activities/week (n = 28) and 3+ activities/week (n = 23).

ANOVA computations indicated significant differences between the groups in percent body fat, $F(1, 49) = 8.47, p<.01$, PACER performance, $F(1, 49) = 17.32, p< .00$, curl-up performance. $F(1, 49) = 8.54$; $p<.01$, push-up performance, $F(1, 49) = 8.24$, $p<.01$, right sit-and-reach, $F(1, 49) = 4.76, p<.03$, left sit-and-reach, $F(1, 49) = 4.48$, $p<.04$, and Healthy Fitness Zone scores, $F(1, 49) = 18.59, p<.00$. The only fitness measure that was not associated with significant statistical differences between the groups was the trunk lift, $F(1, 49) = 1.01, p<.32$ The 3+ activities/week group demonstrated better performance across all physical fitness measures than did the 0-2 activities/week group. Information on group performances and differences are presented in Table 10.

Table 10

Fitnessgram Performances by Physical Activity Participation

	0-2 Activities/week $n = 28$		3+ Activities/week $n = 23$	
Fitness Variable	*M*	*SD*	*M*	*SD*
Scores in Healthy Fitness Zone (#)	4.79	1.10	5.83	.39
Percent Body Fat (%)	22.48	6.21	18.26	3.46
PACER (laps completed)	9.39	3.98	17.09	8.75
Curl-Ups (total)	18.32	12.23	31.00	18.59
Push-Ups (total)	6.04	5.16	10.74	6.55
Trunk Lift (inches)	9.11	1.88	9.65	1.98
Right Sit-and-Reach (inches)	9.63	2.73	11.39	3.05
Left Sit-and-Reach (inches)	9.45	2.71	10.91	2.12

The results indicated physical activity performance outside of the school setting influenced the physical fitness of deaf children. Those children who participated in three or more activities per week demonstrated better overall physical fitness performance, with the exception of the trunk lift than did those children who participated in less than the recommended three activities per week.

Factors Which Influence the Physical Fitness Levels of Deaf Children

Through statistical correlational methods, it was found that many of the independent variables correlated with one another, an indication that MANOVA procedures should have been used to evaluate interactions between variables on fitness measures. However, this study did not satisfy the assumptions of having at least seven subjects per cell required to compute MANOVA statistics. Therefore, multiple regression procedures were computed as a post hoc analyses to determine which independent variables provided the most influence on the physical fitness levels of deaf children. The subject base from this study (n=51) satisfied the assumption of sample size for multiple regression given that only one cell per independent variable is required for computation rather than the different levels of each independent variable used in MANOVA procedures. Table 11 details the results of the multiple regression computations for each fitness measure. To interpret Table 11, R refers to the regression coefficient or the relationship between the weighted sum of the independent (predictor) variables and the fitness measure being evaluated, R^2 refers to the amount of variance in the evaluated fitness scores accounted for by the independent variables, and $R^2\Delta$ refers to the increase in explained variance with the addition of other independent variables.

Table 11

R^2 Values for Independent Variables on Fitness Measures

	R	R^2	R^2	p
Healthy Fitness Zone				
Physical Activity Participation	.524	.275	.275	.000
Parents' Hearing Status	.553	.306	.031	.000
School Placement	.560	.314	.008	.000
Age at Onset	.567	.321	.007	.001
Physical Education	.574	.328	.007	.002
Percent Body Fat				
Physical Activity Participation	.384	.147	.147	.005
School Placement	.423	.179	.032	.009
Parents' Hearing Status	.446	.199	.020	.014
Age at Onset	.449	.202	.003	.032
Physical Education	.451	.203	.001	.061
PACER				
Physical Activity Participation	.511	.261	.261	.000
Parents' Hearing Status	.560	.314	.053	.000
School Placement	.564	.318	.004	.000
Physical Education	.604	.365	.047	.000
Age at Onset	.608	.370	.015	.001
Curl-Ups				
Physical Activity Participation	.385	.148	.148	.005
Physical Education	.556	.309	.161	.000
School Placement	.587	.345	.037	.000
Parents' Hearing Status	.592	.350	.015	.000
Age at Onset	.597	.357	.007	.001

Table 11 (continued)

	R	R^2	R^2	p
Push-Ups				
Physical Activity Participation	.379	.144	.144	.006
Parents' Hearing Status	.414	.171	.027	.011
School Placement	.439	.193	.022	.017
Physical Education	.442	.195	.002	.037
Age at Onset	.452	.204	.009	.060
Trunk Lift				
Physical Education	.231	.053	.053	.103
Parents' Hearing Status	.368	.135	.082	.030
School Placement	.417	.174	.039	.028
Physical Activity Participation	.438	.191	.017	.041
Age at Onset	.449	.202	.011	.063
Right Sit-and-Reach				
Physical Activity Participation	.297	.088	.088	.034
Parents' Hearing Status	.319	.102	.014	.076
Age at Onset	.344	.119	.018	.112
Physical Education	.382	.146	.027	.116
School Placement	.421	.177	.031	.107
Left Sit-and-Reach				
Physical Activity Participation	.289	.084	.084	.039
Physical Education	.337	.114	.030	.055
School Placement	.409	.167	.053	.034
Parents' Hearing Status	.448	.200	.037	.033
Age at Onset	.462	.214	.014	.048

Percent Body Fat

Table 11 identifies the R^2 values computed for all independent variables and their influence on deaf children's percent body fat. Multiple regression statistics indicated that physical activity participation accounted for the most variance seen among the participants for percent body fat ($R^2 = .15$). These results indicated that 15% of the variance seen in percent body fat between the subjects could be attributed to physical activity participation. No other combination of independent variables contributed to a meaningful increase in $R^2\Delta$ with school placement contributing 3.2%, parents' hearing status 2.0%, age at onset of hearing loss .3%, and physical education participation .1%.

PACER Performances

Multiple regression procedures were computed for R^2 values to determine which variables had the greatest influence on deaf children's PACER performance. This information is presented in Table 11. The results showed an R^2 value of .26 for physical activity participation, indicating that this one independent variable accounted for 26.0% of the variance in PACER performances across subjects. No other independent variables provided a meaningful increase in $R^2\Delta$ for PACER performances. Parents' hearing status contributed only 5.3% of explained variance, followed by physical education participation with 4.7%, age at onset of hearing loss with 1.5%, and school placement with .4%. However, the variance explained by physical education participation was a negligible $R^2\Delta$ of .007 when inserted into the regression equation before or without school placement. This statistical outcome can probably be attributed to the high correlation ($r = .88$) between school placement and physical education participation.

Curl-Up Performances

Regression procedures yielded a $R^2\Delta$ value of .31 for the combination of physical activity participation and physical education, indicating that 31% of the variance in curl-up performances can be attributed to these two factors. No other combinations of independent variables contributed to any reasonable increase in the $R^2\Delta$ value, with school placement contributing 3.7%, parents' hearing status 1.5%, and age at onset of hearing loss .7% of the variance in curl-up performances.

Push-Up Performances

Table 11 identifies the $R^2\Delta$ values for all independent variables with respect to their influence on push-up performance. The highest R^2 value was associated with physical activity participation, with 14.0% of explained variance in push-up performance accounted for by that one variable. No other combinations of independent variables contributed to a meaningful increase in the percent variance accounted for by the independent variables. Of the remaining variables, parents' hearing status contributed to a 2.7% change in the $R^2\Delta$ value, school placement 2.2%, age at onset of hearing loss .9% and physical education participation .2%.

Flexibility Performances

Multiple regression computations revealed no meaningful influence by any of the independent variables on the three flexibility measures of trunk lift, right sit-and-reach, and left sit-and-reach (Table 11). Physical activity participation had the most impact, a negligible influence of less than 8% on all three measures of flexibility, indicating that these fitness measures were influenced by variables not evaluated within this study.

Healthy Fitness Zone Scores

The independent variable of physical activity participation contributed to the greatest R^2 value of .28 to differences seen in scores within the Healthy Fitness Zone. The $R^2\Delta$ progression for the Healthy Fitness Zone scores is in Table 11. These results indicated that 28.0% of the variance seen among groups for overall physical fitness performances within the Healthy Fitness Zone was explained by physical activity participation. The addition of parents' hearing status contributed to a $R^2\Delta$ of 3.1%, school placement .8%, age at onset of hearing loss .7%, and physical education participation .7%.

Overall Outcome of Multiple Regression

These results indicated that physical activity participation was the greatest influential factors on physical fitness performances with the exception of flexibility. Physical activity participation was the only consistent independent variable that accounted for variance seen in physical fitness scores among the deaf children. None of the other variables, with one exception of physical education participation on curl-up performances, had any meaningful influence on the outcome of physical fitness performances.

CHAPTER 5

Discussion

The purpose of this study was to determine factors that influence the physical fitness levels of deaf children. Physical activity participation was the lone factor found to influence the physical fitness levels of deaf children. Parents' hearing status, school physical education, school placement, and age at onset of hearing loss did not have a statistically significant influence. In this discussion section, information on influential factors, usefulness of the Fitnessgram protocol, and implications of the results of the present study will be discussed.

Fitnessgram Test Protocol

The Fitnessgram test protocol has been widely used to evaluate the physical fitness of school-aged children (Cooper Institute of Aerobic Research, 1999) and was the measure used within this study to evaluate the physical fitness of deaf children. This test battery was modified for deaf children using visual cues for the PACER, curl-up, and push-up tests. These modifications were evaluated through two pilot studies with results showing acceptable reliability and validity, indicating that the modified test was appropriate for evaluating the physical fitness of deaf children (Appendix B). This finding was important because it indicates that with some simple modifications, the popular Fitnessgram test battery is not only a feasible, but also a valid and reliable measure for evaluating the fitness of deaf children. In addition, the use of the modified Fitnessgram for evaluating the physical fitness of deaf children increases the likelihood that deaf children will understand the test directions and perform the tests correctly. Therefore, the scores from the modified Fitnessgram are likely to be more representative of the true abilities of deaf children than would scores obtained from the original, unmodified Fitnessgram.

Physical Fitness Levels of Deaf Children

In contrast to much of the research literature, the results of this study indicated that deaf children have at least minimally acceptable levels of physical fitness. One of the major differences between the present and past studies is that in this investigation deaf children were not compared to hearing children when evaluating their fitness levels. Rather, fitness performances were evaluated with reference to the Healthy Fitness Zone (Cooper Institute of Aerobic Research, 1999), an indication of adequate fitness. The Healthy Fitness Zone was designed for and evaluated through fitness research on hearing children. Within the current sample of deaf children, 73% of boys (n = 22 of 30) and 91% of girls (n = 19 of 21) between the ages of 6-11 years satisfied the recommended criteria of at least four of six test performances within the Healthy Fitness Zone, including percent body fat and cardiorespiratory endurance. Of the 10 participants who did not meet the criteria, most were from the 10-11 year old group. The finding that 59% of the participants from the 8-9 year old group achieved scores in the Healthy Fitness Zone on all six measures, compared to 56% of the 6-7 year old group and 46% of the 10-11 year old group was likely due to the lack of criterion standards on the PACER for the younger groups and because most statistical outliers occurred within the older group. These results are discussed further in the following paragraphs.

Cardiorespiratory endurance. While this study indicated that deaf children generally demonstrated adequate fitness levels, there is concern regarding the interpretation of their PACER performances. The outcome that 73% of male and 91% of female participants scored within the Healthy Fitness Zone for all fitness measures can easily be misinterpreted given that the Fitnessgram does not provide criterion-referenced standards for the PACER for participants under the age of 10 years. Rather, the administration manual indicated that if children under the age of 10 years participated then they "passed" and were therefore considered to have scored within the Healthy Fitness Zone. Due to this, 100% of the children under 10 years of age were considered to fall within the zone due solely from the fact that they participated. For those participants in the 10-11 year old group, only 54% performed within the Healthy Fitness Zone for the PACER test. This results is an indication that almost half of the children in the 10-11 year old group had poor cardiorespiratory endurance.

The results of the PACER performance cause concern in the interpretation not only of the deaf children's fitness levels, but also when making comparisons to the literature. This or any similar study cannot conclusively indicate that children younger than the age of 10 years have appropriate levels of cardiorespiratory endurance because of the absence of criterion-referenced standards within the Healthy Fitness Zone for these children. Other than to say that these children participated and therefore "passed" the PACER test, no evidence of their true cardiorespiratory endurance can be reported. Thus, this study does not provide evidence to the field regarding the cardiorespiratory endurance of deaf children under the age of 10 years.

In order to gain insight on potential PACER performance, the deaf children in the younger age groups were compared to the Healthy Fitness Zone criterion values for 10 year olds. The purpose of this comparison was to determine if any of the younger children reached the minimum criterion set for the 10 year old group, with the hypothesis that if they did reach this level then they would actually have cardiorespiratory performances within the Healthy Fitness Zone. These comparisons indicated that 38% of the participants in the 6-7 year old group and 55% of those in the 8-9 year old group met the minimum criterion for performance within the Healthy Fitness Zone set for 10 year old children.

Cardiorespiratory endurance results from this study are difficult to compare to existing research because no previously published studies with deaf children used the PACER test. While direct comparisons cannot be made between the present cardio-respiratory endurance results and those form past studies, general conclusions can be provided. Campbell (1983) and Winnick and Short (1986) both reported that hearing children demonstrated higher cardiorespiratory endurance than did deaf children, and Ellis (2001) reported that cardiorespiratory endurance performances by deaf children fell below the 40^{th} percentile of standardized norms designed for hearing children. The present study is in agreement with these results with the demonstration that 46% of the deaf children in the 10-11 year old group performed below the lower limit (corresponding to approximately the 20th percentile) of the Healthy Fitness Zone on the PACER test. This conclusion was also supported by the observation of the low number of laps compared by many deaf children in the younger 6-9 years age groups where criterion-referenced standards were not available.

Percent body fat. Within the present study, 82% of all participants scored within the Healthy Fitness Zone for percent body fat. However, gender differences indicated that while 100% of the females scored within the Healthy Fitness Zone, only 73% of the males scored within this range for percent body fat. Most male participants demonstrated appropriate levels of percent body fat, however, four of the seven statistical outliers for percent fat (scores more than 3 *SD* from the mean) were for males in the 10-11 year old group and corresponded to those who performed below the 20th percentile on the PACER test. These outlier scores were compared to the Center of Disease Control and Prevention growth charts for age and gender (CDC, 2001). The males in the 10-11 year old group whose percent body fat levels were classified as statistical outliers demonstrated body weights that were at least 25 percentile points higher when compared to their heights for age and gender. For example, one 10 year old male had a height which was in the 50th percentile for age and a body weight at the 85th percentile. The percentile difference between height and weight for these four males in the 10-11 year old group ranged from 25 to 40 percentile points, with all four body weights being classified as above the 60th percentile for age.

Percent body fat from the present study could not be directly compared to existing research which evaluated deaf children due to differences in the anatomical sites used for measurements or incomplete reports of data in the literature. The present study evaluated percent body fat of children 6-11 years of age using the tricep and calf anatomical sites for measurement. However, sum of skinfolds from the present study was compared to results from the Winnick and Short (1986) investigation which used the same skinfold sites for evaluation. Deaf females from the present study demonstrated similar but higher sum of skinfolds (M = 27.95mm) than did deaf (M = 25.80mm) and hard of hearing (M = 27.70mm) females from the Winnick and Short study (1986). Males from the present study demonstrated higher sum of skinfolds (M = 27.69mm) than both the deaf (M = 23.20mm) and hard of hearing (M = 22.50mm) males from the Winnick and Short study.

However, only the sum of skinfolds from the 10-11 year old group from the present study could be compared because the Winnick and Short study focused on children between the ages of 10-12 years. AAHPERD (1984) percentile norms were not comparable with the results from the present study because of differences in site measurement (tricep and calf versus tricep and subscapular).

Muscular strength and endurance. The results of this study indicated that 90.2% of all participants performed within the Healthy Fitness Zone on the curl-up measure and 88.2% on the push-up test, indicating that the majority of deaf children demonstrated appropriate levels of muscular strength and endurance. However, it is difficult to make direct comparisons with existing research because a 3-second cadence was required for completion of both the curl-up and push-up test. For this reason, any comparisons must be done with caution when interpreting the results of the present study to those in the literature. Comparing the results of the curl-up test from the present study to normative standards for the 60-second sit-up test (AAHPERD, 1984) indicated that all performances were below the 50th percentile, with curl-up performances demonstrated by participants from the 10-11 year old group falling below the 20th percentile. In the present study, none of the mean curl-up performances by age group fell below the 20th percentile or low end of the Healthy Fitness Zone, but several low (but adequate) performances by the 10-11 year old group caused some concern with their performances. Normative standards for the regular no-cadence push-up test were not reported; therefore, the results of this study could not be directly compared to existing performance norms.

Flexibility. The results of this study revealed that 92.2% of the participants within the present study scored within the Healthy Fitness Zone for the trunk lift, 80.4% on the right sit-and-reach, and 78.4% on the left sit-and-reach. This was an indication that the majority of deaf children generally demonstrated adequate flexibility scores, a finding which is in accordance with past research that reported similar performances between deaf and hearing children (Ellis, 2001; Wiegersma & Van Der Velde, 1983; Winnick & Short, 1986). Comparing mean flexibility performances to AAHPERD (1984) national norms indicated that the deaf children from the present study demonstrated sit-and-reach performances above the 50th percentile for age and gender. The lone exception was for females in the 10-11 year old group with mean performances below the 20th percentile. Generally, research has indicated that females demonstrate improvements in flexibility with increasing age (McKenzie & Sallis, 1997; Wilmore & Costill, 1994). The results of this study were somewhat in contrast with this research finding with the demonstration of average female sit-and-reach performances below the 20^{th} percentile for the 10-11 year old group. However, this may have been due to both the small sample size and the wide variability of scores ranging from well above the 50^{th} percentile to below the 10^{th} percentile for age and gender.

Conclusions and implications. The results of this study not only indicated that deaf children generally demonstrate adequate fitness levels, but also reinforced the belief that deaf children are more similar than dissimilar to hearing children. The significance of this information is that the physical fitness of deaf children fitness can be evaluated based on national criterion standards and norms designed for hearing children, including the Healthy Fitness Zone used with the Fitnessgram. Information about deaf children's fitness can be gained through simple modifications of the same test batteries used for hearing children. The results of these fitness tests can benefit not only the deaf child, but also their parents and teachers. Therefore, it is safe to assume that since deaf children are similar to hearing children, they can also benefit from the same activities designed to enhance fitness and that different activities are not necessary for deaf children to improve on their fitness levels.

In addition, the outcome of this study and that of past research emphasize the importance of having performance levels for comparison and evaluation of fitness performances not only for muscular strength and endurance, but also for percent body fat and cardiorespiratory endurance. Whether criterion or normative standards are used, this information allows for evaluation or ranking of individual performances and tracking of trends related to fitness over a period of time. In addition, normative standards give a more specific performance outcome (30th percentile, 35th percentile, and so forth) which can be used for motivational purposes when working with children on improving fitness levels. With criterion-referenced standards, the performance is to a certain specified criterion, and it is sometimes difficult to determine how much improvement has been accomplished. However, both standards are important in that they provide information relative to an individual's fitness level. This is an important suggestion for a fitness test battery as popular as the Fitnessgram and especially one that is used within the school system, a setting where accountability has increased in importance over the years. Not only does this information permit easier identification of children's levels of fitness, but also helps children, teachers, and parents to assess improvements with respect to the normative standards.

Influence of Physical Activity and Physical Education Participation

Physical activity participation was the lone factor that influenced the overall physical fitness performance of deaf children. Regular physical activity participation of three or more activities per week for at least 30 minutes per session was associated with significantly better overall physical fitness performances, especially on the tests of cardiorespiratory endurance, percent body fat, and muscular strength/endurance. These results are not surprising as they are in agreement with past research indicating that regular physical activity participation positively influences physical fitness levels (Colchico, Zybert, & Basch, 2000). This outcome also reinforces the assumption that deaf children are physiologically similar to hearing children and that the same principles of exercise physiology and fitness apply to this group of participants. While these results are in agreement with existing research regarding physical activity participation, caution must be exercised due to the small sample size and limitations associated with self-report data. The surveys used within this study were investigator-developed because there were no existing protocols within the literature that focused on evaluating children's physical activity participation and were appropriate for the age range evaluated within this study. In addition, the investigator-formulated survey was not validated through pilot testing and could therefore pose a limitation on reporting such information as children's physical activity participation. Another limitation in reporting fitness results involves the overall sample make-up. In this study, all children who provided consent to participate were tested for physical fitness. Out of the 208 potential subjects, only 51 or approximately 25% of all prospective participants actually participated. Because of this small number and the results generated from this study indicating that this group was generally fit and active, it was possible that those students who did participate may have been a biased sample and not truly representative of deaf children in grades first through fourth.

In contrast to results reported by existing research, physical education was not found to be an influential factor on deaf children's fitness. The lone exception was that physical education was found to influence curl-up performance when combined with physical activity participation. This outcome could have been because students participating in the daily physical education classes (all from the same school) were taught by a classroom teacher with no physical education background. The children who participated in 45-90 minutes of physical education per week demonstrated the highest overall number of scores in the Healthy Fitness Zone when compared to the daily and <45 minutes/week physical education groups. The results of this study were in contrast to past research which indicated physical education to be influential on the physical fitness levels of hearing children (McKenzie, et al., 1996; Sallis, et al., 1997). However, both the <45 minutes/week and 45-90 minutes/week physical education groups were instructed by certified physical education teachers, lending support to the importance of both the duration of physical education classes and leadership within these classes (Sallis, et al., 1997).

The conclusion regarding physical education participation by the deaf children was limited because only one school offered daily physical education, a small number of schools/programs were evaluated, and there was no investigator control over the activities offered within these programs. No information was collected pertaining to the types and quality of instruction and activities provided within the physical education classes;

therefore, it was difficulty to conclusively state that physical education classes did not have an influence on the physical fitness of the subjects within this study.

The results of this study support the importance of regular physical activity participation for enhancing physical fitness. The results also indicate that the knowledge gained from testing hearing children on fitness-related measures probably generalizes to deaf children as well. Thus, deaf children and their parents should be encouraged to follow the same healthy lifestyle goals formulated for the hearing population with respect to physical activity participation and fitness.

Influence of Parents' Hearing Status

Parents' hearing status was not found to influence the physical fitness levels of deaf children. However, the results indicated that all of the children with two deaf parents (n = 10) demonstrated performances within the Healthy Fitness Zone on all six measures of fitness. In addition, 80% of these children participated in at least three regular physical activities per week. In comparison, only 37% of the children with at least one hearing parent participated in the recommended three regular physical activities per week. This outcome suggests that even though the results were not significant, parents' hearing status may play an importance in the children's physical fitness levels. This possibility is supported by the finding that the children with two deaf parents were older (M = 8.6 years) than both the children with two hearing parents (M = 8.0 years) and one hearing/one deaf parent (M = 7.8 years). Younger children are more naturally active and not as influenced by extraneous variables with respect to physical activity participation (Rowland, 1999). Taking this information into account, as well as the fact that the deaf children with two deaf parents were from the older age group, there is the possibility that the deaf parents influenced both their physical activity and fitness levels. It is possible that the deaf parents in this study allowed their deaf children more opportunities to participate in physical activities leading to positive changes in fitness. The hypothesis is that the changes in fitness were due to physical activity participation encouraged by the parents rather than the deaf children being more habitually active as is common with younger children.

In the current study, parents' hearing status did not influence the physical fitness of deaf children, an outcome that contrasts with existing research which shows that parents of hearing children exert a strong influence on their children's physical fitness levels (Biddle & Armstrong, 1992; Pate, et al., 1997). However, deaf children with two deaf parents demonstrated more scores within the Healthy Fitness Zone, as well as higher physical activity participation levels, than children with two hearing parents or with one deaf and one hearing parent, suggesting that deaf parents of deaf children do influence their children's physical fitness and activity levels. This conclusion must be tempered with the recognition that there were a relatively small number of participants in each of the parent status groups. There were 3 participants in the one hearing/one deaf parent group and 10 participants in the two deaf parents group, compared to the larger sample of 38 participants in the two hearing parents group.

Multicollinearity is also an issue that affects interpretation of the results related to parents' hearing status. There was a significant correlation ($r = .62$) between parents' hearing status and physical activity participation. This finding, in combination with the knowledge that physical activity participation was the only variable that had a significant influence on physical fitness scores, suggests that the actual influence of parents' hearing status may have been overshadowed by the influence of physical activity participation.

However, these potential limitations do not nullify the indication that deaf parents may indeed encourage greater physical activity participation for their deaf children as speculated by both Ellis (2001) and Stewart (1991). Deaf parents may be more familiar with not only the fact that their children have no restrictions to activity participation and encourage this behavior, but also more knowledgeable regarding activity opportunities for their children. Hearing parents may be more apprehensive of allowing their children to participate in physical activities and may restrict participation which could enhance physical fitness. In fact, compared to deaf parents, hearing parents have been found to be more overprotective of their deaf children and apprehensive about their involvement in school-related activities, such as extracurricular activities, within the educational setting (Vernon & Andrews, 1990), a behavior which may generalize into the physical activity setting.

The findings that parents' hearing status may influence the physical fitness of deaf children suggests that a parent education program may be needed for parents who are sedentary, apprehensive, or even unaware of opportunities for allowing their deaf children to participate in physical activities. A program focused on educating parents may provide sedentary parents, regardless of hearing status, with information regarding the importance of fitness and activity participation and the incentive to get their children involved. It could also provide the evidence of the similarities between hearing and deaf children's capabilities in order to demonstrate that deaf children can and should participate in regular physical activities and can reap the same benefits as any other child.

Influence of Other Variables

Neither school placement nor age at onset of hearing loss influenced the physical fitness of deaf children. This outcome indicated that when the child lost their hearing and where the child attends school are not as important as other factors in the attainment of appropriate fitness levels. These results are potentially limited by the small sample size and number of schools that participated within this study. Regarding school placement, these results are in contrast to past research which indicated that deaf children in *special* schools demonstrated higher fitness levels than did deaf children in *regular* schools (Winnick & Short, 1986). It is possible that these results were affected by school-related factors such as physical education classes and self-contained classroom settings, which were not identified in past research. School placement should be considered in future studies, as all students within both school settings were in segregated classrooms and taught by deaf education teachers, making it impossible to evaluate the effects of inclusive settings on any of the fitness measures. There was no evidence provided by this study that age at onset affected the outcome of physical fitness; therefore, along with the results from past research that indicated similar outcomes, future studies should focus on other variables rather than solely age at onset of hearing loss.

Conclusions and Recommendations

Several conclusions can be drawn from the present study:

1. Deaf children, as a group, demonstrate adequate physical fitness as defined by the Healthy Fitness Zone (Cooper Institute of Aerobic Research, 1999). The lone exception was with the cardiorespiratory endurance performance of the 10-11 year old group where 46% of the participants performed below the 20th percentile.

2. Physical activity participation has a greater influence on the physical fitness of deaf children than other variables tested in this study, namely physical education participation, parents' hearing status, school placement, and age at onset of hearing loss.
3. Parents' hearing status may also influence the physical fitness of deaf children. Deaf parents may be more aware of their deaf children's physical capabilities and provide greater encouragement for their children to become involved in a wide range of physical activities. Hearing parents may be more overprotective or apprehensive of their deaf children and may restrict their participation in activities which could enhance fitness. Even though this study did not find that parents' hearing status was an influential factor on deaf children's physical fitness levels, information supporting the influence of parents was provided. Deaf children with two deaf parents not only performed within the Healthy Fitness Zone on all six fitness tests, but also had the highest average number of physical activities participated in per week. Comparatively, the deaf children with two hearing parents had the lowest average number of physical activities participated in per week.
4. The modified Fitnessgram is a valid and reliable method for evaluating the physical fitness of deaf children.

Several recommendations are suggested for future research:

1. The present study consisted of a modest sample size for a group of deaf children from one midwestern state. Future studies should consist of a larger sample size to protect against a biased sample which is non-representative of a given group of deaf children and to allow greater generalizability. In addition, having a larger sample size would

allow the use of appropriate statistical methods for analyzing interactions among independent variables.

2. The present study focused on elementary school children in grades first through fourth. Future research should evaluate children in middle school and high school to determine whether there are differences in physical fitness seen at these educational levels.
3. The present study only evaluated the number of minutes per week of physical education instruction. Future research should involve a more in-depth evaluation of the quality of instruction and the curriculum of physical education classes in order to determine more conclusively whether physical education is an influential factor on deaf children's physical fitness levels.
4. This study identified a main influential factor of physical activity participation. However, the information was collected by an investigator-formulated, self-report questionnaire completed by the parents. A future study could use more reliable and valid means for evaluating physical activity participation.

References

Albright, A., Franz, M., & Hornsby, G. (2000). Exercise and type 2 diabetes. *Medicine and Science in Sports and Exercise, 32*(7), 1345-1360.

American Alliance of Health, Physical Education, Recreation, and Dance. (1984). *Technical manual: Health related physical fitness*. Reston, VA.

American Alliance of Health, Physical Education, Recreation, and Dance. (1994). *Efforts between nation's leading health organizations to promote youth fitness*. Reston, VA.

American Health and Fitness Foundations, Inc. (1986). *FYT-FIT youth today*. Austin, TX.

Batshaw, M. L. (1997). *Children with disabilities* (4th ed.). Baltimore, MD: Brookes.

Biddle, S., & Armstrong, N. (1992). Children's physical activity: An exploratory study of psychological correlates. *Social Science in Medicine, 34*(3), 325-331.

Blair, S. N., Kohl, H. W., Gordon, N. F., & Paffenbarger, R. S. (1989). Physical fitness and all-cause mortality. *Journal of the American Medical Association, 262*, 2395-2437.

Bona, S. T., Schwartz, N. E., Spain, C. G., & Natchipolsky, M. M. (1995). Food, physical activity, and fun: Inspiring America's kids to more healthy lifestyles. *Journal of the American Dietary Association, 95*(7), 816-818.

Boyd, J. (1965). *Motor behavior in deaf and hearing children*. Unpublished doctoral dissertation, Northwestern University.

Brace, C. (1936). *A comparison of the ability of deaf boys with normal boys in balance control.* Unpublished master's thesis, University of Texas at Austin.

Bresett, S. A. (1971). *Comparative study of the athletic capabilities of deaf and non-deaf students*. Unpublished doctoral dissertation, Springfield College, MA.

Butterfield, S. A. (1983). *A comparison of fundamental motor and balance skills of deaf and hard of hearing children ages three to fourteen*. Unpublished doctoral dissertation, The Ohio State University.

Campbell, M. E. (1983). *Motor fitness characteristics of hearing impaired and normal hearing children.* Unpublished master's thesis, Northeastern University, Boston.

Centers for Disease Control and Prevention: Clinical Growth Charts. (2001). [available online at: http://www.cdc.gov/nchs/about/major/nhanes/growthcharts/ clinical_charts.htm].

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

Chase, M. A., & Dummer, G. M. (1992). The role of sports as a social status determinant for children. *Research Quarterly for Exercise and Sport, 63*(4), 418-424.

Coakley, J. J. (1990). *Sport in society: Issues and controversies.* St, Louis, MO: Mosby/Times Mirror.

Cohen, J. (1982). A power primer. *Psychological Bulletin, 112*(1), 155-159.

Colchico, K., Zybert, P., & Basch, C. E. (2000). Effects of after-school physical activity on fitness, fatness, and cognitive self-perceptions: A pilot study among urban, minority adolescent girls. *American Journal of Public Health, 90*(6), 977-978.

Cooper Institute of Aerobic Research. (1999). *FITNESSGRAM test administration manual.* Champaign, IL: Human Kinetics.

Dale, D., Corbin, C. B., & Dale, K. S. (2000). Restricting opportunities to be active during school time: Do children compensate by increasing physical activity levels after school? *Research Quarterly for Exercise and Sport, 71*(3), 240-248.

Ellis, M. K. (2001). The influence of parents hearing level and residential status on health-related physical fitness and community sports involvement of deaf children. *Palaestra, 17*(1), 44-49.

Faigenbaum, A., Zaichkowsky, L. D., Westcott, W. L., & Long, C. L. (1997). Psychological effects of strength training on children. *Journal of Sport Behavior, 20*(2), 164-175.

Federal Register, August 23, 1977, *PL 94-142, The Education for All Handicapped Children Act.*

Ford, H. T., Puckett, J. R., Blessing, D. L., & Tucker, L. A. (1989). Effects of selected physical activities on health-related fitness and psychological well-being. *Psychological Reports, 64*(1), 203.

Fox, K. (1992). Physical education and development of self-esteem in children. In N. Armstrong (Ed.), *New directions in physical education II: Toward a national curriculum* (p. 3344). Champaign, IL: Human Kinetics.

Francis, K. T. (1999). Status of the year 2000 health goals for physical activity and fitness. *Physical Therapy, 79*(4), 405.

Goodman, J., & Hopper, C. (1992). Hearing impaired children and youth: A review of psychomotor behavior. *Adapted Physical Activity Quarterly, 9*, 214-236.

Greenberg, M., & Kusche, C., (1989). Cognitive, personal and social development of deaf children and adolescents. In M. C. Wang, M. C. Reynolds, & H. J. Walberg (Eds.), *Handbook of special education: Research and practice* (pp. 95-129). Oxford, England: Pergamon.

Harris, D. R. (Ed.). (1996). *Fitness and exercise sourcebook.* Detroit, MI: Omnigraphics.

Harter, S. (1985). *Manual for the self perception profile for children.* Bethesda, MD: National Institute of Child Health and Human Development.

Hastad, D. N., & Lacy, A. C. (1998). *Measurement and evaluation in physical education and exercise science.* Boston, MA: Allyn and Bacon.

Heyward, V. J. (1990). *Advanced fitness assessment and exercise prescription.* Champaign, IL: Human Kinetics.

Ignico, A. (1994). A longitudinal study of children's fitness levels during and following daily physical education. *Journal of the International Council for Health, Physical Education, and Recreation, 30*, 31-35.

Johnson, B. L., & Nelson, J. K. (1986). *Practical measurements for evaluation in physical education* (4th ed.). Minneapolis, MN: Burgess.

Kohl, H. W., & Hobbs, K. E. (1998). Development of physical activity behaviors among children and adolescents. *Pediatrics, 101*, 549-554.

Lehnhard, H. R., Lehnhard, R. A., Butterfield, S. A., Beckwith, D. M., & Marion, S. F. (1992). Health-related physical fitness levels of elementary school children ages 5-9. *Perceptual and Motor Skills, 75*, 819-826.

Leith, M. L. & Taylor, A. H. (1991). Behavior modification and exercise adherence: A literature review. *Journal of Sport Behavior, 15*, 60-74.

Lohman, T. G. (1987). The use of skinfold to estimate body fatness on children and youth. *Journal of Health, Physical Education, Recreation and Dance, 58*, 98-102.

Long, J. A. (1932). Motor abilities of deaf children. *Contributions to Education, No. 514*. New York: Teachers College, Columbia University.

Malina, R. M., & Bouchard, C. (1991). *Growth, maturation, and physical activity*. Champaign, IL: Human Kinetics.

Marsh, H. W., & Redmayne, R. S. (1994). A multidimensional physical self-concept and its relations to multiple components of physical fitness. *Journal of Sport & Exercise Psychology, 16*(1), 43.

Martinsen, E. W. & Stephens, T. (1994). Exercise and mental health in clinical and free-living populations. In R.K. Dishman (Ed.), *Advances in exercise adherence* (pp. 55-71). Champaign, IL: Human Kinetics.

Massicote, D. (1990). *Partial curl-up, push-ups, and multistage 20 meter shuttle run, national norms for 6 to 17 year-olds*. Montreal, Canada: Canadian Association for Health, Physical Education and Recreation and Fitness and Amateur Sport Canada.

McArdle, W. D., Katch, F. I., & Katch, V. L. (1996). *Exercise physiology: Energy, nutrition and human performance*. (4th ed.). Baltimore, MD: Williams & Wilkins.

McKenzie, T. L., Nader, P. R., Strikmiller, P. K., Yang, M., Stone, E. J., Perry, C. L., Taylor, W. C., Epping, J. M., Feldman, H. A., Luepker, R. V., & Kelder, S. H. (1996). School physical education: Effect of the child and adolescent trial for cardiovascular health. *Preventive Medicine, 25*(4), 423-431.

McKenzie, T. L., & Sallis, J. F. (1997). Physical activity, fitness, and health-related fitness. In S. Silverman and C. Ennis (Eds.), *Student learning in physical education: Applying research to enhance instruction* (pp. 223-246). Champaign, IL: Human Kinetics.

McKenzie, T. L., Sallis, J. F., & Nader, P. R. (1991). SOFIT: System for observing fitness instruction time. *Journal of Teaching Physical Education, 11*, 195-205.

Moores, D. E. (1996). *Educating the Deaf: Psychology, principles, and practices*. (4th ed.). Geneva, IL: Houghton Mifflin.

Morsh, J. E. (1936). Motor performance of the deaf. *Comparative Psychology Monographs, 1-51*. Los Angeles, CA: University of California Press.

Myklebust, H. R. (1964). *The psychology of deafness*. New York: Grune & Stratton.

Pate, R. R., Baranowski, T., Dowda, M., & Trost, S. G. (1996). Tracking of physical activity in young children. *Medicine and Science in Sports and Exercise, 28*(1), 92-96.

Pate, R. R., Trost, S. G., Felton, G. M., Ward, D. S., Dowda, M., & Saunders, R. (1997). Correlates of physical activity behavior in rural youth. *Research Quarterly for Exercise and Sport, 68*, 241-248.

Payne, V. G., & Isaacs, L. D. (1999). *Human motor development: A lifespan approach* (4th ed.). Mountain View, CA: Mayfield.

Pender, R. H., & Patterson, P. E. (1982). A comparison of selected motor fitness items between congenitally deaf and hearing children. *The Journal for Special Educators, 18(*4), 71-75.

President's Council on Physical Fitness and Sports. (1993). *The President's challenge physical fitness program packet*. Washington, DC.

Public Health Service. (1980). *Promoting health/preventing disease: Objectives for the nation*. Washington, DC: U.S. Department of Health and Human Services.

Public Health Service. (1990). *Healthy people 2000: National health promotion and disease prevention objectives*. Washington, DC: U.S. Department of Health and Human Services. DHHS Publication No. (PHS) 91-50212

Public Health Service. (2000). *Healthy people 2010: Health promotion and disease prevention objectives for a nation.* Washington, DC: U.S. Department of Health and Human Services.

Ramsey, G., & Rank, B. (1997). Rethinking youth sport. *Parks and Recreation, 32*(12), 30-36.

Ross, J. G., Dotson, C. O., Gilbert, G. G., & Katz, S. J. (1985). After physical education: Physical activity outside of school physical education programs. *Journal of Physical Education, Recreation, and Dance, 56*, 35-39.

Ross, J., & Pate, R. (1987). The national children and youth fitness study II: A summary of findings. *Journal of Physical Education, Recreation, and Dance, 58*, 51-56.

Rowland, T. W. (1999). One-mile run performance and cardiovascular fitness in children. *Archives in Pediatric and Adolescent Medicine, 153*(8), 845-849.

Rowland, T. W., & Freedson, P. S. (1994). Physical activity, fitness and health in children: A close look. *Pediatrics, 93*, 669-672.

Safrit, M. J. (1995). *Complete guide to youth fitness testing*. Human Kinetics, Champaign, IL.

Sallis, J. F., McKenzie, T. L., & Alcaraz, J. E. (1993). Habitual physical activity and health-related physical fitness in fourth-grade children. *American Journal of Diseases of Children, 147*, 890-896.

Sallis, J. F., McKenzie, T. L., Alcaraz, J. E., Kolody, B., Faucette, N., & Hovell, M. F. (1997). The effects of a 2-year physical education program (SPARK) on physical activity and fitness in elementary school students. *American Journal of Public Health, 87(*8), 1328-1334.

Salokum, S. O. (1994). Positive change in self-concept as a function of improved performance in sports. *Perceptual and Motor Skills, 78*(3), 752.

Schein, J. D., & Stewart, D. A. (1995). *Language in motion: Exploring the nature of sign*. Washington, DC: Gallaudet University Press.

Schirmer, B. R. (2001). *Psychological, social, and educational dimensions of deafness*. Needham Heights, MA: Allyn and Bacon.

Sherrill, C. (1998). *Adapted physical activity, recreation, and sport: Crossdisciplinary and lifespan* (5th ed.). Boston, MA: WCB McGraw-Hill.

Slaughter, M. H., Lohman, T. G., Boileau, R. A., Horswill, C. A., Stillman, R. J., Van Loan, M. D., & Benben, D. A. (1988). Skinfold equations for estimation of body fatness in children and youth. *Human Biology, 60*, 709-723.

Stewart, D. A. (1991). *Deaf sport: The impact of sports within the Deaf community*. Washington, DC: Gallaudet University Press.

Stewart, D. A., Dummer, G. M., & Haubenstricker, J. L. (1990). Review of administration procedures used to assess the motor skills of deaf children and youth. *Adapted Physical Activity Quarterly, 7*(3), 231-239.

Strand, B., Scantling, R., & Johnson, B. (1997). Fitness education. *Teaching concepts-based fitness in the schools*. Boston, MA: Allyn and Bacon.

Stucky-Ropp, R. C., & DiLorenzo, T. M. (1993). Determinants of exercise in children. *Preventive Medicine, 22*, 880-889.

United States Department of Education. (1996). *Eighteenth annual report to congress on the implementation of the individuals with disabilities education act*. National Center for Educational Statistics, Digest of Educational Statistics.

United States Department of Health and Human Services. (1996). *U.S. Surgeon General's Report on Physical Activity and Health*. Washington, D.C.

Vernon, M., & Andrews, J. F. (1990). *The psychology of deafness.* New York, NY: Longman.

Vincent, S. D., Barker, R., Clarke, M., & Harrison, J. (1999). A comparison of peak heart rates elicited by the 1-mile run/walk and the progressive aerobic cardiovascular endurance run. *Research Quarterly for Exercise and Sport, 70*(1), 75-78.

Wiegersma, P. H., & Van Der Velde, A. (1983). Motor development of deaf children. *Journal of Child Psychology, Psychiatry, and Allied Disciplines, 24*, 103-111.

Williams, J. M., & White, K. A. (1983). Adolescent status systems for males and females at three age levels. *Adolescence, 18*, 381-389.

Wilmore, J. H., & Costill, D. L. (1994). *Physiology of sport and exercise.* Champaign, IL: Human Kinetics.

Winnick, J. P., & Short, F. X. (1986). Physical fitness of adolescents with auditory impairments. *Adapted Physical Activity Quarterly, 3*, 58-66.

Winnick, J. P., & Short, F. X. (1988). A comparison of the physical fitness of segregated and integrated hearing impaired adolescents. *Clinical Kinesiology, 42*(4), 104-109.

APPENDICES

Appendix A: UCRIHS Approval

MICHIGAN STATE
UNIVERSITY

February 23, 2001

TO: Gail DUMMER
132 IM Sports Circle

RE: **IRB# 01-036** CATEGORY: EXPEDITED 2-D

APPROVAL DATE: February 23, 2001

TITLE: FACTORS THAT INFLUENCE THE PHYSICAL FITNESS LEVELS OF DEAF CHILDREN

The University Committee on Research Involving Human Subjects' (UCRIHS) review of this project is complete and I am pleased to advise that the rights and welfare of the human subjects appear to be adequately protected and methods to obtain informed consent are appropriate. Therefore, the **UCRIHS approved this project.**

RENEWALS: UCRIHS approval is valid for one calendar year, beginning with the approval date shown above. Projects continuing beyond one year must be renewed with the green renewal form. A maximum of four such expedited renewals possible. Investigators wishing to continue a project beyond that time need to submit it again for a complete review.
REVISIONS: UCRIHS must review any changes in procedures involving human subjects, prior to initiation of the change. If this is done at the time of renewal, please use the green renewal form. To revise an approved protocol at any other time during the year, send your written request to the UCRIHS Chair, requesting revised approval and referencing the project's IRB# and title. Include in your request a description of the change and any revised instruments, consent forms or advertisements that are applicable.
PROBLEMS/CHANGES: Should either of the following arise during the course of the work, notify UCRIHS promptly: 1) problems (unexpected side effects, complaints, etc.) involving human subjects or 2) changes in the research environment or new information indicating greater risk to the human subjects than existed when the protocol was previously reviewed and approved.

If we can be of further assistance, please contact us at (517) 355-2180 or via email: UCRIHS@msu.edu. Please note that all UCRIHS forms are located on the web: http://www.msu.edu/user/ucrihs

Sincerely,

Ashir Kumar, M.D.
Interim Chair, UCRIHS

AK: bd
cc: Kathleen Ellis
1501 W. Stoll Rd, #D
DeWitt, MI 48820

OFFICE OF
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Appendix B: Pilot Test Results

Pilot Study Results

Pilot Study #1

Pilot study #1 was conducted to determine the validity of the PACER test using visual cues (cable lights) rather than auditory cues (compact disc recording). In addition, validity was evaluated for the curl-up and push-up tests using both the auditory cues via CD recording and hand signals used by the investigator. A small sample of hearing children (n=6) between the ages of 7-12 years completed two measures of the PACER, curl-ups, and push-ups, once with auditory cues and once with visual cues. Each test was administered one week apart in the same school gymnasium, with the auditory cued tests completed during the first test session. Validity was determined to be r=.90 for the PACER, r=.88 for the curl-up test, and r=.83 for the push-up test using Pearson correlations. These results indicated that valid modifications were used in the form of visual signals.

Pilot Study #2

Pilot study #2 was completed to determine the feasibility of using the Fitnessgram tests for evaluating the physical fitness performances of deaf children. A group of 21 deaf children (16 males, 5 females) aged 6-11 years participated in this study. In order to validate the PACER, which has not been used to evaluate the cardiorespiratory endurance of deaf children, participants' performances on the timed one-mile run were compared to their performances on the PACER using visual cues. Each participant completed the mile run once and the Fitnessgram tests twice. The Fitnessgram tests included the PACER, curl-ups, push-ups, trunk lift, right sit-and-reach and left sit-and-reach. Curl-up and push-ups were evaluated using the hand signals in place of the auditory 3-second cadence described by the Fitnessgram test administrators manual and evaluated for validity by comparison to the 60-second sit-up and regular push-up tests, respectively. In addition, tricep and calf skinfolds were measured on both test dates. Each evaluated period occurred one week apart. All reliability and validity coefficients, computed through Pearson correlational methods, were found to be significant. This indicated that the Fitnessgram tests, including the PACER and hand-signaled curl-up and push-up tests, were appropriate measures of fitness for deaf children. Reliability and validity results for all Fitnessgram measures are summarized in Table 14.

Table 12

Reliability and Validity of Fitnessgram Measures of Deaf Children aged 6-11 years (Pilot Study #2)

Test 1/Test 2	Reliability	Validity
Mile/PACER 1		-.70
Mile/PACER 2		-.74
60s Sit-Ups/Hand Curl-Ups		.90
Push-Ups/Hand Push-Ups		.76
PACER 1/PACER 2	.79	
Tricep 1/Tricep 2	.98	
Calf 1/Calf 2	.99	
Curl-Up 1/Curl-Up 2	.88	
Push-Up 1/Push-Up 2	.92	
Right S&R 1/Right S&R 2	.89	
Left S&R 1/Left S&R 2	.88	
Trunk Lift 1/Trunk Lift 2	.96	

Appendix C: Surveys

Factors that Influence the Physical Fitness of Deaf Children

School Information Survey

You indicate your voluntary agreement to participate in this research by completing and returning this questionnaire

School: ______________________________

Address: ______________________________

Principal or Administrator: ______________________________

Phone: ____________________ Email: ____________________

Please answer the following regarding your students in 1st through 4th grades.

	Number of deaf students	Number of deaf students in physical education
Regular class/Regular school	________	________
Special class/Regular school	________	________
Special class/Special school	________	________

Person to contact to set up testing dates: ______________________________

Phone Number: ____________________ Email: ____________________

How may I contact the parents/guardians of your students?

________ We will provide a list of mailing addresses.

________ We will add mailing labels and conduct the mailing of information packets prepared and stamped by the investigator.

Should you have any questions or concerns, please do not hesitate to contact my dissertation directors or myself. Thank you.

M. Kathleen Ellis
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Physical Education Survey

Please complete the following information pertaining to the physical education program that your 1st-4th graders participate in.

Days per week that physical education classes meet: ____________

Minutes per week that physical education classes meet: ____________

Please complete the following information pertaining to the use of communication methods with deaf students in your physical education class.

Do you use sign language during class to explain directions? YES NO

If yes, type of sign language used: (please circle all that apply)

ASL English Contact SEE

Does an interpreter come to your PE class to communicate directions to the deaf student? YES NO

Please complete the following consent form to allow use of the above information in this research study.

I have read the description pertaining to the research study "Factors which affect the fitness levels of deaf children."

[ ] YES, I give permission to the investigator to use the information pertaining to my PE program.

[ ] NO, I do not want the investigator to use the information pertaining to my PE program.

Name: ____

School: ____

Signature: ______________________________ Date: ____________

Factors that Influence the Physical Fitness of Deaf Children

Parent and Student Information Survey

You indicate your voluntary agreement to participate in this research by completing and returning this questionnaire

Student Name: ______________________________

Date of birth: ______________ Age: ______ Grade: ______

School: ______________________________

Mailing address (where personal fitness analysis will be sent to): ______________________________

____

Please supply the following information for the child listed above:

Is your child: (please circle) Hard of Hearing Deaf

Decibel hearing loss in the: Right ear: __________ Left ear: __________

What is the cause of your child's hearing loss? (please circle)

Congenital Acquired Unknown

If you do know the specific cause of your child's deafness, please answer the following:

Genetics/hereditary Meningitis CMV

Other: ______________________________

How many years has your child attended his/her present school: ______________

Which accommodations does your child receive at his/her present school?

____

Please provide the following information regarding the above child's parents:

Is this child's mother: (please circle) Hearing Deaf

Decibel hearing loss in this parent's: Right ear: __________ Left ear: __________

Is this child's father: (please circle) Hearing Deaf

Decibel hearing loss in this parent's: Right ear: __________ Left ear: __________

Please provide information pertaining to the above child's sports and recreation participation.

On the chart below, please insert a:

√ under each month that your child participated in the activity **at least** three times per week for more than 30 minutes each time

Sport	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Basketball												
Softball/Baseball												
Football												
Volleyball												
Running												
Swimming												
Golf												
Cheerleading												
Tennis												
Racquetball												
Bowling												
Soccer												
Bicycling												
Other – Specify												

Do you regularly participate in Deaf community activities? YES NO

If yes, which activities? ______________________________

If yes, in what capacity? ______________________________
(participant, spectator, coach, etc.)

Please return completed questionnaire to Kathleen Ellis in the provided envelope.

Your time and participation in this study is greatly appreciated. Thank you!