8-2001

The Role Physical Maturation Plays When Children Perform the Presidential Fitness Test

Anil M. Joseph

THE ROLE PHYSICAL MATURATION PLAYS WHEN CHILDREN PERFORM THE PRESIDENTIAL FITNESS TEST

by

Anil M. Joseph

A Thesis
Submitted to the
Faculty of The Graduate College
in partial fulfillment of the
requirements for the
Degree of Master of Arts
Department of Health, Physical Education,
and Recreation

Western Michigan University
Kalamazoo, Michigan
August 2001

ACKNOWLEDGMENTS

I would like to begin by acknowledging Dr. Craig Hayword for giving me the impetus to pursue the area of research regarding maturation and performance. His time, guidance, direction, and knowledge were crucial to this research.

Secondly, I would like to thank the people on my graduate committee, Dr. Dawson, Dr. Liu, and Dr. Zabik. I would specifically like to recognize Dr. Dawson as an integral part to the completion of this research.

Finally, I would like to thank my wife Kristi and two kids, Alyssa and Brennan, for patience and understanding. Thanks, kids, for sitting in the stroller while I conversed with members of my committee. I love you guys.

Anil M. Joseph

THE ROLE PHYSICAL MATURATION PLAYS WHEN CHILDREN PERFORM THE PRESIDENTIAL FITNESS TEST

Anil M. Joseph, M. A.

Western Michigan University, 2001

The problem of the study was to determine the relationship between maturational age and performance on the Presidential Fitness Test. Seventy three subjects, boys and girls ranging in age from 8 to 12 years were involved in the study. It was the intent of the researcher to determine the relationship between maturational age and performance on The Presidential Fitness Test. The Roche, Wainer and Thissen (RWT) (Roche, Wainer, & Thissen, 1975) method of maturation was used to establish maturational age for all the subjects. The researcher used data that waere previously collected by Spring Arbor College for this current research. The Pearson product moment correlation was used to determine relationship between the variables. This correlation helps the researcher determine how strong a correlation exists between percent of maturation and level achieved in performing the sit-up, pull-up, shuttle run, mile run, and V-sit.

The findings showed no correlation between the Presidential Fitness Test and percent of maturation. One reason the research may not have seen the results expected is that body fat was not considered in the maturation formula. Another reason could be due to age of both boys and girls in the research.

TABLE OF CONTENTS

CHAPTER

Table of Contents—Continued

CHAPTER

LIST OF TABLES

CHAPTER I

INTRODUCTION

Often children who exhibit excellence in sports do so as a result of specific sport skill acquisition at a young age. These children are often faster, stronger, and more agile than their peers. It is evident through visual observation that these children tend to be closer to their full maturational growth then their peers. This evidence is seen in many athletic events where some children are physically larger than others. One may have witnessed basketball games where one child totally dominates because of their physical presence. In many athletic events children are grouped according to age. Within any of these age groups there are a wide variety of sizes and maturational levels. As a five-year director of soccer camps, for children ages 6–13 years, it was evident that children who were visually observed as early maturers possessed greater speed, strength, and agility when executing activities and playing the actual game.

The quest to predict height of children has been of interest to many parents, coaches and others involved in athletics. If a child's adult height could be predicted, parents could be more effective in exposing their children to sports in which they will excel, for a long period of time. If a male child is predicted to achieve a height of 5 ft 3 in., it is highly unlikely that he will be a star basketball player. Or if a female child wants to be a ballet dancer her height should be within narrow limits. By predicting the future, valuable information is gained to use in the selection of a possible occupation (Tanner, Whitehouse, Marshall, Healy, & Goldstein, 1975). According to Roche, Tyleshevski, and Rogers (1983), physical educators would benefit from measurements of maturity because of the significant interrelationships among maturity, size, physique, strength, and physical performance.

Statement of the Problem

The problem of the study was to determine the relationship between maturational age and performance on the Presidential Fitness Test. The Roche, Wainer and Thissen (RWT) (Roche, Wainer, & Thissen, 1975) method of maturation was used to establish maturational age for all the subjects.

Purpose

Understanding the role physical maturity plays in the development of speed, strength, and agility in children is an important aspect in the field of physical education. It is often observed that children closer to their full maturational growth tend to be faster and stronger than slower maturing children. This is evident when watching organized sports where children are grouped according to chronological age.

Specific reasons for this advantage are not necessarily due to social influences such as a father, mother, friend, or coach. However, early maturers can have mechanical and physiological advantages that may enhance performance. Bale (1992) stated, “Aerobic capacity in children is more related to size and body composition than age" (p. 151). Some of these advantages include longer bones that would allow children to throw, kick, and run faster. Likewise, larger bodies and muscle (greater mass) contribute to greater force production.

Chronological age is usually the only measure used to classify children in many athletic activity groups. Presently, most club and school sports only account for chronological age when grouping children in sport leagues. Volleyball and soccer clubs often are grouped according to age divisions. In elementary and middle school, children try out for teams according to their grade level. Sometimes these children are very frustrated because they do not have the size, strength, and speed that other children the same age may have.

One researcher suggested, that the possible decrease in motivation for sports participation in children could be due to physical maturity. Some researchers argue that even though most children are chosen for their skill in their particular sport, size and physique are also important in the selection criteria (Adam & Baxter, 1995; Malina, 1988). Because physical maturity plays an important role in physical abilities, children who are closer to their full maturational growth may dominate in many sports activities. This can lead to much frustration for late maturing children and their parents. Currently, the Pop Warner Football Administration groups children according to body weight. Other sports such as boxing and wrestling also use maturational growth when grouping participants into weight classes. It would seem prudent to consider a system of age classification where percent of maturation was included for categorizing children.

Often elite performance and performance of growing adolescents, is associated with biological maturity status (Beunen et al., 1997). Therefore, it is very important that there be an accurate assessment of biological maturity status for those involved with children in sports, especially those involved in the guidance of young children in sports (Beunen et al., 1997).

Delimitations

The study was delimited to the following:

1. Seventy-two girls and boys ages 8–12 years were administered the Presidential Fitness Test. The physical abilities measured were: mile run, pull up, curl up, sit and reach, and shuttle run.

2. A questionnaire completed by the subjects' parents provided biological parent heights, child's weight, and child's height (see Appendix A).

3. The Presidential Fitness Test was administered and data collected by the physical education instructors at Concord Schools, Concord, MI.

Limitations

Weaknesses of the study included the following:

1. The subjects were a homogenous group. All were from the same geographic location and socioeconomic status. Therefore, the results of the study will only be beneficial to those people in a similar setting.

2. Measures used to calculate the subjects' maturational age are numbers reported by parents. The accuracy of the parents' report will be a factor in the true maturational age calculated for each subject.

3. Data were not measured by the researcher, but by several others. Thus, the potential for tester error was greater than if a single tester was used. This potential error may influence the internal validity of the study.

Assumptions

Several assumptions were made in this research project:

1. It was assumed that the Presidential Fitness Test was a valid measure of strength, speed, agility, and endurance.

2. It was also assumed that each individual subject put out his or her best effort for each test.

3. The researcher assumed that the parents provided accurate information when addressing the questionnaire.

4. It was assumed that the growth and maturation formulas used to predict percent of full maturation were a valid measure.

Hypotheses

After review of the related literature, the following hypothesis are stated:

1. There will be a positive relationship (a correlation of .70 or higher) between boys' performance on sit up and pull tests and maturational age.

2. There will be a negative relationship (a correlation of –.70 or less) between boys' performance on the shuttle run and mile run and maturational age.

3. There will be a negative relationship (a correlation of –.70 or less) between girls' performance on sit up and pull up tests and maturational age.

4. There will be a positive relationship (a correlation of .70 or higher) between girls' performance on shuttle run and mile run and maturational age.

5. There will be a low correlation (.70 or higher) between combined boys' and girls' maturational age and their scores on sit and reach, sit ups, pull ups, shuttle run and mile run.

Definition of Terms

The following terms are pertinent to this study:

1. Agility: The ability to rapidly change direction of movement.

2. Ability: A person's capacity to perform physical activity.

3. Chronological Age: The point of reference used for growth and maturation given as a numerical value.

4. Maturation: The tempo and timing of progress toward the mature biological state.

5. Percent of Maturation: The numerical percentage given between 0 and 100 determining percentage of full growth.

6. Recumbent Length: The measurement of length taken from head to toe.

7. Strength: The expression of muscular force, or an individual's capacity to develop tension against an external resistance.

8. Speed: The ability to move the body as rapidly as possible.

9. Skill: Dexterity and coordination in the execution of learned physical tasks.

10. Skeletal Age: The age of the skeleton, usually taken from radiographs of the hand and wrist.

CHAPTER II

REVIEW OF RELATED LITERATURE

Introduction

The process of understanding growth and maturity in children has been extensively researched over the last millennium. Research dates back to the late 1700s where one longitudinal study was conducted on a boy whose growth measurements were taken every year from birth to18 years of age (Tanner, 1978). Understanding the growth of the human body has given researchers a variety of information to use for medical purposes. By understanding the growth of the human body, physicians can verify growth abnormalities, give parents accurate information on their child's growth status, and develop diagnosis and cures for growth diseases. Besides medical benefits, understanding growth and knowing a child's percent of maturation can help parents, teachers, and coaches develop that child's potential in a sport that is best suited for his physique.

The literature related to growth and maturation and its relationship to motor performance is reported in this chapter. The literature is presented under the following topics: (a) history of the prediction system, (b) RWT system of prediction, (c) cardio-respiratory factors, (d) strength and power, (e) speed and agility, and (f) summary.

History of the Prediction Systems

According to Roche et al. (1975), early work on the prediction of adult stature stems from longitudinal studies conducted in the United States during the 1920s. In these studies, skeletal age was found to be important for prediction. In order to determine skeletal age, one must take measurements from several different sites. The question remained as to which area of the body to assess and how to assess it. These studies acknowledged the fact that present height and skeletal maturity of the child, as well as midparent stature, were extremely useful predictors of full maturational growth.

There are several useful predictors of full maturational growth. These include: (a) stature, (b) age at menarche, (c) peak height velocity, and (d) the development of secondary sex characteristics. However, since these characteristics appear very late in development, they are not considered useful in developing prediction formulas. Other data used include the child's previous pattern of growth, but unless careful records have been kept on the individual, these data have limited potential for use. Some of the earliest prediction tables were developed by Bayley (1946). These prediction tables were developed based on stature and skeletal age. Until recent years the most common prediction system utilized was the Bayley and Pinneau system (1952), which was based on the Greulich-Pyle atlas of 1950. The Bayley-Pinneau tables were derived from data collected in the 1930s and 1940s and were validated against a very small sample size of 16–22 boys and 11–22 girls of different ages (Roche et al., 1975). The lack of validity associated with the Bayley-

Pinneau tables led to the development of a number of other systems. Tanner (1962) popularized a system that designated stage of maturity as based upon reference to the development of secondary sex characteristics. This system has a limitation related to the invasion of privacy, as well as the late onset of the secondary sex characteristics in the growth process. Roche et al. (1983) cited a number of other systems, all of which made use of standardized radiographs of bones and teeth as measures of physical maturity. However, the built in expense, exposure to radiation, and lack of convenience all limit the use of these methods.

The RWT System

Often maturation is associated with how tall a child is and how much that child weighs. Children are generally assessed for these two components during their pediatric visits. Pediatricians give this information as a percentile rank. A 4-year old child at the 90th percentile for height and 50th percentile for weight would imply that 10% of the children measured would be taller than he/she and 50% heavier than he/she at the same age. Does this mean that this child will always be at the top of the norms for height and in the middle of the norms for weight? That would be difficult to predict. However, methods for calculating a child's percent of maturation, thereby predicting the height of that child at full maturation, have been reported in the literature. Roche et al. (1975) developed a procedure to predict percent of full maturation called the RWT method (R- Roche, W- Wainer, T- Thissen). The researchers developed a way to identify a child's percent of maturation at a given age by looking at four variables: (1) chronological age, (2) child's recumbent height, (3) child's weight, and (4) biological parents' height. The RWT method was developed by studying 823 white middle-class children. The researchers collected 80 different variables for each child, narrowed them down to 18, and finally to 4 predictor variables as stated above. This system allows individuals to know more than just maturational age. It also allows one to ascertain the percent of full grown maturation. Two children the same age could easily have two very different percents of maturation. One child could be 60% of full maturation, while another may be 80% of full maturation. Because this method originally involved using skeletal age as determined by the analysis of radiographic procedures, it became costly and also required some exposure to radiation. Therefore, the researchers developed a system using chronological age rather than skeletal age as a variable in the prediction equation. The researchers correlated skeletal age to chronological age by using earlier studies: the RWT, as discussed earlier, the Greulich-Pyle method involving the skeletal age of the hand and wrist, and the Tanner-Whitehouse (TW) method involving the skeletal age of the hand and wrist. The researchers hoped that using chronological age in the formula would yield similar results to that of skeletal age. The results showed that they were close enough to justify use when evaluating boys between the ages of 5 to15 years and girls between the ages of 3 to13 years. All one would have to do is replace chronological age for skeletal age in the prediction equation. One of the reasons this system is not being used is that one must have access to the tables and materials necessary to calculate percent of maturation.

Cardio-Respiratory Factors

Several factors determine VO_2 max. However, two factors that are directly correlated to VO_2 max are body size and heart size. As a person grows from a child to an adult, so does the size of the heart. The size increase is related to the individual's body mass. Therefore, one can say that heart size increases proportional to body mass. According to Malina and Bouchard (1991), heart size is highly correlated with VO_2 max in children and youth. Maximal oxygen consumption increases with age in both sexes because of increased physical size (Armstrong & Davies, 1984; Bale, 1992). As the size of the heart increases, so does the stroke volume, thereby the ability to produce more work. As a result, boys, particularly those who mature early, often have greater success in sports, especially in those sports where height, weight, strength, and power are an advantage (Bale, 1992). However, other research has concluded that a stronger correlation exists between heart volume and fat-free mass (Malina & Bouchard, 1991). Children that are early maturers with relatively low body fat would have higher blood volume capabilities than late maturers. Extra fat does not contribute to oxygen consumption or to strength and power as does muscle bulk, and it may decrease performance by increasing body weight. (Bale, 1992). This combination of lean body mass and physical maturity would allow for the greatest cardiorespiratory advantage.

Strength and Power

Several studies have shown children with advanced skeletal age as being stronger than those who were not (Adam & Baxter, 1995; Bale, 1992; Clarke & Harrison, 1960; Krogman, 1959; Malina & Bouchard, 1991). One study looked at the maturation age of boys in the 1957 Little League World Series. Fifty-five boys were assessed for skeletal age as well as chronological age. The study concluded that 83% of the boys that were finalists for the Little League World Series were advanced in skeletal age for their chronological age. Through the data collected, one could conclude that these boys' success came about because they were biologically more stable and structurally and functionally more advanced. The researcher went on to conclude that advanced biological maturation is definitely a positive factor in Little League Baseball. In a similar study of Little League baseball players, the researcher recorded a similar observation: Hale (1955) found that almost all the pitchers in the study were postpubescent. Hale also discovered that the most powerful hitters, the hitters placed in the "clean-up" position or the fourth in the batting order, were all postpubescent. The strength and power advantages of being an early maturer were evident in both studies.

In another study, Clarke and Harrison (1960) examined 273 children at ages 9, 12, and 15 years. Their purpose was to determine if there were differences in structural measures, muscular strength tests, and explosive muscular power in boys who were advanced, normal, and retarded in skeletal age. In all the strength and power tests, the skeletally advanced boys performed better than the others. The researchers noted that the biggest difference between mean scores were with the 15-year-old group, then the 12-year-old group, and last the 9-year-old-group. This may suggest that the greatest differences in strength and power would come after pubescence. In general, the researchers found that in all instances where the differences were significant, the more mature group had the higher mean.

Speed and Agility

According to Malina and Bouchard (1991), speed is one of several areas where early maturing children perform better than late maturing children. When children were tested for speed and agility, such as in the shuttle run, their scores improved with age, showing us that size is an important factor in speed and agility. In one study (Rarick & Oyster, 1964), 63 children ages 6–9 years were tested on a number of strength and motor performance tasks. The results showed that the correlation between skeletal age and speed was stronger than chronological age and speed. The same study showed similar results when looking at agility. When comparing all motor performance tasks completed in that study, speed and agility had the highest correlation to skeletal maturity. In Rarick and Oyster's study, all correlations between skeletal age and performance were positive, especially in running, jumping, and throwing.

Track athletes are often known for their speed. One study (Cummings, Garand, & Borysyk, 1972) showed track athletes to be skeletally advanced for their chronological age. In another study, Clarke and Harrison (1971) found track athletes did not differ in skeletal maturity from nonathletes between ages 9–12 years. However, when looking at the junior high level, the athletes were skeletally advanced. Beunen, Ostyn, Renson, and Van Gerven (1981) investigated several motor tasks which included shuttle run and running speed. They pointed out that motor performance of adolescent males was significantly influenced by body size. The researchers also concluded that early maturing boys perform better than average compared to late maturing boys. Beunen et al.'s (1981) results for girls were different. They concluded that maturity status may not be significantly related to speed and agility. Malina and Bouchard (1991) stated, "Female adolescence brings about slight improvements in strength but no marked changes in motor performance, so individual variation in maturation rate has much less influence on girls' strength and motor performance" (p. 298).

Summary

Overall, most of the literature showed the importance of physical maturity as an important factor in performance of motor tasks when considering boys. One area of importance is the relationship of physical maturity to performance of motor tasks in girls. Much of the research showed that skeletal maturation in girls was not necessarily associated with high performance on motor tasks. In fact, much of the literature showed the opposite. The skeletally advanced girls had a strength advantage but did not have advantages in speed and agility when performing motor tasks. This was often seen after girls reached puberty. More studies are needed to understand the relationship of maturity status to performance.

CHAPTER III

PROCEDURES

The problem of the study was to determine the relationship between maturational age and performance on the Presidential Fitness Test. This chapter describes the procedures used in the collection and analysis of the data for this investigation. The chapter has been divided into five sections describing: (1) subjects, (2) motor tasks, (3) measuring instruments, (4) procedures, and (5) statistical analysis of data.

Subjects

All of the subjects were from Concord Elementary School. The subjects for this investigation were 72 girls and boys (37 girls and 35 boys) ages 8–12 years. The subjects were from a lower- to middle-class rural town. The data were collected in the spring of 1998. Permission to use these data was granted by Western Michigan University's Human Subjects Institutional Review Board (see Appendix B).

Data Collection

The data were collected in the spring of 1999. The researcher obtained data from Spring Arbor College concerning maturational information (see Appendix C). The data included information on biological parental height, child height, and child weight. Each child's and parent's information was used in the growth and maturation formula to predict percent of maturation of the child.

Next, the researcher acquired data from Concord Elementary School. The data included subjects' height, weight, and date of birth, as well as scores attained on the President's Fitness Challenge Test. The President's Fitness Challenge was administered by Concord Elementary School. All motor tasks were performed according to the guidelines in the Instructions for the President's Challenge Test Items.

Measuring Instruments

The (RWT) system was used to determine percent of maturation of each child. The following formula describes the system.

$$Y = B_o + (B_{rl} \times RL) + (B_w \times W) + (B_{mps} \times MPS) + (B_{sa} + SA) \qquad (1)$$

Y = Estimated adult stature

B_o = Intercept of the regression equation

B_{rl} = Regression coefficient associated with recumbent length

RL= Child's present recumbent length

B_w = Regression coefficient associated with midparent stature

W = Child's present weight

B_{mps} = Regression coefficient associated with midparent stature

M_{ps} = Midparent stature

B_{sa} = Regression coefficient associated with skeletal age

SA = Child's present skeletal age

Motor Tasks

The motor tasks administered by Concord Elementary School, which was later used by the researcher, included the following: (a) the shuttle run, (b) one mile run/walk, (c) curl-ups, (d) pull-ups, and (e) V-sit reach. All motor tasks were administered according to the guidelines in the Instructions for the President's Challenge Test Items.

Design and Statistical Analysis

The design was a correlational study comparing five dependent variables—the sit-up, pull-up, shuttle run, mile run, and V-sit—to the independent variable, maturational age. The Pearson product moment correlation was used to determine the relationship between the variables. This correlation enabled the researcher to determine if correlations exist between a child's percent of maturation and the President's Fitness Challenge Motor Skills Test (sit-up, pull-up, shuttle run, mile run, and V-sit).

CHAPTER IV

RESULTS AND DISCUSSION

This study was conducted to determine the relationship between maturational age and performance on the Presidential Fitness Test. The researcher wanted to determine if percent of maturation would be a significant factor in motor skill performance.

The analysis of data and discussion of the results are presented in this chapter. The Pearson product moment correlation was used to indicate relationships between variables. The Pearson product moment correlation was applied across the data of all subjects, to male subjects, and to female subjects.

Results

The raw data contain scores for all subjects on the Presidential Fitness Test. The data were separated into boys' scores, girls' scores, and combined scores. Other information included age, percent of maturation, and number of subjects.

Descriptive Data

Table 1 contains the descriptive data for chronological and maturational age for the study. Included are the number of participants and age ranges for the boys, girls, and combined data.

Table 1

Demographic Data for Subjects

Group	N	Age Range	Percent of Maturation Range
Boys	35	8.10–12.02	72.65–86.94
Girls	37	8.04–11.02	78.01–92.07
Combined	72	8.04–12.02	72.65–92.07

The total number of boys in this study was 35. Their ages ranged from 8 years and 10 months to 12 years and 2 months. Their maturation ranged from 72.65% to 86.94%.

Thirty-seven girls were used in the study. Their age ranges were slightly broader than the boys. The girls ages ranged from 8 years and 4 months to 11 years and 2 months. As a result, their percent of maturation range was broader, going from 78.06–92.07%.

The total combined number of participants used in this study was 72. Subjects' combined age ranged from 8 years and 4 months to 12 years and 2 months. The percent of maturation ranged from 72.06–92.07%.

Table 2 contains the descriptive data for the Presidential Fitness Test. Included are the means, standard deviations, and the ranges for the boys, girls, and combined scores data.

Boys' results, according to Table 2, show mean scores on the sit-up and pull-up at 33.26 and 2.44, respectively. Girls' mean scores on the sit-up and pull-up were

Table 2

Descriptive Data for Test Results From the Presidential Fitness Test

Group	Sit-up	Pull-up	Mile Run (min/sec)	Shuttle Run (sec)	Sit and Reach
Boys					
Mean	33.26	2.44	11.57	11.35	1.06
SD	7.06	2.24	2.84	1.16	3.61
Max	53	8	17.50	15.80	8
Min	15	0	6.53	9.90	–7
Range	38	8	10.96	5.90	15
Girls					
Mean	31.68	.94	13.27	11.77	1.97
SD	9.23	1.77	2.49	1	3.02
Max	56	7	21	14.30	7
Min	12	0	8.27	10.11	–9
Range	44	7	12.82	4.19	16
Combined					
Mean	32	1.60	12.43	11.40	1.55
SD	9.34	2.11	2.82	1.79	3.31
Max	56	8	21	15.80	8
Min	12	0	6.53	9.90	–9
Range	44	8	15.53	5.90	17

31.68 and .94, respectively. The results showed boys having slightly higher mean scores than the girls. Likewise, mean scores for the boys were lower or better on the shuttle run and mile run, 11 min 57 s and 11 min 35 s, respectively. The girls' scores on the shuttle run and mile run were 13 min 27 s, and 11.77 s, respectively. The range in scores for the girls was higher in every area except for shuttle run, where the boys had a slightly higher range. The greatest standard deviation scores were in the sit-up, and the lowest standard deviation score was in the shuttle run.

Correlational Results for the Boys

It was hypothesized that there would be a correlation (.70 or higher) between boys' scores on the sit-up, pull-up, and maturational age. As noted in Table 3, there was not a correlation between boys' scores on the sit-up or pull-up with maturational age. The correlation found between boys' scores on the sit-up and maturational age was .30. The correlation for pull-ups was –.28.

Table 3

Pearson Product Moment Correlation for the Presidential Fitness Test

	Percent of Maturation to Performance				
Group	Sit-up	Pull-up	Mile Run	Shuttle Run	Sit and Reach
Boys	.30	–.28	.02	–.09	.06
Girls	.05	–.18	–.17	–.07	–.02
Combined	.07	–.39	.14	.05	.10

It was hypothesized that there would be an inverse correlation (–.70 or higher) between boys' scores on the shuttle run, mile run, and maturational age. However, this was not evident in either the shuttle run or mile run. The correlation between shuttle run and maturation was –.09 and mile run was .02.

Results of boys' maturational age to the sit reach showed a correlation of .06, which indicated no relationship. The highest correlation found was between percent of maturation and the sit-up, .30. This fell short of the .70 criteria signifying a good relationship. The lowest correlation existed between the mile run and percent of maturation at .02.

Correlational Data for the Girls

It was hypothesized that there would be a correlation (.70 or greater) between girls' scores on shuttle run, mile run, and maturational age. The researcher hypothesized a positive correlation rather than a negative correlation because of the negative effects that maturation plays on performance in girls. The correlation between shuttle run and maturation was –.07, which was contrary to what was expected. Likewise, as shown in Table 3, the mile run had a low correlation at –.17.

It was hypothesized that there would be an inverse correlation (–.70 or greater) between girls' scores on sit-up, pull-up, and maturational age. A correlation of –.18 was found between pull-up and maturational age, and a correlation of .05 was found between sit-up and maturational age. Again, the correlation coefficients failed to support the hypothesis.

Correlational Data for the Combined Results

It was hypothesized that there would be no correlation (.70 or below) between combined boys and girls scores on sit and reach, sit-ups, pull-ups, shuttle run, mile run, and maturational age. Table 3 shows a correlation of –.39 for pull-ups, .07 for sit-ups, .14 for mile run, .05 for shuttle run, and .10 for sit and reach. As hypothesized, low correlations were found between combined scores and percent of maturation.

Discussion

The discussion of the results is divided into three sections. These include: boys percent of maturation to performance, girls percent of maturation to performance, and combined scores to maturation. The study failed to conclude the results expected by the researcher. Therefore, through the discussion, the researcher will offer insight into the results found.

Boys' Percent of Maturation to Performance

According to several researchers (Adam & Baxter, 1995; Bale,1992; Beunen, et al.,1981; Malina, 1978), children who were closer to their full maturational growth performed better in many sports and fitness related skills. However, as noted in Table 2, it was shown that there was a low correlation between percent of maturation and performance.

The lack of evidence shown through this research could be due to several reasons. First, the researcher did not account for body fat as a variable in affecting performance or calculating percent of maturation. This means a child could have been predicted closer to his full maturation due to his body weight. However, body fat does not help in enhancing strength, endurance, speed, or power. Therefore, one could achieve poorer results since fat impedes performance. Second, the male subjects may not have achieved puberty. During puberty, motor skill performance and developmental age are greatest. As a result, variation in maturity may not have been great enough to show a significant age related difference.

Sit-ups test abdominal muscular endurance and strength. Generally, boys put on fat around their midsection. Since increased fat does not enhance muscular strength or endurance, fat around the midsection could have made it harder for obese boys to do sit-ups. This could be one of the reasons why better performance was not associated with a higher percent of maturation in this skill. The pull-up tests muscular strength of the biceps, forearms, shoulders, and latissimus. Children with increased body fat would need great muscular strength to lift their body weight over the bar. If children have a high percent of body fat, their fat weight would hinder their muscular output, thereby making it more difficult to lift the increased weight over the bar. As a result, subjects, even though considered closer to full maturational growth, would not have as high a performance as expected. Another area which needed to be considered was the importance of lean body mass in running performance. Bale stated, "Early maturing boys and girls, for example, who are bigger in size especially if the increase is mainly as a result of an increase in lean body weight, have greater VO_2 max at age levels 8 to 15 years" (Bale, 1992, p. 151). This statement emphasizes the point that lean body mass was very important when calculating VO_2 max. One could conclude that extra fat weight would therefore hinder performance rather than enhance it. According to Haubenstricker (1998), fat can account for as much as 30% of a child's performance on a given task. Some researchers (Malina & Bouchard, 1991) have noted that there is a negative correlation between endomorphy and performance in running, jumping, and agility. Malina and Bouchard (1991) stated, "During childhood, absolute and relative fat-free mass are moderately and positively related to strength and motor performance, but absolute and relative fatness are negatively related to motor items in which the body must be projected" (p. 200). Heavier children do not seem to perform as well as lighter children in which the body is projected. However, the opposite was true when tasks involving throwing was assessed. Therefore, it can be said that fat can adversely affect performance where the entire body is required to move.

Several researchers have shown that maximum oxygen uptake may increase with age as a consequence of increased size (Armstrong & Davies 1984; Borms 1986). However, results of the study showed that there was no correlation between boys' percent of maturation and performance on the mile or shuttle run, r = .02 and –.09, respectively. Performance results for boys' scores on the mile run and shuttle run could have been affected by body fat since fat can adversely affect performance when the whole body is required to move. As stated earlier, fat was not accounted for in determining percent of maturation in this study.

As noted earlier, the researcher may have tested the male subjects early in their chronological development. According to Malina (1988), the association between developmental age and motor skill performance was greatest during the pubertal years. Puberty for boys often starts around 13 years of age. The age range for boys in this study was 8–12 years. Rarick and Oyster (1964) applied chronological age and skeletal age to several strength variables, such as knee extension and elbow flexion in 45 second-grade boys. The results of this study indicated that skeletal maturity was an insignificant factor in accounting for individual differences in strength and motor proficiency. Males achieve puberty between the ages of 13 and 16 years of age. The subjects in this study were between the ages of 8 and 12 years. This may suggest that the variation in maturity was not great enough to show a significant age-related difference in motor performance. If this study would have been performed on students between the ages of 13-16 years, a stronger correlation may have been seen due to the varying physical differences of subjects. Adam and Baxter (1995) stated, "In boys aged 13 and 16 years, skeletal age has been shown to explain a fairly high percentage of variation in body dimension" (p. 60). Other research has shown that the age range between 10 and 15 years was significant when identifying success in athletics (Rarick & Oyster, 1964). "Between the ages of 8 and 11 years, the relationship among chronological age, skeletal age, stature, and weight make it difficult to detect a significant contribution of skeletal age to submaximal and maximal working capacity" (Malina & Bouchard, 1991, p. 298). The age of the male children could have accounted for the results in this study.

Girls' Percent of Maturation to Performance

According to researchers (Beunen et al., 1997, Malina & Bouchard, 1991), girls that were closer to their full maturational growth showed slight improvements in strength and showed no significant changes in motor performance. It is generally accepted that performance of girls reached a plateau or decline during adolescence. Therefore, the researcher should have found an inverse relationship between the scores (pull-up and sit-up) and maturation except for the shuttle run and mile run.

The strongest correlation existed between maturational age and the pull-up, –.18. However, this was not considered a strong correlation. Correlations between shuttle run and mile run were –.17 and –.07, respectively, which demonstrate little relationship between the variables and maturational age. It was expected that female students closer to their full maturation would have achieved lower performance results. This was expected due to maturity and extra weight gained because of menarche. Results of the sit and reach showed a correlation of –.02, which demonstrated no relationship as hypothesized.

One reason the researcher may not have found the results expected could be that many of the girls tested may not have achieved a level of maturity which hindered performance to the degree stated in the literature (Beunen et al., 1997; Malina & Bouchard, 1991). Girls who achieve menarche at a later age seem to do better in motor tasks than those who achieve menarche at an early age. Girls tend to plateau or even decline in performance as they draw closer to full maturation. According to researchers (Malina & Bouchard, 1991), the mean age for menarche for girls is 13 years of age, with 12–14 years being the general range . The girls in this study had an age range of 8–11 years. Therefore, few were close enough to full maturation to show negative performance results at the level hypothesized. In one study conducted by Haubenstricker and Seefeldt (1986), performance of the long jump was assessed. It showed that girls' scores improved up to 11 years of age. After that point, the scores plateaued and then declined. Haubenstricker also assessed running speeds, which mirrored similar results. In another study testing shuttle run

(Branta, Haubenstricker, & Seefeldt, 1984), the results showed a definite plateau at 11 years with slight increases until 15 years of age, followed by a decrease in performance from 16–18 years.

Peak Height Velocity (PHV) is often used to identify adolescence in longitudinal studies requiring somatic maturity. PHV is very beneficial in determining when maximum growth occurs. Menarche generally occurs after PHV. Generally during menarche girls gain weight, develop breasts, and can deteriorate in motor performance. PHV of the girls Malina (1988) tested ranged from 11 years and 2 months to 12 years and 2 months. He went on to say that most mean ages at PHV cluster around 12 years in girls and 14 years in boys. If PHV is generally attained between 11.2 to 12.2 years and menarche comes afterwards, it is apparent why results from this study were contrary to what was hypothesized.

Combined Scores to Maturation

Combined scores showed no relationship, as hypothesized. According to Table 3, the strongest correlation was between pull-up and maturation, –.39. This inverse correlation between the pull-up and maturation may indicate that height and weight could be a negative factor in performance of the pull-up. The lowest correlation was between sit-up and maturation, .04. Since flexibility is not associated with speed, strength, agility, or cardiovascular capabilities, it was expected that no correlation would exist. As a result, no correlation was found between sit and reach and maturation, as hypothesized.

CHAPTER V

SUMMARY, FINDINGS, AND CONCLUSIONS

Summary

The present study was conducted to investigate the role physical maturity plays in the development of speed, strength, and agility in children. Seventy-two girls and boys ages 8–12 years were administered the Presidential Fitness Test. The subjects for this investigation were from a lower- to middle-class rural town. The physical abilities measured were (a) mile run, (b) pull-up, (c) curl-up, (d) sit and reach, and (e) shuttle run. The results of the physical abilities measured as well as information regarding maturation were attained through Concord Schools Physical Education Program.

The researcher obtained additional data from Spring Arbor College. These data included information on biological parental height, child height, and child weight. Each child's and parents' information was used in the growth and maturation formula to predict percent of maturation of the child. Permission to use the data was granted by Western Michigan University's Human Subjects Institutional Review Board.

The data were analyzed using the Pearson product moment correlation. The correlational study compared five dependent variables—(1) sit-up, (2) pull-up, (3) shuttle run, (4) mile run, and (5) V-sit—to the independent variable, maturational age. The correlation enabled the researcher to determine the relationship that exists between maturation and performance on the Presidential Fitness Test.

Findings

On the basis of the data collected and analyzed, the following results were observed:

1. A low correlation was found between percent of maturation and boys' scores on sit-up, pull-up, mile run, shuttle run, and sit and reach, .30, –.28, .02, –.09, and .06, respectively.

2. A low correlation was found between percent of maturation and girls' scores on sit-up, pull-up, mile run, shuttle run, and sit and reach, .05, –.18, –.17, –.07, and –.02, respectively.

3. No correlation was found between combined maturation and combined scores on sit-up, pull-up, mile run, shuttle run, and sit and reach.

Conclusions

Based on the findings of the study and the literature reviewed, the following conclusions appear to be justified:

1. Correlations between boys' scores and motor abilities were low; therefore, there is no relationship between percent of maturation in boys ages 8–12 years and performance on the Presidential Fitness Test.

2. Inverse correlations between girls' percent of maturation and performance were not evident; therefore, there is no relationship between girls' percent of maturation in girls 8–11 years and performance on the Presidential Fitness Test.

3. As hypothesized, there were low correlations between combined scores and performance on the Presidential Fitness Test, as the researcher was looking for negative correlations for girls' scores and positive correlations for boys' scores.

Recommendations for Further Study

From the results of this study, further investigation into how maturity affects performance on motor abilities is recommended as follows:

1. A similar study should be completed with skin-fold calculation for each subject.

2. A study should be conducted involving narrower stratification of ages for both girls and boys to determine an accurate account of maturation to performance and change which is presumed to occur over the years.

3. A wider, more diversified group of participants should have been used to allow a good representation of the sample population.

Appendix A

Parent and Child Maturational Information

Maturational Growth Data Sheet

I. Raw Data

Child's Name ______________________ Classroom Teacher __________

Biological Father's Height __________

Biological Mother's Height __________

________________________________ Signature of Parent

_____________ Date

Appendix B

Human Subjects Institutional Review Board
Letter of Approval

Human Subjects Institutional Review Board

Kalamazoo, Michigan 49008-5162
616 387-8293

WESTERN MICHIGAN UNIVERSITY

Date: 13 October 2000

To: Mary Dawson, Principal Investigator
Anil Joseph, Student Investigator for thesis

From: Sylvia Culp, Chair

Re: HSIRB Project Number: 00-09-01

This letter will serve as confirmation that your research project entitled "Maturation and Performance" has been **approved** under the **expedited** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: 13 October 2001

BIBLIOGRAPHY

Adam, D. G., & Baxter, J. (1995). Growth and development of young athletes. Sports Medicine, 20, 59–64.

Armstrong, N., & Davies B. (1984). The metabolic and physiological responses to children to exercise and training. Physical Education Review, 7, 90–105.

Bale, P. (1991). Anthropometric, body composition and performance variables of young elite female basketball players. Journal of Sports Medicine and Physical Fitness, 31, 173–177.

Bale, P. (1992). The functional performance of children in relation to growth, maturation and exercise. Sports Medicine, 13, 151–159.

Bayley, N. (1946). Tables for predicting adult height from skeletal age and present height. Journal of Pediatrics, 28, 49–54.

Bayley, N., & Pinneau, S. R. (1952). Tables for predicting adult height from skeletal age: Revised for use with the Greulich-Pyle hand standards. Journal of Pediatrics, 40, 423–441.

Beunen, G. P., Malina, R. M., Lefevre, J., Claessens, A. L., Renson, R., Eynde, B. K., Vanreusel, B., & Simons, J. (1997). Skeletal maturation, somatic growth and physical fitness in girls 6–16 years of age. International Journal of Sports Medicine, 18, 413.

Beunen, G., Ostyn, M., Renson, R., & Van Gerven, D. (1981). Chronological and biological age as related to physical fitness in boys 12 to 19 years. Annals of Human Biology, 4, 321–331.

Borms, J. (1986). The child and exercise: An overview. Journal of Sports Sciences, 4, 3–20.

Branta, C., Haubentstricker, J, & Seefeldt, V. (1984). Age changes in motor skills during childhood and adolescence. Exercise and Sport Sciences Reviews, 12, 467–520.

Clarke, H. H., & Harrison, J. C. (1960). Differences in physical and motor traits between boys of advanced, normal and retarded maturity. Research Quarterly, 33,13–25.

Cox, L. A. (1997). The biology of bone maturation and ageing. Acta Paediatrica, 423, 107.

Cummings, G., Garand., T., & Borysyk L. (1972). Correlation of performance in track and field events with bone age. Journal of Pediatrics, 80, 970–973.

Genel, M. (1995). Gender differences in growth and maturation: Are these relevant for athletic competition? Journal of Women's Health, 4, 425.

Glassow, R. B., Kruse, P, & Hernandez, M. (1991). Skeletal maturation and height prediction: Atlas and scoring methods. Madrid, Spain: Diaz de Santos.

Greulich, W. W., & Pyle, S. I. (1950). Radiographic atlas of skeletal development of the hand and wrist. Stanford, CA: Stanford University Press.

Greulich, W. W., & Pyle, S. I. (1959). Radiographic atlas of skeletal development of the hand and wrist (2nd ed.). Stanford, CA: Stanford University Press.

Hale, C. (1955). Physiological maturity of Little League baseball players. Research Quarterly, 27, 277–283.

Haubenstricker, J. (1998). Spartan profiles. Performance in Motion, 6–8.

Koziel, S. M. (1997). Combined effects of the tempo of maturation and mid-parent height on the shape of individual growth curves. American Journal of Human Biology, 9, 555.

Krogman, W. (1959). Maturation age of 55 boys in the Little League World Series, 1957. Research Quarterly, 25, 439–449.

Malina, R. M. (1978). Adolescent growth and maturation. Yearbook of Physical Anthropology, 21, 63–94.

Malina, R. M. (1988) Young athletes: Biological, psychological and educational perspectives. Champaign, IL: Human Kinetics.

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

Rarick, G. L., & Oyster, N. (1964). Physical maturity, muscular strength and motor performance of young school age children. Research Quarterly, 35, 522–531.

Roche, A. F., Tyleshevski, F, & Rogers, E. (1983). Non-invasive measurements of physical maturity in children. Research Quarterly for Exercise and Sport, 54(4), 364–371.

Roche, A. F., Wainer, H., & Thissen, D. (1975). Prediction adult stature for individuals. Monographs in Pediatrics, 3, 50.

Rochelle, R., Kelleher, M., & Thornton, R. (1961). Relationship of maturation age to incidence of injury in tackle football. Research Quarterly, 32, 78–82.

Rotch, T. (1908). Chronological and anotomic age in early life. Journal of the American Medical Association, 51, 1197–1205.

Smoll, F. L., Magill. R. A, & Ash, M. J. (1988). Children in sport (3rd ed.) Champaign, IL: Human Kinetics.

Strickland, S. S. (1994). Growth, maturation and body composition. Journal of the Royal Anthropological Institute of Great Britain and Ireland, 29, 990.

Tanner, J. M. (1962). Growth at adolescence, with a general consideration of the effects of heredity and environmental factors upon growth and maturation from birth to maturity. Oxford: Blackwell.

Tanner, J. M. (1978). Fetus into man. Cambridge, MA: Harvard University Press.

Tanner, J. M., Whitehouse, R. H., Marshall, W. A., Healy, M. J. R., & Goldstein, H. (1975). Assessment of skeletal maturity and prediction of adult height. London: Academic Press.

Wheildon, D. (1978). Maturity sorting: A new balance for young athletes. Physician Sports Medicine, 6, 127–132.