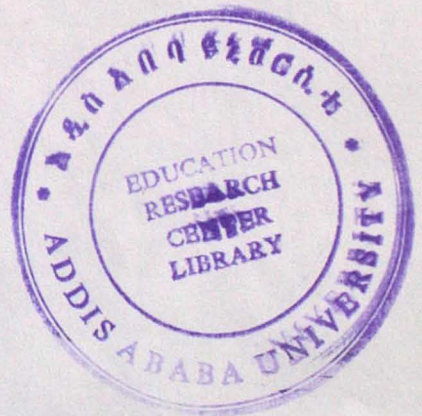


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**Predictive Validity of Physical Development
on Cognitive Development during Early and
Middle Childhood**



By: Azmeraw Belay

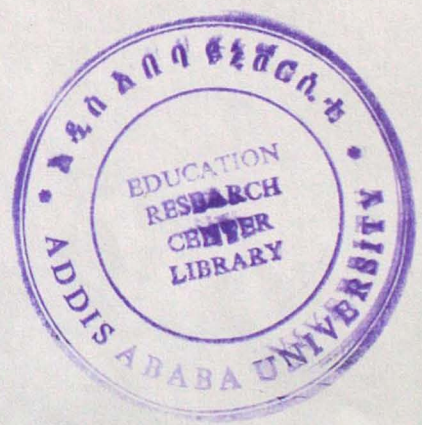
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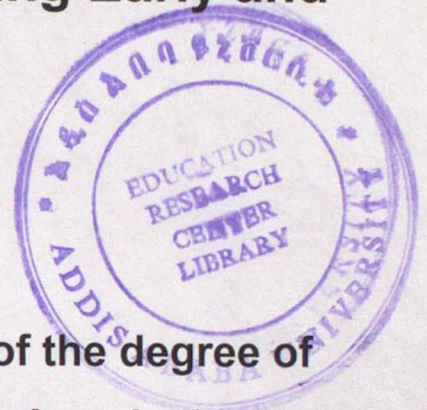


By: Azmeraw Belay

June, 2006

Addis Ababa

**Predictive Validity of Physical Development
on Cognitive Development during Early and
Middle Childhood**



**A thesis submitted in partial fulfillment of the degree of
Masters of Arts in Developmental Psychology in Addis
Ababa University**

By: Azmeraw Belay

June, 2006

Addis Ababa

I

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The writing of this paper is not the fruit of my individual effort. It has involved many individuals, the name of all those can not be mentioned individually.

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III

ACRONYMS

1. CCQ-Children's Cognitive Questionnaire
2. HC-Head Circumference
3. MUAC-Mid-upper-arm-circumference
4. WHO-World Health Organization
5. NHES-National Health Examination Survey
6. ANOVA-Analysis of Variance

IV

Abstract

The study investigated the association between physical and cognitive development during early and middle childhood. Multistage sampling technique was followed in the selection of participants. As part of multi stage sampling, using simple random sampling, 60 children between the ages of 4 to 6 years and 60 children between the ages of 7 to 9 years were selected from the two preschools and two primary schools respectively. Children's height, head circumference, and mid-upper-arm circumference were measured in cm and weight in kilogram. Then cognitive questionnaire was administered for each child. The result showed that there is positive and statistically significant relationship between physical and cognitive development. The result also showed that the predictive validity of physical development on cognitive development is significant for the preoperational group but not for concrete operational group. When across chronological age is considered, the predictive validity of physical development on cognitive development was found to be statistically significant for children of 4 and 5 years but not for children of 6 to 9 years. The finding also showed the existence of statistically significant difference in the predictive validity of physical development on cognitive development across sexes particularly between male medium and female medium, and male high and female high groups, but not between male low and female low groups.

CHAPTER ONE

1 INTRODUCTION

1.1 Background of the study

Development is holistic and multidimensional in its nature. One of the principles of development is the principle of inter-relatedness among the major aspects of development. Progression or delay in one aspect of development could be associated with other developmental domain (Hurlock, 2003).

Physical development provides the milestone for other developmental domains. In view of this, developmentalists call attention to basic facts about early physical development during childhood years and the implications for other developmental domains in general and cognitive development in particular (Wade, 2004).

Bhargava (1998) indicated that physical and cognitive development are intertwined, for example, anthropometric measures such as weight-for-age, height-for-age, weight-for-height, head-circumference, mid-upper-arm-circumference, and skinfold thickness are predictors of cognitive abilities in school age children in a longitudinal framework.

Various investigators (Belmont, Stein, and Susser, 1975; Weinberg, Dietz, Penick, and McAlister, 1974; Wilson, and Hammer, 1986, as cited in Ernhart, Marler, and Tlucak, 1987) have also documented a positive relationship of size measures and cognitive performance. The finding of the study indicated that the relationship of measures of weight, height, and head circumference in early (preschool) years with measures of cognitive development were generally positive in direction. The research report further indicated that the direction of association remained consistent after controlling relevant confounding variables. And reports of this relationship to date have been evident for children age six years and older and of adults.

To understand the association between physical and cognitive development in children, investigators have taken a variety of approaches. Some have examined cross-sectional correlations and have either disregarded or controlled for children's socio-economic background, with varying degree of vigor. Others have looked for longitudinal associations between change in physical development and change in cognitive development or have examined the relationship

between early physical development and later cognitive development. Still some others have examined the effect of early malnutrition as measured by anthropometry in infancy and childhood and later cognitive development (Grantham-McGregor, 1999).

Thus, the purpose of the present study is to examine the association between physical development as measured by anthropometric indexes-height, weight, head circumference, and mid-upper-arm circumference and cognitive development during early and middle childhood in normal population.

1.2 Statement of the problem

A number of researches have been conducted to examine the relationship between anthropometric measures and cognitive functions. The results of such studies have been of paramount importance especially in developing nations where the problem of malnutrition is of a great concern for child developmentalists. Based on the findings, they have developed clear measures to assess and/or monitor the growth and development of children and used it for further intervention (Launde, 1999). However, at country level, there are few or no researches conducted in the area considering the relationship between physical and cognitive development.

Thus, in this study, the scientific investigation focused on whether physical development across change in chronological age predicts cognitive development in early and middle childhood. To closely examine the issue, the researcher poses the following basic research questions.

- 1 Does physical development have predictive validity on cognitive development?
- 2 What is the predictive validity of height on cognitive development?
- 3 What is the predictive validity of weight on cognitive development?
- 4 What is the predictive validity of head circumference on cognitive development?
- 5 What is the predictive validity of mid-upper-arm circumference on cognitive development?
- 6 Is there a statistically significant difference ($\alpha=0.05$) in the predictive validity of physical development on cognitive development across sexes?
- 7 Is there a statistically significant difference ($\alpha=0.05$) in the predictive validity of physical development on cognitive development between children found in preoperational and concrete operational stages?

8 Is there a statistically significant difference ($\alpha=0.05$) in the predictive validity of physical development on cognitive development across changes in chronological age?

1.3 Research hypotheses

There are two hypotheses of interest underlying this research. The researcher (I) hypothesizes that there is a positive relationship between physical and cognitive development across change in chronological age. The researcher (II) hypothesizes that, as chronological age increases, the predictive validity of physical development on cognitive development decreases because of the influence of different confounding factors.

1.4 Objective of the study

The general objective of the study is to investigate the relationship between physical and cognitive development during early and middle childhood.

More specifically, the study tried to address the following objectives.

- To examine the predicative validity of physical development as measured by anthropometric indexes-height, weight, head-circumference, and mid-upper-arm circumference on cognitive development.
- To examine if there is a statistically significant difference at alpha level 0.05 in the predictive validity of physical development on cognitive development across sexes.
- To examine if there is a statistically significant difference at alpha level 0.05 in the predictive validity of physical development on cognitive development between children in the preoperational and concrete operational stages.
- To examine if there is a statistically significant difference at alpha level 0.05 in the predictive validity of physical development on cognitive development across changes in chronological age.

1.5 Delimitation

- The study considered Jean Piage's preoperational and concrete operational stages of cognitive development.
- The study was conducted on 120 children within the age category of 4 to 9.
- The study was conducted in four schools in Debre Zeit town only.

1.6 Limitation of the study

The study in such a challenging and time consuming work is not without limitation. The following are the major limitations of the study which may pave the way for carefully undertaking similar studies in the future.

- Small sample size. The research was conducted on only 120 children in four schools. Had it been possible, it could have been conducted on large sample size. Hence it would be difficult to generalize the finding unless further study is conducted.
- Influence of confounding factors. There could be a number of factors, which might have influenced the finding. These factors include parents socio-economic status, birth order, family size, etc which were not controlled

while undertaking this study.

- The researcher did not contact children's parents to interview the participant children. The children's interview was conducted based on the consent of the respective school directors and teachers. This might violate the issue of ethical consideration in research.
- Lack of adequate past and present research findings on the problem is also one of the limitations of the study.

1.7 Operational definitions of variables

- 1 Physical development: in this study, it is defined by height (in cm), head circumference (in cm), mid-upper-arm-circumference (in cm), and weight (in kg).
- 2 Cognitive development: In this study it refers to the major cognitive development features of preoperational and concrete operational stages found by Jean Piaget.
- 3 Early childhood: in this study, it is defined as the period in childhood from 4 to 6 years.
- 4 Middle childhood: in this study, it is defined as the period in childhood from 7 to 9 years.

1.8 Significance of the study

The finding of the study has both theoretical and practical significance.

1.8.1 Theoretical significance

The study was expected to provide additional theoretical input for developmental psychology. Developmental Psychologists like Hurlock (2003) argued that, developmental domains are interrelated. This study provided additional theoretical evidence into the validity of the existence of relationship between physical and cognitive development. To what extent and at which developmental stage physical development reasonably predicts cognitive development is another theoretical input, which this study provided.

1.8.2 Practical significance

The finding of the study is of paramount importance for teachers, parents, academic staff, and organizations/child care institutions working with children. The anthropometric measurement could be used by parents and teachers who interact closely with children, and hence use the measurement to monitor and assess the growth and

development of children, which provides information in understanding and comparing children's well-being. Teachers can also use the cognitive measurement/test to assess the children's developmental level and identify at which developmental stages they are, group them accordingly, and design their instruction accordingly. The study also has applied significance for child care institutions working with children for screening and grouping children (early diagnosis) and design interventions accordingly. The finding will be a resource material for academic staff who will conduct researches in the area. Last but not least, it is obvious that measuring cognitive development of children is not an easy task. Thus, the finding is significant in this regard that, by measuring physical development using the four anthropometric indexes, one can reasonably predict the cognitive developmental level of a child with in fact a certain margin of errors.

1.9 Structure of the report

The research report is prepared with four major sections. The first part deals with introduction which includes the background of the study, statement of the problem, research hypotheses, objectives the study, delimitation, limitations, definition of variable, significance of the study. Review of past and present findings in relation to the subject area is also included under this section. The second section deals with the research methodology, which includes research design, participants of the study, sampling technique, data gathering instrument, data collection procedure, and statistical design and analysis. The third section deals with the results and discussion. And the fourth part presents the conclusive remarks of the study. The data gathering tools and result of item analysis are also annexed with the research report.

1.10 REVIEW OF RELATED LITERATURE

The literature review provided an initial understanding of the problem and its context. The overall lack of research on the problem forced the researcher to investigate the previously untapped sources. The literature review provided a solid foundation for this new research work to formulate worthwhile and relevant questions to design the investigation and leading support and justifying the study.

The investigation has proceeded from several perspectives. Firstly, a theoretical background, which serves as a stepping-stone for formulating the problem, is presented. Secondly, the major areas of physical development during early and middle childhood are described. Thirdly, the major cognitive development features of early and middle childhood are overviewed. Lastly, past and recent research findings on the relationship between physical and cognitive development at different stages of human development are overviewed.

1.10.1 Theoretical Perspective

A number of theories have tried to describe the human cognitive development at different stages of life. But, from among these theories, the one that has got great attention by psychologists and most generally accepted is that of Jean Piaget (Sugarman, 1987).

Hence, with regard to cognitive development, this study primarily bases on the theoretical foundation of Piaget's cognitive development work. Jean Piaget, a Swiss Psychologist and well-known researcher in the field of cognitive development, classified stages of cognitive development to correspond with the approximate stages of physical development used in this study. He maintained that children at different ages reach developmental stage in an invariant sequence in the same order, and in each stage, they perform specific cognitive tasks with certain limitations. These stages, according to him, are universal across cultures. He also argued that cognitive development represents increasingly comprehensive ways of thinking in which children are constantly exploring, manipulating, and trying to make sense out of their environment, and in this process, they actively construct new and more elaborate

structures dealing with them. Cognitive development, thus, is an active construction process, in which children through their own activities build increasingly differentiated and comprehensive cognitive structures in different stages of cognitive development. These stages represent qualitative differences in modes of thinking, not merely quantitative differences (Piaget, as cited in Crain, 2000). The cognitive developmental stages that characterize early childhood and a school year child are named as preoperational and concrete operational stages respectively. The details of the cognitive features of these stages of cognitive development are presented in the subsequent section.

With regard to physical development, anthropometric indexes as recommended by World Health Organization for international use are used in this study. In many research undertakings, anthropometry has been used in measuring physical development at different stages of human life. Anthropometry has been defined as a science, which deals with the measurement of size, weight, and proportion of human body. Basic measurements are used to describe individual or populations, while some measurements are used

for correlation with performance (WHO, 1995).

The WHO affirmed the significance and universal applicability of anthropometry as follows.

---anthropometry is the single most portable, universally applicable, inexpensive, and non-invasive method to assess the proportion, size, and composition of human body. It reflects both health and nutrition, and predicts performance. It is used in screening and monitoring of adequate growth in individuals and populations (WHO ,1995:75).

Accordingly, the World Health Organization identified and developed the most commonly used anthropometric indexes for assessing child growth to be weight-for-height, height-for-age, weight-for-age, head circumference, and mid-upper-arm circumference.

1.10.2 Physical development during early childhood

1.10.2.1 Body growth

During preschool years, both boys and girls slim down as trunks of their bodies lengthen. Although their heads are still somewhat large for their bodies, by the end of preschool years, most children have lost their top-heavy

look (Santrock, 1999). Brain and head grow more rapidly than other parts of the body in early childhood, less rapid than during infancy. By the time children have reached 3 years of age, the brain is 3/4's of adult size. By age 5, it has reached 9/10's of its adult size (Santrock, 2000). The average child grows 2 ½ inches in height and gain between 5 and 7 pounds a year during early childhood. As the preschool child grows older, the percentage of increase in height and weight decreases with each additional year. Girls are only slightly smaller and lighter than boys during these years, a difference that continues until puberty (Santrock, 2000). Growth patterns vary individually. Much of the variation is due to heredity, but environmental experiences are involved to some extent (Hurlock, 1995). A review of height and weight of children around the world concluded that the two most important contributors of height difference are ethnic origin and nutrition (Meredith, as cited in Santrock, 2000).

1.10.2.2 Motor development

During early childhood, young children show considerable improvement in the development of both gross and fine motor skills, especially as a result of their mastery play (Whitable, as cited in Maguire and Dunn, 1997). As children

move their legs with more confidence and carry themselves more purposefully, moving around the environment becomes more automatic. Three years old children have highest level of any age with gradual increase of sense of adventure especially up to age 5 (Daehler 2001). Children enjoy simple movements, such as hopping, jumping, and running back and forth, just for the sheer delight of performing these activities. The run and jump will be a source of considerable pride and accomplishment (Schmidt, 1991). At 4 years of age, children are still enjoying the same kind of activities, but they have become more adventurous. At 5 years of age, children are even more adventuresome than when they were 4. A self-assured 5 years old can perform hair-raising stunts on practically any climbing object. These children can run hard and enjoy races with each other and their parents (Tanner, 1990). With regard to fine motor skills, three years olds are still emerging from infancy ability to place and handle things. By 4 years of age, children's fine motor coordination has improved substantially and become much more precise. When they are 5-6 years of age, their fine motor coordination has improved further. Hand, arm, and body all move together under better command of the eye (Santrock, 2003).

1.10.3 Physical development during middle childhood

The period of middle childhood involves slow, steady, consistent growth. Compared to the extreme growth occurring from birth through the preschool years and the rapid physical changes that occur in adolescence, this period is uneventful (Santrock, 2000). Among the most important aspects of growth and proportion in this developmental period are those involving skeletal and muscular systems.

1.10.3.1 Skeletal and muscular system

During the elementary school years, children grow on average of 2 to 3 inches a year until, at the age of 11. The average girl is 4 feet, 10 $\frac{1}{4}$ inches tall, and the average boy is 4 feet, 9 inches tall. The weight increase is mainly due to increase in the size of skeletal and muscular systems, as well as the size of some body organs.

They increase on average of an inch in head circumference per year (Karen, 1996). Muscle mass increases as 'body fat' decreases while the legs become longer, and the body trunk becomes slimmer. Muscular strength is due to heredity and exercise, doubling their strength during these years. Because of their greater number of muscle cells, boys are

usually stronger than girls (Eveleth and Tanner, 1990). Proportional changes are among the most pronounced physical changes in middle childhood. Head circumference, waste circumference, and leg length decrease in relation to body height (Ayatollahi and Carpenter, 1991).

1.10.3.2 Motor Development

During middle childhood, children's motor development becomes smoother and more coordinated than it was in early childhood. Children's muscle strength, muscle skills, and stamina increase. They acquire motor skills necessary to perform complex movements allowing them to participate in a variety of physical activities (Whitable as cited in Maguire and Dunn, 1997). The major developments in motor skills are improved muscle coordination and manipulative skills. At this stage, children can perform almost any motor skills as long as it does not require adult strength or judgment (Tanner, 1990). Running, climbing, hopping, skipping rope, swimming, bicycle riding, and skating are just a few of the many gross motor skills elementary school children can master. And when mastered, these physical skills are sources of great pleasure and accomplishment for children (Santrock, 2000). Fine motor skills are those

dealing with dexterity like cutting, pasting paper toys, drawing, painting, coloring, using a table knife for cutting and other common tools, brushing and combing their hair usually in an acceptable manner, etc (Santrock, 2000). In gross motor skills involving large muscle activities, boys usually outperform girls. Girls, on the other hand, perform better than boys in fine motor skills (Santrock, 1999).

1.10.4 Cognitive development during early childhood

Preoperational thought is the stage of cognitive development associated with children of approximately preschool age, 2 to 7 years old (Piaget, 2001). It is the stage when children start to reason, build concepts, and lay the foundations for concrete operation (Santrock, 2003). The most significant cognitive feature of early childhood is the emergence of symbolic activity. Children begin to use symbols when they use one object, action or words to represent an absent one and their ability to understand, imagine, and communicate increase rapidly (Garmston, Robert and Wellman, Bruce 1994). Driscoll(1994) added that, the preoperational stage is a time when symbolic thinking grows, mental reasoning emerges, the use of concepts increase and imaginary beliefs are constructed.

Santrock (2003) indicated that symbolic function is the first stage that occurs between the ages of 2 and 4. At this stage, egocentrism and animism play a role in the children's development and their mental symbols are not completely real or logical. Preschool children play many games of pretend. Though play often has a distinctly social flavor, it seems to build distinctly cognitive skills in preoperational child, and may thus constitute a bridge between the social world and the more individualistic world of cognitive skills. Pretended play somehow makes children eager to be more advanced than they really are. In doing so, children use their cognitive structures to operate, impose, pretend, and real world representation of the child's real world knowledge (Flavell, 1998).

Equally important achievement during this stage is the use of language. Language vastly widens the child's horizon. It enables the child to relieve the past, anticipate the future, and communicate events to others. However, a child does not use words to stand for true classes of objects (Santrock, 2003). The development of language corresponds with the child's growing sense of relationship between objects in the world and their acquisition of general mental concepts. Preschoolers rapidly develop

towards more social speech as they themselves become social (Zahorick, 1997). Crain (2000) added that children begin to use language, memory, and imagination, and they engage in make believe and understand and express the relationship between past and future. Children are also capable of recognizing and memorizing things and events. However, more complex concepts, such as cause and effect relationships have not been learned (P 120).

Egocentrism, one of the characteristics of preoperational thought is "the child's inability to distinguish between one's own perspective and someone's perspective" (Piaget, 2000). Animism is another characteristic of preoperational thought that adds to the magic of the young child's symbolic representation. It is the child's belief that things are alive or have human characteristic because they move or grow. Rational thought makes little appearance and the child links together unrelated events, and attributes all things to human cause, which Piaget calls artificialism (Piaget, 1995). Intuitive thought is the second sub-stage of preoperational thought, which occurs in children between 4 to 7 years of age. The child is able to believe in something without knowing why he or she believes it. Children at this stage want to know the answers of all

kinds of questions, for every thing that happens and they tend to be sure of knowledge and understanding that they become unaware of how they gained knowledge (Piaget, 2000). The child begins to make comparisons, but fails to see the difference in properties of an object or objects based on perspective and lacks direction in speech. Successive opinions can differ and contradict each other (Piaget, 1995). A child focuses on one characteristic of someone or something, and bases his or her decision or judgement on one characteristic, which is called centration. For example, if a 4 years old child is given some blocks and asked to put the blocks into groups in which he or she thought they belonged, the child may focus his or her attention on the color instead of shape (Piaget, as cited in Crain, 2000). Lack of conservation, classification, seriation, and reversible thinking are also the cognitive limitations of this stage (Piaget, 2000).

1.10.5 Cognitive development during middle childhood

Concrete operational thought is a stage in cognitive development that characterizes a school year child. It is the third of the stages of cognitive development in Piaget's theory. Children during middle childhood largely share this thought process, which lasts from about seven to

eleven years. During this stage, children use logical operations or principles in solving problems (Boeree, 1999). Children not only use symbols representationally, but also can manipulate those symbols logically. Children, for the first time, are capable of applying logical thought process to concrete problems. For example, at this stage, the child has the ability to apply reversible mental action on real, concrete objects (Piaget, 1983). Another feature of this stage is understanding conservation, the knowledge that quantities such as mass, weight, volume, number, and length are unrelated to the arrangement and physical appearance of objects. For example, a child can conserve number at approximately 6-7 years of age and substance at the age of 7-8 years (Kamii, 1982). Children of this stage are overcoming the egocentric perspective that was present in preschoolers, a process called decentering, and are able to take multiple aspects of a situation into account (Boeree, 1999). Classification and seriation are also among the cognitive features of this stage. Seriation is putting things together in an order according to size, shape, or any other characteristics. The younger child may start putting things in order, by, say size, but will quickly lose track. Now, the concrete operational child has no problem with such a task (Sugarman, 1987). Classification

implies reasoning about the relationship between objects. It is the ability to name and identify sets of objects according to appearance, size, shape, or any other characteristics including the idea that one set of objects can include another (Piaget, as cited in Crain, 2000). Children have the ability to perform spatial reasoning tasks and concept of time also increases (Piaget, 2001). All the limitations of preoperational stage are overcome at this stage. Although, children at this stage can understand concrete problems, Piaget argued that they can not yet contemplate or solve abstract problems and they are not yet able to consider all of the logically possible outcomes (Piaget, 1995).

1.10.6 Research works on the subject

Various investigators have tried to examine the relationship between physical and cognitive development at different stages of human development. And, in most of the studies, predictive relations are found, which served as essential sources for this research work. In doing so, researchers have either examined cross-sectional associations or longitudinal approaches in their search for a statistically significant relationship between physical and cognitive development. Most cross-sectional studies

have found significant associations between height-for-age and children's cognitive functions without controlling for socio-economic status (Ernesto and Nita, 1995). Even after controlling for socio-economic status, investigators have found significant associations between height-for-age and cognitive functions in school age children in many countries including the Philippines, Jamaica, Guatemala, Nepal, Kenya, Bangladesh, and India (Grantham-McGregor, 1999). In one of the studies conducted on 6 to 30 months of age participants, Grantham McGregor found out that height-for-age predicted cognitive function ($P < .01$, 33% variance explained) when child's sex, birth order, and family socio-economic status are controlled for. In another study done on a sample of 118 children aged 1 to 3 years, a positive correlation ($r = 0.56$, $p < 0.001$) was found between height-for-age and cognitive development (Monckeberg, as cited in Grantham-McGregor, 1999). Only a few studies failed to find significant associations between height and measures of mental development. In a longitudinal study, recent evidences indicate that measures of height and weight taken at infancy predict cognitive performance 5 years later (WHO, 1995). In the US National Health Examination Survey (NHES), cycle 2 and 3, a sample of 13,887 US children age 6-17 years old were taken with which

to examine the relationship between height (normalized for age and sex) and measures of different cognitive test scores. Additionally, 2177 children were studied first in cycle 2 and 2 to 5 years later in cycle 3 forming a well-selected longitudinal group. The finding revealed positive and statistically significant relationship between height and children's cognitive scores. Children who were one standard deviation above average in height-for-age scored more than one point on cognitive performance tests than did children of average height. When genders were considered separately, the relationship remained significant for boys but not for girls. However, there was essentially no relationship between weight and cognitive development. The authors indicated that, this differential finding should not be surprising. They considered height to be a better summary measure of lifetime nutritional status of the child, while weight conveys information primarily about current nutritional status (Wilson, Hammer, Duncan, Durnbusch, and Gross, 1986). Similar researches indicated the existence of positive relationships between postnatal anthropometry and concurrent cognitive performance. Stronger relations appear for height-for-age, which has been associated with cognitive performance in Brazilian school age children. Weight for height has been associated

with older children's cognitive performance in Brazil (Wake, Coghlan, and Hesketh, 2000). Small but consistent correlations with concurrent cognitive performance and predictive correlations have been reported for height (Martorell, 1992). Postnatal head size was found to be moderately correlated with childhood IQ, whereas indexes of skinfold thickness and arm-circumference were found to be associated with preschool cognitive performance (De Onis, yip, and Mei, 1997).

Again, however, closer inspection of the available data suggest that the results are not consistent, as they would appear at first glance. First, not all studies show positive and significant associations between physical and cognitive development. A number of studies reported essentially insignificant associations between standard anthropometric measures and cognitive development. A study conducted on children 4-5 years of age in Chile using Wescheler Intelligence Scale for children (WISC) found no significant correlation between height-for-age and children's cognitive function. The reason for the negative finding are not always clear, but as concluded by the investigators, small sample size could explain the finding. Although the lack of relationship may be attributed to

insufficient statistical power, this does not appear to be true for the remaining studies (Wachs, 1993). In addition, even when significant relations are found between anthropometry and cognitive performance, there is always some degree of ambiguity because anthropometry scores could be associated with a variety of factors. Finally, a number of studies suggest that, the relationship between anthropometry and cognitive performance may be moderated by a variety of parameters. Moderators that were identified include nutrition, birth order, family size, parental occupation, sex of the child, race, generation as well as a particular component of anthropometry utilized, for example, leg length versus trunk length when assessing height. Perhaps the most consistent moderator appear to be the quality of the child's psychosocial environment whether maternal education or family income, and the quality of the child's physical and psychosocial rearing environment (Weinberg, Dietz, Penick, McAlister, 1974).

CHAPTER TWO

2 RESEARCH METHODOLOGY

2.1 Research design

The study employed a cross-sectional design to examine the relationship between physical and cognitive development across changes in chronological age in early and middle childhood periods.

2.2 Research participants /

The samples of the study were 50 and 120 children who were selected for the pilot and main study respectively from four schools in Debre Zeit town. Their age ranges from 4 to 9 years. Children selected for the pilot study were from different schools and were not included in the main study. Out of 120 children included in the main study, equal number of children (60 boys and 60 girls) were included in the study. Accordingly, from each age group, equal number of participants (20 children from each age) were included in the sample.

2.3 Sampling technique

2.3.1 Area Sampling

The selection of the study area was using both purposive and convenient sampling. Debere Zeit town is easily accessible as it is found in close proximity to Addis and the researcher can easily get the four types of schools. This eased for the researcher to have frequent contact with sample schools and facilitated the research work. Moreover, Debre Zeit, is relatively small town where the dwellers have similar socio-economic status which would contribute to minimize the influence of the socioeconomic factor in influencing the study.

Following area sampling, multi-stage sampling technique was employed at different stages of sampling procedure. Accordingly, cluster sampling, stratified purposive sampling, and simple random sampling were employed in the selection of participants for the study.

2.3.2 Cluster Sampling

There were four clusters of schools from which the research participants were sampled. These were government, public, mission, and private schools. Then the potential research participants were identified from the respective schools. Children were then tentatively grouped into preoperational and concrete operational category through document investigation of the school record.

2.3.3 Stratified Purposive Sampling

First Children in the four schools were categorized into preoperational and concrete operational groups. Then, these children were again purposefully categorized according to sex and age strata so that required number of children would be picked from each stratum.

2.3.4 Simple random sampling

Using simple random sampling technique (lottery method), equal number of children were picked from both sexes and each age group. Accordingly, 20 children (10 boys and 10 girls) were picked from each age category, making 60 boys and 60 girls in the total sample.

2.4 Data gathering instruments

The instrument employed to gather the required data from the research participants has two parts.

Part I. In the first part, anthropometry was used in which children's height (in cm), head-circumference (in cm), mid-upper-arm-circumference (in cm), and weight (in kg) were measured for each child. Moreover, items on personal and demographic information of participants were included in this instrument. (See appendix VI).

Part II. In the second part, Children's Cognitive Questionnaire (CCQ) was designed separately for children found in preoperational and concrete operational stages. The value of Children's Cognitive Questionnaire (CCQ) in a continuum scale lies between 0-12 for children in preoperational stage and 0-20 for children in concrete operational stage. If the child answers all the items in the given developmental stage, it means that he or she has fully achieved the cognitive blocks of that particular stage. If he or she missed all the items, he or she has not achieved the cognitive tasks in a given cognitive developmental stage at the time of the study.

2.4.1 Children's Cognitive Questionnaire Development (CCQ) and Validation

First, 17 cognitive components (4 for preoperational stage and 13 for concrete operational stage) of Piaget's stage of cognitive development were identified. Based on Piaget's theoretical foundation, these cognitive development tasks were clearly defined for the purpose of the study (see appendix II). Following this, three items were developed for each developmental task. Accordingly, 14 items for children in preoperational stage and 24 items for children in concrete operational stage, making a total of 38 items were developed. The items were designed in such a way that they would measure cognitive development tasks found in Piaget's preoperational and concrete operational stages.

Bearing in mind the abstract nature of the Piaget's theory, these items were given to two experts who have experience in teaching psychology here in Addis Ababa University. These experts were made to label each item as to the developmental task it measures. Following experts' rating, expert correlation was computed using Pearson Product Moment Correlation. The expert correlation coefficient of the two raters was found to be 0.9828, which indicated high raters' agreement and this ensured the construct validity of the items/instrument.

Moreover, reliability of the instrument was computed using KR 20 to find internal consistency of the items. And the reliability coefficient was found to be $r_{xy} = 0.75$. Initially, the items were developed in English. But, since they would be administered to children, the items were translated to Amharic language by a language expert who has taught the English subject for many years. Then, the translated version was again back translated into English language to check whether the translated version was similar to the original one or not.

Then, the 38 items were administered to a group of 50 male and female children who proportionally represent all age categories and item analysis was carried out (see appendix III). Out of the 38 items originally written for the developmental tasks identified, 32 best items (12 for preoperational and 20 for concrete operational group respectively) were selected for final administration (see appendix IV).

2.5 Data collection procedure

First, the four target schools were identified and the respective school directors were contacted to get informed consent for the study. Having got informed consent from the respective school directors and reached mutual understanding about the research work, schedule was developed with the respective schools so as to avoid clashes with the regular class program. Accordingly, morning and after noon shift were found to be convenient for one school and three schools respectively.

- Identification and training of research assistants

Two research assistants, one diploma nurse with rich experience in her profession and one Psychology graduate from Addis Ababa University participated during data collection. Before the onset of actual data collection, they were given a half-day orientation on the objective of research project, interviewing approach, ethical considerations, communication and interaction skills. The second research assistant also was oriented on the basic content of Children Cognitive Questionnaire (CCQ) so that he has a clear understanding of the instrument before the actual data collection started.

Children's age was obtained through investigation of school record/birth certificate and children's baptismal record.

Anthropometric data were recorded for each child including demographic information by the study nurse. Standing height (without shoe), mid-upper-arm-circumference, and head circumference were measured to the nearest centimeter for each child. Weight of each child was measured to the nearest kilogram using a weight scale. Following anthropometric measurement, the cognitive questionnaire was administered for each child. The interview was facilitated by the principal investigator and the second research assistant. The average time allocated for each child was 30 minutes. The data collection process took 15 days.

2.6 Statistical design and analysis

The study basically employed quantitative method of data analysis. Descriptive statistics (percentage) is used analyze and present the profile of the participants. The independent variable is physical development, which was measured using anthropometry and the dependent variable is cognitive development scores. Using Pearson Product Moment Correlation, a separate correlation is computed to find the association between each physical development index and

cognitive development as well as for physical development (total). Correlational analysis is also carried out for children in the preoperational and concrete operational stages and across chronological age.

Following computation of correlation, a test of significance of the coefficient of correlation is computed using t-distribution at $\alpha=0.05$. A two-way analysis of variance (ANOVA) is used to examine if there is a difference ($\alpha=0.05$) in the predictive validity of independent variable on the dependent variable across sexes. Following computation of analysis of variance, Sheffe's pair wise means comparison was employed to find mean differences within groups, between groups (across sexes) and different levels of physical development.

CHAPTER THREE

3. RESULTS AND DISCUSSION

This section of the research report has two major parts. The first part deals with the finding of the study. Under the finding of the study, profile of the research participants, results of descriptive statistics of physical development indices, results of the correlation between physical development indices and cognitive development, results of mean cognitive scores within groups across physical development levels, results of a two-way analysis of variance (ANOVA) including Sheffe's Pair wise mean comparison (table matrix) are presented. Result showing the difference in the predictive validity of physical development on cognitive development between preoperational and concrete operational groups is also presented. Lastly, the result showing the predictive validity of physical development on cognitive development across chronological age is also dealt under this part.

The second section discusses the findings of the study in relation to the theories and past and present research findings.

3.1 RESULTS

Table 1

Profile of children respondents

Description	Classification	Sex			
		Male	Female	Total	%
Age (in years)	4	10	10	20	16.67
	5	10	10	20	16.67
	6	10	10	20	16.67
	7	10	10	20	16.67
	8	10	10	20	16.67
	9	10	10	20	16.67
	Total	60	60	120	100
	Educational level	Preschool	30	30	60
First grader		30	30	60	50
Total		60	60	120	100

As shown in Table 1 above, equal proportion of male and female children respondents participated in the study. Their age ranges from 4-9 years. Of the total participants, 50% are in early childhood stage while the remaining 50% are in middle childhood. Equal number of children (10 from each age group) were included in the study.

As far as their educational level is concerned, 50% are preschoolers while the remaining 50% are first graders.

Table 2

Descriptive statistics for physical development indices.

	Physical Development Indices			
	Height	Weight	Mid-upper-arm circumference	Head circumference
Mean	115.69	20.34	15.51	50.1
Standard Deviation	16.05	5.85	1.36	1.85

Table 2 above, is descriptive statistics for physical development indices for children under study. The mean height score is 115.69 which is the highest from among the anthropometric indices. The mean scores for head circumference is 50.1, for weight 20.3 and mid-upper-arm circumference is 15.51. The standard deviation for height is found to be 16.05 which indicates higher dispersion of scores followed by weight which is 5.85. The standard deviation for Mid-upper-arm-circumference and head circumference is insignificant which indicates the homogeneity of scores.

Table 3

Coefficient of correlation showing the association between physical and cognitive development for children 4-9 years.

	Physical Development Indexes				Physical development (Total)
	Height	Weight	Mid-upper-arm circumference	Head circumference	
Coefficient of Correlation (r_{xy})	0.51*	0.45*	0.41*	0.43*	0.52*
Explained Variation (r_{xy}^2)	26%	20%	17%	18.5%	27%

* Significant at .05

As shown in Table 3 above, a separate correlation was computed to find the association between physical and cognitive development for children 4-9 years. And the result showed that there is positive association between each physical development index and cognitive development.

The coefficient of correlation between height and cognitive development was found to be $r_{xy}=0.51$, which explained 26% of the variance in cognitive development. The coefficient of correlation between weight and cognitive development was found to be $r_{xy}=0.45$ (20% of the variance explained). For head circumference and mid-upper-arm circumference, the coefficients of correlation were found to be $r_{xy}=0.43$ (18.5%

of the variance explained) and $r_{xy}=0.41$ (17% of the variance explained) respectively. When the association between physical development (total) and cognitive development was computed, the coefficient of correlation was found to be $r_{xy}=0.52$, which explained 27% of the variation in cognitive development for children under study.

From the four anthropometric indexes, height explained relatively the highest variation in cognitive development, which is 26%, and mid-upper arm circumference explained the least, which is 17%.

Although the result showed the existence of positive correlation between physical and cognitive development, the coefficient of correlation is not generally strong for all anthropometric indexes.

A test of significance was computed out using t distribution for each correlation coefficient. Surprisingly, though the coefficient of correlation appeared to be generally weak, in all the tests, the result is statistically significant for physical development (total), $t(df118)=6.61, \alpha=0.05$, for height $t(df 118)=6.64, \alpha=0.05$, for weight $t(df 118)=5.47, \alpha=0.05$, for mid-upper-arm-circumference $t(df 118)=4.88, \alpha=0.05$, and for head circumference $t(df 118)=5.17, \alpha=0.05$.

Table 4

Mean cognitive scores within groups across physical development levels.

Sex	Physical development levels	N	Mean cognitive scores
Male	Low	14	11
	Medium	27	15.5
	High	19	16.63
Female	Low	23	11.35
	Medium	19	14.26
	High	18	14.83

As shown in Table 4 above, there are three levels of physical development low $<Z-0.05$, medium $Z-0.05$ to 0.05 , and high $>Z 0.05$. The second factor (sex) has two levels. From among the six groups, male high group has the highest mean cognitive score, which is 16.63 while male low group has the least mean cognitive score (11).

Sex specific comparison shows that male high group has the highest mean cognitive score followed by male medium group which is 15.5, and male low group having the least mean cognitive score, which is 11. The male high group averaged 5.63 higher than the male low group. Similarly, the male medium group averaged 4.5 higher than the male low group. The least difference exists between male high and male medium which is only 1.13.

With regard to the female groups, female high group has the highest mean cognitive score, which is 14.83 followed by female medium group (14.26), while female low group having the least mean cognitive score (11.35). The female high group averaged 3.48 higher than the female low group and the female medium group averaged 2.91 higher than the female low group. The least difference exists between male high and male medium groups, which is only 0.57.

Mean difference in cognitive score across sexes showed that male high group averaged 1.8 higher than female high group and male medium group averaged 1.24 higher than female medium group. There exists no significant difference between male low and female low groups, which is 0.35 only. The overall mean difference between the sexes showed that male children averaged 0.89 higher than female children.

Table 5

Summary of a two-way analysis of variance (ANOVA) for physical development and sex factors (3 X 2 factorial design).

Source	Sum of Squares	df	Mean Squares	F
Physical Development (factor 1)	438.9	2	219.45	34.67*
Sex (factor 2)	67.5	1	67.50	10.66*
Physical development and sex factors (interaction)	-20.4	2	-10.20	-1.61
Error	721.5	114	6.33	

* Significant at .05

As shown in Table 5 above, a two-way analysis of variance (ANOVA) was computed to examine the difference in the predictive validity of physical development on cognitive development across sexes. The first factor (physical development) was partitioned into three levels and the second factor (sex) has two levels.

Here, there are three hypotheses to be tested. Concerning the effect of the first factor, the effect of the second factor and the interaction effect.

The result of analysis of variance showed that F is statistically significant for physical development, $F(2,114)=34.67, \alpha=0.05$ and sex factor, $F(1,114)=10.66, \alpha=0.05$. However, the observed F ratio was not found to be statistically significant for interaction factor, $F(2,114)=-1.61, \alpha=0.05$.

The finding above showed that the predictive validity of physical development on cognitive development varies across different levels of physical development (low, medium, and high) and sexes.

Since the result was found to be statistically significant for both physical development and sex factors and the sample size for each group was unequal, Sheffe's pair wise means comparison was computed within groups, across sexes, and levels of physical development. However, since the result does not show the existence of any statistically significant difference across sexes for the interaction factor, no pair wise mean comparison was computed.

Table 6

Matrix showing results of Sheffe's pair wise mean comparison within groups, between groups (across sexes) and physical development levels.

Within Groups (Male)			
	Male low	Male medium	Male high
Male low	-	*	*
Male medium	*	-	X
Male high	*	X	-
Within Groups (Female)			
	Female low	Female medium	Female high
Female low	-	*	*
Female medium	*	-	X
Female high	*	X	-
Between Groups (across sexes)			
	Female low	Female medium	Female high
Male low	X	-	-
Male medium	-	*	-
Male high	-	-	*

X-groups compared but not significant.

*Groups compared and significant.

-Groups not compared.

Table 6 above shows the results of Sheffe's pair wise mean comparison within groups, between groups (across sexes), and physical development levels.

When we compare male children with low physical development index with male children with medium physical development

index, the result was found to be statistically significant. The result was also confirmed by their respective coefficient of correlation. The coefficient of correlation for male low and male medium groups was found to be $r_{xy}=0.23$ and $r_{xy}=0.36$, respectively. The comparison was also found to be statistically significant for male low and male high group whose correlation coefficient was $r_{xy}=0.23$ and $r_{xy}=0.45$ respectively.

The result of the pair wise mean comparisons indicated that the existence of statistically significant difference within groups is due to the physical development factor. The predictive validity for physical development on cognitive development is higher for male high and male medium groups when each group was compared with male low group. However, the result of pair wise mean comparison between male medium and male high groups was not found to be statistically significant.

With regard to the female children, pair wise mean comparison showed the existence of statistically significant difference between female low and female medium groups and female low and female high groups, but not between female medium and female high groups. When their

coefficient of correlation was computed, it was found to be $r_{xy}=0.29$ and $r_{xy}=0.34$ for female low and female medium groups respectively. The coefficient of correlation for female high group was found to be $r_{xy}=0.38$, which is relatively higher than female low and female medium groups. The existence of statistically significant difference within groups is due to physical development factor i.e. the predictive validity of physical development on cognitive development is higher for female high and female medium groups when each group is compared with female low group.

When Sheffe's pair wise means comparison was computed for groups across sexes, the result showed the existence of statistically significant difference between male high and female high, and male medium and female medium groups. The coefficient of correlation for male high and female high groups was found to be $r_{xy}=0.45$ and $r_{xy}=0.38$ respectively. Similarly, the coefficient of correlation for male medium and female medium groups was found to be $r_{xy}=0.36$ and $r_{xy}=0.34$ respectively.

However, the comparison did not show the existence of statistically significant difference between male low and female low groups.

The finding indicated that, when physical development factor is controlled, the existence of statistically significant difference between male high and female high groups and male medium and female medium groups is due to sex factor i.e. the predictive validity of physical development on cognitive development is higher for male high group compared to female high group. Similarly, the predictive validity of physical development on cognitive development is higher for male medium group compared to female medium group. Although the predictive validity of physical development on cognitive development varies across sexes, it is not statistically significant for children (male and female) with low physical development indexes.

Table 7

Coefficients of correlation showing the association between physical and cognitive development for preoperational and concrete operational groups.

Group	N	Coefficient of correlation (r_{xy})	Explained variation (r_{xy}^2)
Preoperational Group	60	0.43*	18.5%
Concrete operational Group	60	0.20	4%

*Significant at .05

As shown in Table 7 above, to find out the association between physical and cognitive for children in the

preoperational and concrete operational groups, separate correlation was computed for each group. Accordingly, the coefficient of correlation was found to be $r_{xy}=0.43$ for preoperational group (18.5% of variance explained) and $r_{xy}=0.20$ for concrete operational group where only 4% of the variance explained.

To test if there is statistically significant difference in the predictive validity of physical development on cognitive development between the two groups of children, a test of significance was computed using t distribution for each group. The result of the test showed that the coefficient of correlation is statistically significant for children in the preoperational stage, $t(df\ 58)=3.62$, $\alpha=0.05$. However, the result of the test is not found to be statistically significant for children in the concrete operational stage, $t(df\ 58)=1.62$, $\alpha=0.05$.

The finding showed that there is a difference in the predictive validity of physical development on cognitive development between children in the preoperational stage and children in the concrete operational stage which implies that physical development reasonably predicts cognitive development during early childhood.

Table 8

Coefficients of correlation showing the association between physical and cognitive development across chronological age.

Chronological age	N	Coefficient of correlation (r_{xy})	Explained variation (r_{xy}^2)
4	20	0.50*	25%
5	20	0.45*	20%
6	20	0.36	13%
7	20	0.23	5.3%
8	20	0.21	4.4%
9	20	0.13	1.7%
Total	120		

- Significant at $\alpha=0.05$

As shown in Table 8 above, to examine the predictive validity of physical development on cognitive development across chronological age, a separate correlation coefficient was computed for each age group. The coefficient of correlation for children of age 4 is found to be $r_{xy}=0.50$, which explained 25% of the variance in cognitive development. For children of age 5, the coefficient of correlation is found to be $r_{xy}=0.45$ (20% of the variance explained) while for children of 6 years, it is found to be $r_{xy}=0.36$ (13% of the variance explained). When we examine children in middle childhood, the coefficient of correlation is found to be $r_{xy}=0.23$ (5.3% of variance explained) for children of 7 years and $r_{xy}=0.21$ for children of 8 years where 4.4% of the variance explained.

For children of 9 years, the coefficient of correlation is found to be $r_{xy}=0.13$ where only 1.7% of the variance explained.

To test if the coefficient of correlation is statistically significant, a test of significance (one tailed) was computed for each correlation coefficient. The result of the test of significance showed that the coefficient of correlation is statistically significant for children of 4 years, $t(df18)=2.45, \alpha=0.05$ and 5 years, $t(df 18)=2.14, \alpha=0.05$. However, though the coefficient of correlation appeared to be positive for children above 5 years, it is not found to be statistically significant for children of 6 years, $t(df 18)=1.64, \alpha=0.05$, 7 years, $t(df 18)=1, \alpha=0.05$, 8 years, $t(df 18)=0.91, \alpha=0.05$, and 9 years, $t(df 18)=0.56, \alpha=0.05$.

The coefficient of correlation, being statistically significant in early childhood particularly for children of 4 and 5 years, implies that the predictive validity of physical development on cognitive development is higher for children in early (childhood) years compared to middle childhood.

3.2 DISCUSSION

The data from the present study clearly supported one of the hypotheses that there is positive and statistically significant association between physical and cognitive development in children under study. A positive association is found between each physical development index and cognitive development. Height and weight predicted 26% and 20% of the variance in cognitive development respectively. Similarly, head circumference and mid-upper arm circumference predicted 18.5% and 17% respectively.

Supporting this finding, Bhargava (1998) argued that anthropometric data such as weight-for age, height-for-age, weight-for-height, and head circumference are predictors of cognitive abilities in school-aged children. The finding of Grantham-McGregor (1999), also supports this finding who found out a positive and statistically significant association between height-for-age and cognitive development in school age children in many countries where height explained 33% of the variation. Studies also indicate the presence of positive relationship between physical and cognitive development in early years.

- Comparison within groups, and between groups (across sexes).

The finding showed that the predictive validity of physical development on cognitive development varies within groups, across sexes, and levels of physical development. For example, Sheffe's pair wise mean comparison revealed the existence of statistically significant difference between male low and male medium groups, male low and male high, female low and female medium, female low and female high groups. This shows that, the difference within groups is attributed to physical development factor. When physical development factor is controlled, pair wise means comparison across sexes revealed the existence of statistically significant difference between male high and female high and male medium and female medium groups. In either of the comparisons across sexes, the predictive validity of physical development on cognitive development is found to be higher for males than females.

Previous findings support the current finding. The US National Health Examination Survey (NHES) conducted on sample of 13,887 children aged 6-17 years in cycle 2 and 3,

and later on 2177 children aged 2-5 years, the relationship between physical and cognitive development was statically significant for boys but not for girls.

- Comparison between preoperational and concrete operational groups, and across chronological age.

The second hypothesis supported by this finding is the predictive validity of physical development on cognitive development is found to be higher for children in the early (preschool) years i.e. as age increases the predictive validity of physical development on cognitive development decreases. For example, the finding indicated the coefficient of correlation is statistically significant for children in preoperational stage but not for children in concrete operational stage.

Comparison across chronological age, also revealed that the coefficient of correlation appeared to statistically significant for children of age 4 ($r_{xy}=0.50$) and 5 years ($r_{xy}=0.45$) and showed a subsequent decrease in magnitude as age increases from 6 to 9 years. However, though, the magnitude of coefficient of correlation decreases and becomes statistically not significant with increase in

chronological age, it is generally positive which basically supports the hypothesis.

A test of statistical significance of the correlation coefficient across chronological age revealed that the test is significant for children in the early (preschool) years particularly for children of 4-5 years. However, it is not found to be statistically significant for children above 5 years.

Supporting this finding, Belmont, etal, (1975); Weinberg, etal, (1974); Wilson, and Hammer, (1986) as cited in Ernhart, Marler, and Tlucak, (1987) found out positive and consistent relationship between weight, height, and head circumference in the early (preschool) years with measures of cognitive development. On the contrary, the existence of statistically not significant relationships between physical and cognitive development for children 6 to 9 years could be due to the fact that as chronological age increases, cognitive development would be moderated by a number of environmental factors. Previous findings also support this finding. For example, a study conducted by Waches (1993) on children of 4-5 years age in Chile found out no statistically significant relationship between physical (height) and cognitive development which as

attributed to small sample size. Moreover, Weinberg, et al (1974) argued that the relationship between anthropometry and cognitive performance is influenced by a variety of moderators which include nutrition, birth order, family size, parental occupation, family income, sex of the child, and the child's psychosocial environment.

CHAPTER FOUR

4. CONCLUSION AND IMPLICATIONS

4.1 CONCLUSION

The study investigated the relationship between physical and cognitive development during early and middle childhood. Based on the finding of the study, the researcher has drawn the following conclusive remarks. The conclusive remarks presented here addressed the research objectives.

1. The finding revealed that physical development has predictive validity on cognitive development. There is positive and consistent correlation between physical and cognitive development in the children under study. A positive and statistically significant correlation has been found between each anthropometric index and cognitive development. Accordingly, height and weight explained 26% and 20% of the variation in cognitive development respectively. While head circumference and mid-upper-arm circumference explained 18.5% and 17% of the variation in cognitive development respectively.

Physical development (total) explained 27% of the variation in cognitive development while height predicted (explained) relatively the highest variance in cognitive development from among physical development indexes used in this study. Though the coefficient of correlation for each physical development index is positive, it is not generally strong in magnitude.

2. The predictive validity of physical development on cognitive development differed across sexes for children with medium and high physical development indexes, but not for those with low physical development indexes. There is a statistically significant difference in the predictive validity of physical development on cognitive development between male medium and female medium, and male high and female high groups, but not between male low and female low groups. When sex factor is controlled, within group comparison showed the existence of statistically significant difference between male low and male medium groups, male low and male high, female low and female medium, female low and female high groups.

3. There is a statistically significant difference in the predictive validity of physical development on cognitive development between children found in the preoperational and concrete operational stages. The coefficient of correlation for children in the preoperational stage ($r_{xy}=0.43$) was found to be statistically significant where it predicted 18.5% of the variance in cognitive development. The coefficient of correlation for children in the concrete operational stage ($r_{xy}=0.20$), which predicted only 4% of the variation, was not found to be statically significant.

4. The predictive validity of physical development on cognitive development decreases as chronological age increases, which could be attributed due to the influence of different confounding factors. The coefficient of correlation was found to be statistically significant for children of 4 ($r_{xy}=0.50$, which explained 25% of the variance) and 5 ($r_{xy}=0.45$, which explained 20% of the variance) years. The magnitude of correlation coefficient decreased across ages and all the correlation coefficients for children above 5 years, though they appeared to be positive, they were statically significant.

4.2 IMPLICATIONS

1. The study underscores the importance of early (preschool) years and implies that teachers, child care institutions and others who are dealing with children need to emphasize on early interventions. Early diagnosis of children enables to identify those children who need physical enrichment so that their holistic development undergo in normal manner.

2. Although children appear to be having normal physical development indexes, it does not mean they could perform better in cognitive tasks. A child may appear tall in height but having low cognitive score. And on the contrary, a child may appear short in height but may perform better in cognitive tasks.

3. The study was conducted taking relatively small sample size from selected schools. Hence, further investigation should be carried out by taking large sample size so as to broaden our understanding as to the relationship between physical and cognitive development.

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APPENDICES

Appendix I

Description

Children's Cognitive Questionnaire (CCQ) is constructed to measure the various components of cognitive development within the two Piaget's stages i.e. preoperational and concrete operational stages. The cognitive questionnaire consists of 32 items. Out of these, 12 items were designed for children in preoperational stage and 20 items for children in concrete operational stage.

Cognitive components in preoperational stage

Preoperational stage is a stage that lasts from 2-6 years when children start symbolic thinking and language, and they start to reason, build concepts, and lay foundations of concrete operation.

1. Symbolic thinking
2. Understanding concept of time
3. Comparing objects
4. Seriation
 - 1.1 Serial correspondence

Cognitive components in concrete operational stage

Concrete operational stage is a stage covering the period from 7-12 years when children start logical operations or principles in solving problems. At this stage, children are capable of applying logical thought process to concrete problems.

1. Classification
2. Seriation
3. Conservation
 - 3.1 Conservation of number
 - 3.2 Conservation of length
 - 3.3 Conservation of substance
 - 3.4 Conservation of weight
 - 3.5 Conservation of liquid volume
4. Decentering
 - 4.1 Physical decentering
 - 4.2 Social decentering
 - 4.3 Reasoning
5. Reversible thinking
6. Spatial relation
7. Time and space

Appendix II

Theoretical Foundation of Cognitive Questionnaire (CCQ)

This gives theoretical definitions of the above developmental functions of the two Piaget's developmental stages at global and component level.

Preoperational stage

- 1 Symbolic thinking: the ability of the child to cognize that words, signs, and symbols can represent an absent object and be able to recognize those objects (Piaget, 1983).
- 2 Understanding concept of time: the ability of the child to relieve the past events, which have already happened and anticipate the future (Piaget, 1983).
- 3 Comparing objects: the ability to compare and contrast two or more objects or sets of objects at least based on one characteristics (Piaget, 1983).
- 4 Seriation: the ability of the child to put/arrange objects or numbers in order at least by one identifying feature (Piaget 1983).
 - 4.1 Serial correspondence: the ability to create

correspondence between objects of two or more sets based on size while the corresponding sets are in order (Piaget, 1983).

Concrete operational stage

1. Classification: the ability to name and identify or grasp objects according to identifying characteristics including the idea that one set of object can include the other (Piaget, 2000).
2. Seriation: the ability to construct the orderly position of corresponding objects of two or more sets according to size and/or numerosness when the sets are disarranged or randomized (Piaget, 1983).
- 3 Conservation: the capacity to cognize that quantities such as mass, volume, and weight are unrelated to the arrangement and physical appearance of objects (Piaget 2001).
 - 3.1 Conservation of number: the ability to cognize that the number of objects in a collection remains the same regardless of whether the collection is spread out or bunched together (Piaget 2001).
 - 3.2 Conservation of length: the ability to cognize that the comparative length of two or more objects is

unaffected by their relative positions or straightness (Piaget, 2001).

3.3 Conservation of substance: the ability to conserve the amount of space occupied by an object (Piaget 2001).

3.4 Conservation of weight: the ability to conserve that changes in the shape of an object does not cause changes in its weight (Piaget, 2001).

3.5 Conservation of liquid volume: the ability to understand that the amount of volume does not change regardless of the change in the shape of an object (Piaget 2001).

4 Decentering the ability of the child to understand a single angle instance from various perspectives.

4.1 Physical decentering: decentering in physical relationship refers to the child's ability to cognize physical relationship of objects or sets of objects from various perspectives (Piaget 1983).

4.2 Social decentering: the ability to conceptualize different viewpoints around a common point and shift back and forth between his or her own viewpoints and others (Piaget, 1983).

4.3 Reasoning: the ability to explain the logical

relationship between ideas from different angles
(Piaget 1995).

- 5 Reversible thinking: the ability to go forth and back in a train of thought (Piaget, 1983).
- 6 Spatial relations: the ability to coordinate the nature of space occupied by an object and the object itself (Piaget, 1983).
- 7 Time and space: The ability to conceive the spatial displacement in his or her visual field along with the time and the interrelationship between the two (Piaget, 1983).

Appendix III

Item Analysis of Children's Cognitive Questionnaire (CCQ)

For preoperational stage

Item	Cognitive component	P	D
1	1**	0.63	0.41
2	1**	0.67	0.50
3	1**	0.46	0.42
4	2**	0.50	0.50
5	2	0.25	0.16
6	2**	0.54	0.42
7	2**	0.75	0.50
8	3**	0.58	0.50
9	3**	0.71	0.42
10	3**	0.62	0.41
11	4**	0.63	0.59
12	4**	0.50	0.50
13	4**	0.75	0.50
14	4	0.17	0.17

Components are given numbers based on their alignment in Appendix II

** Items selected

P. Difficulty level

D. Discrimination index

For Concrete operational stage

Item	Cognitive component	P	D
1	1	0.49	0.23
2	1**	0.58	0.39
3	1	0.50	0.08
4	2**	0.62	0.31
5	2**	0.73	0.54
6	2	0.31	0.15
7	3 (3.1)**	0.58	0.39
8	3 (3.2)**	0.66	0.39
9	3 (3.3)**	0.69	0.46
10	3 (3.4)**	0.58	0.39
11	3 (3.5)**	0.50	0.54
12	3 (3.4)**	0.65	0.54
13	4 (4.1)**	0.66	0.39
14	4 (4.2)**	0.66	0.39
15	4 (4.3)**	0.66	0.39
16	5	0.43	0.23
17	5**	0.69	0.46
18	5**	0.65	0.54
19	6**	0.54	0.46
20	6**	0.73	0.38
21	6**	0.62	0.47

22	7**	0.54	0.46
23	7**	0.66	0.39
24	7**	0.58	0.54

Components are given numbers based on their alignment in
Appendix II

** Items selected

P. Difficulty level

D. Discrimination index

Appendix IV

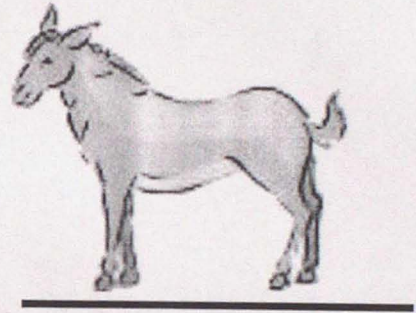
Cognitive Questionnaire (CQ) for children 4-6 years

1. Which word in set A represents the picture in set B?

Set A (words)

- Donkey
- Bird

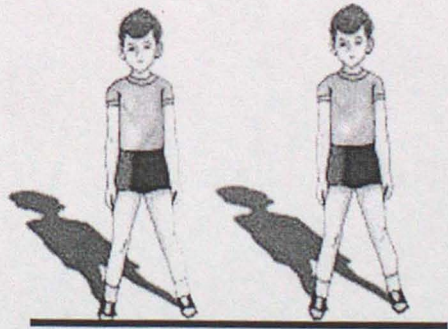
Set B (pictures)



Set A (signs)

4 6 2

Set B (pictures)



2. Which number (sign) in set A indicates the number of children in set B?

3. What does the picture represent? What is its use?

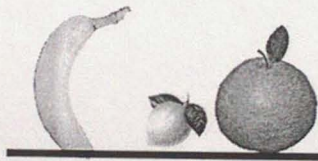


4. If today is Monday, what was the day before today?

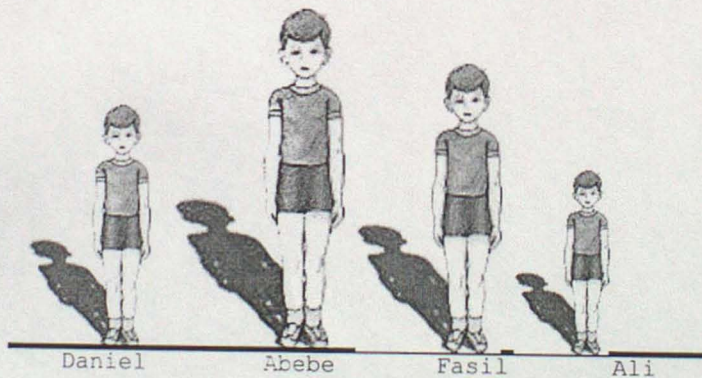
5. If today is Friday, tomorrow is _____?

6. What will you do after school? (Multiple responses can be recorded).

7. As shown in the picture below, there are banana, lemon, and orange. Which one is larger in size?



8. As shown in the picture below, there are four boys. Who is the tallest? Who is the shortest?



9. There are four sets of toys. Which set has more number of toys?

A. ● ● ● ●

C. ● ● ● ●

B. ● ● ● ●

D. ● ● ● ●

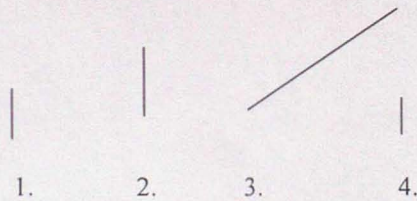
10. Given sets of numbers, arrange them in an increasing order in magnitude?

5 3 2 1 4 6

11. Given sets of pictures, arrange them in an increasing order according to their size.

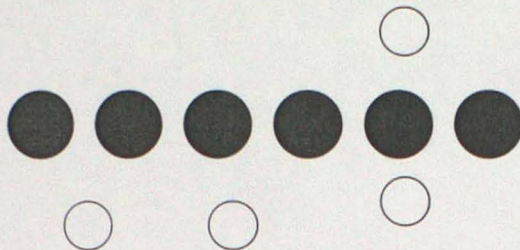


12. There are three sticks having different length laid apart. Arrange them according to their length (from the shortest to the longest).



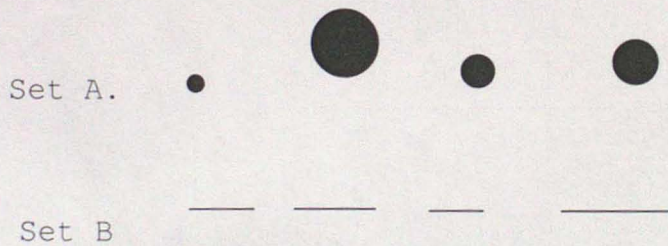
Cognitive Questionnaire (CQ) for children 7-9 years

1. Given group of toys below,



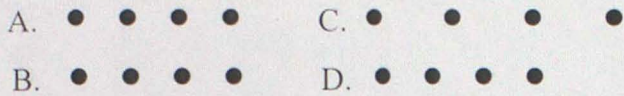
Which toys are larger in size? Black toys or white toys?

Given group of toys in set A and sticks in set B, answer questions 2 and 3 below.

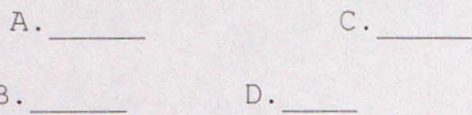


2. Arrange the toys in set A in an increasing order according to their size.
3. Arrange the sticks in set B in decreasing order according to their length.

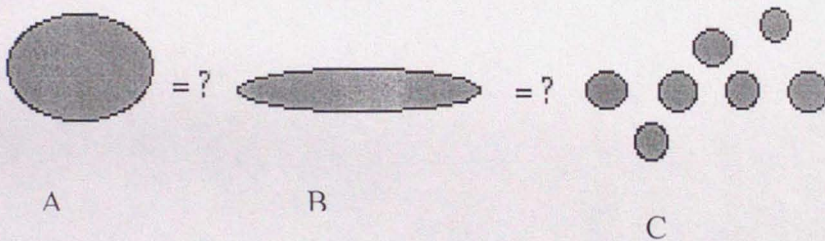
4. As shown below, there are four toys in rows A and B. If we spread them out as shown in C, which row has more number of toys?



5. Given two sticks 5 cm each laid in parallel. If we move stick A and B from their original position to C and D, which stick is longer?

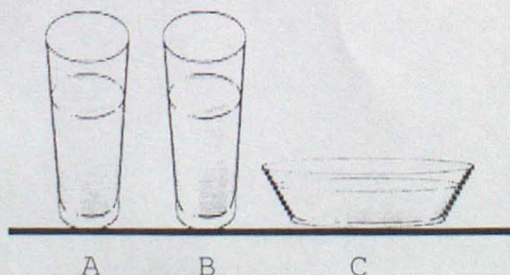


6. As shown in the picture, if I take a ball of clay (in picture A) and roll it into a long thin shape (in picture B) or even split it into 7 little pieces (in picture C), is there the same amount of clay in picture A, B and C?

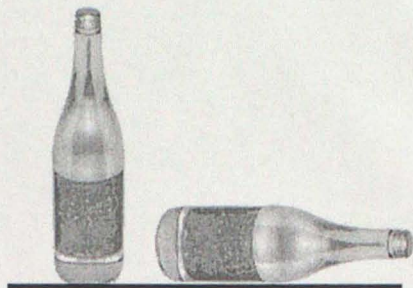


7. Abebe and Kebede bought 50 Kg of sugar each from the shop. Abebe carried 50 Kg on his shoulder while Kebede divided the sugar in two smaller sacks and carried them on his left and right shoulders. Which load is heavier, Abebe's or Kebede's?

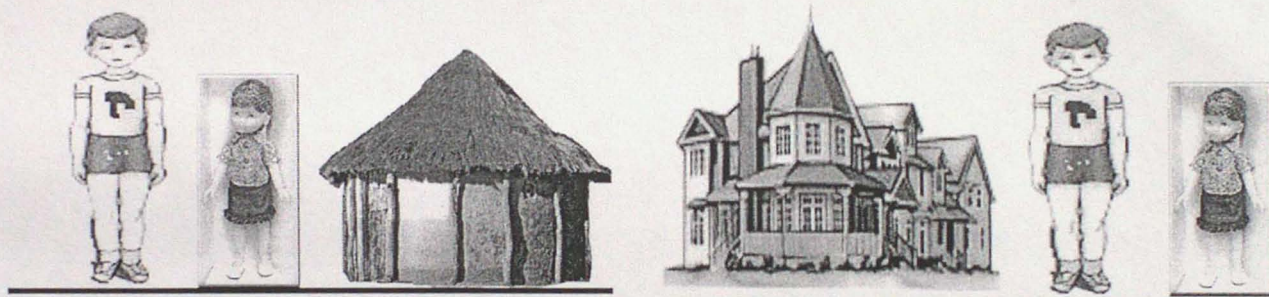
8. As shown in pictures below, glass A and B have equal amount of milk. If we pour the milk from glass B to the bowl c, which one has more milk, glass A or the bowl(c)?



9. We poured equal amount of water into two identical bottles and we laid one of the bottles on its side. Which bottle is heavier?



10. John had a doll in the cupboard in label 1. Then he moved the cupboard from label 1 to label 2. Where is the doll now?



Label 1

Label 2

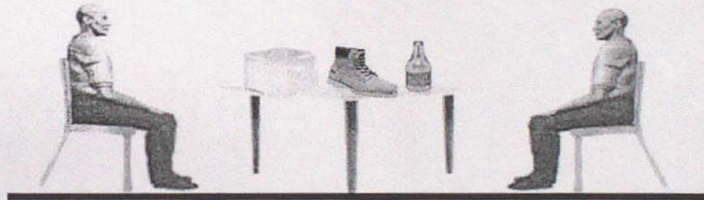
11. Assume you like a model car for your birthday present. And next week, there will be your mother's birthday party. What kind of present would you like to give to your mother. A model car or other?
12. Almaz, Tsion, and Tigist are sisters. Almaz and Tsion like eating bread for their breakfast. What do you think does Tigist like to eat for her breakfast?

13. If we take one orange as shown in picture A and cut it into 4 pieces as shown in picture B and then if I put the four pieces back to their original position as shown in picture C. Would it look like the same as it did?

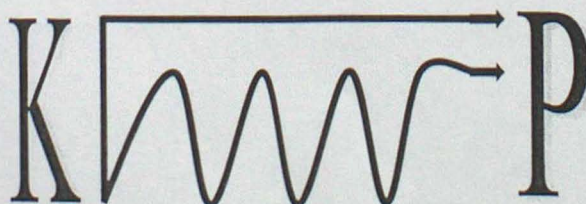


14. Five years back, Ato Fasil had three children. One of his children died at the age of 5. A year after the death of his child, he got a new child, who is now 4 years old. How many children does Fasil have now?

As shown in the picture, there are two chairs around a table. On the table, there are a box, shoe, and a bottle. If you sit on each chair at a time, the view you get on the arrangement of the objects on the table changes. Answer the following three questions (15, 16 and 17).



15. If you sit on chair 1, which object will face you from among the objects on the table?
16. If you sit on chair 1, which object(s) will face for a man sitting on chair 2?
17. If you sit on chair 2, which object (s) is/are visible for you?
18. As shown in the picture, Yared and Fasil started a race at point K. Yared run on the straight line and Fasil run on the other side. Finally, both arrived simultaneously at point P. Who ran for longer time?



19. Abebe and Kebede work as guards in the same organization. Abebe guarded two weeks in the morning shift while Kebede guarded in the afternoon shift. Who guarded for more number of days?

20. Tsige and Almaz were given an exercise to finish it in an hour. Tsige started at 8:00 A.M and finished at 9:A.M while Almaz started at 9:00 A.M and finished at 10:A.M. Who took longer time to finish the exercise?