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Research Article

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# Study On The Relationship Between Anthropometric Indices And Intelligent Quotient (IQ) Among Preschool Children

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## *ABSTRACT*

Nutritional status was thought to have serious effect on intelligence among preschoolers. The objective of this study was to find out the relationship between anthropometric indices and intelligent quotient (IQ) among preschool children. 100 preschool children (62 boys and 38 girls) within the age range of 3 to 5 years were used for the study. The anthropometric indices (Height-for-Age, Mid Upper Arm Circumference-for-age, Weight-for-Age, Weight-for-Height and Head Circumference-for-Age) of 100 pre-school children (3-5years) were assessed in this research. These indices were then correlated with Intelligent Quotient (IQ) of the subjects, which was determined by using *Kohs Block Design Test*. Among the anthropometric indices that were correlated with IQ, Mid Upper Arm Circumference (MUAC)-for-age has the highest correlation coefficient (R= 0.313) and hence has the strongest linear correlation with Intelligent Quotient of the subject. While height-for-age index has the least linear relationship with IQ (R=0.109). Although these indices were found to have a linear correlation with IQ, but they are not only the determinants responsible for IQ variations among the preschoolers. One of such determinants which was proven to have a very strong correlation with IQ is genetics.

***Key words:*** Anthropometric indices, malnutrition, I.Q., preschool children, stunting, wasting, Kohs Block Design Test.

## Introduction

Anthropometric measurements are main indicators in assessing nutritional status. Nutritional status is a sensitive indicator of community health and nutrition. Anthropometry is the measurement of the human body. Anthropometric measures are used to assess the nutritional status of individuals and population groups, and as eligibility criteria for nutrition support programs. Common anthropometric measures are height, weight, and mid-upper arm circumference (MUAC) (Vijayasree *et al.*, 2015).[1]

Malnutrition is one of the most common causes of morbidity and mortality among children throughout the world, more so in developing nations. Malnutrition among urban poor children is worse than in rural areas. Children living in the urban slums are exposed to risks of infectious diseases, malnutrition and possibly impaired cognitive development. Malnutrition among urban poor children is worse than in rural areas. Children living in the urban slums are exposed to risks of infectious diseases, malnutrition and possibly impaired cognitive development. (Popat *et al.*, 2014).[2]

Malnutrition is one of the most important causes for improper physical and mental development of children (Das and Rahman 2011).[3] For assessment of nutritional status of under five children various anthropometric indices are being used indiscriminately and so the estimated prevalence of under nutrition varies in different methods.

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When attempting to improve the nutritional status of children, an appropriate reliable and consistent measurement tool is needed. Anthropometric indices are however, used indiscriminately when assessing under nutrition in children under five years old especially when community based surveys are concerned. The estimated prevalence of malnutrition therefore varies between methods (Pandve and Sin, 2011).[4]

Intelligence may be narrowly defined as the capacity to acquire knowledge and understanding, and use it in different novel situations. There are a number of different methods which purport to measure intelligence, the most famous of which is the IQ, or intelligence quotient test (Philip Carter, 2005).[5] Few researches have been conducted to relate nutritional status with intelligent quotient (IQ) in children of various age groups. Adequate nutrition is essential in early childhood to ensure strong immune system and proper physical and mental development (Asad and Mushtaq, 2012).[6] Malnutrition promotes an increased susceptibility to infection, affects school performance and cognitive development (Sumana *et al.*,2011).[7] The negative impact on cognitive ability occurs not only in malnourished children (severe underweight) but also in short children (stunted) due to chronic malnutrition at an early age (Djalal, 2009).[8] The innate factors refer to the genetic factors existing since conception, whereas environmental factors are those that aid in the cognitive development of children such as nutritional status and psychosocial stimulation (Mayza, 2008).[9]

If appropriate correction of nutrient deficiencies is done it can lead to measurable improvement in cognition and even in situations of good nutritional status, the brain can be very sensitive to short-term fluctuation of glucose availability (Bellisle, 2004).[10] Studies have demonstrated that malnutrition in under-fives could cause poor intellectual development thus poor school performance in later years (Scrimshaw, 1998).[11]

# Materials and Methods

## Study Area and Subjects

A cross-sectional study was conducted among preschoolers (3-5 years) in Salem District, Tamilnadu State, which is located in Southern part of India. Four schools were conveniently selected for the study. Hundred children (62 boys and 38 girls) were randomly selected by simple random sampling technique from the selected schools. Prior to the data collection, ethical clearance was obtained from the district office and also from the schools, to conduct the study.

## Collection of Data

A structured and pretested questionnaire was framed as per the research design of the study. It involves data such as general information, anthropometric indices, clinical profile, as well as the IQ test scores.

## Anthropometric Assessment

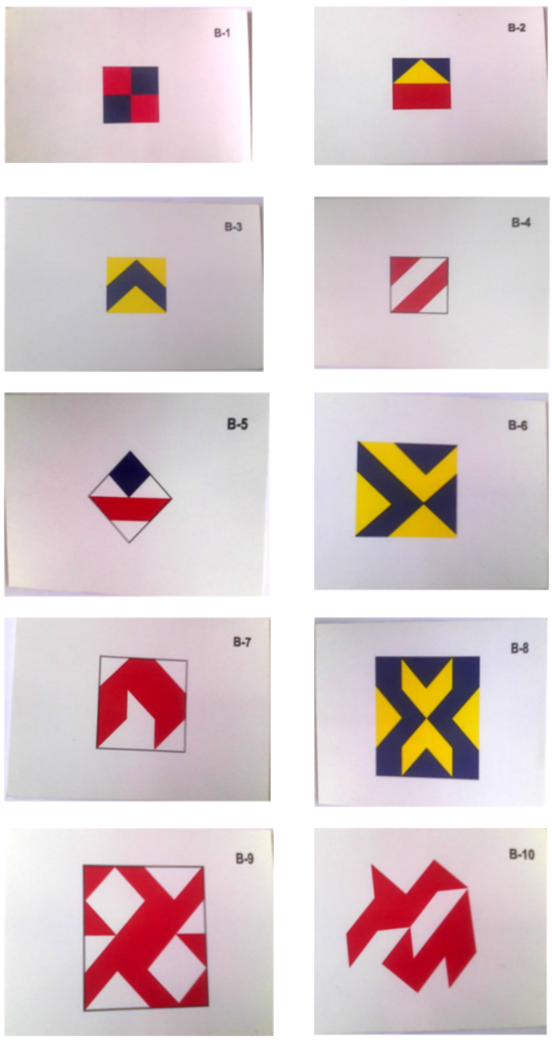
The height of the subjects was measured with the help of inch tape of 5 meters long. The subjects were asked to remove their shoes and stand upright with their heads pointing forward. The tape was then stretched straight without bend to cover from their head to the ground. The heights were recorded in centimeters. Weight of the subjects was measured with Virgo Iron analog body weighing scale to the nearest g. The subjects were asked to take-off their shoes and stand upright on the weighing scale. The weights were recorded in Kilogram (Kg). MUAC was measured with the help MUAC tape. The tape was placed around the middle part of the upper arm. The results were recorded in centimeters. The head circumference of the subjects was measured with a 3 meters long flexible tape. The results were recorded in centimeters.

## Clinical Examination

Clinical examination assesses levels of health of individuals or of population groups in relation to the food they consume. It is the simplest and practical method. When two or more signs characteristic of a deficiency disease are present simultaneously, their diagnostic significance is greatly enhanced. Symptoms are specific to a particular nutrient deficiency. This method is not very expensive and does not require elaborate apparatus and reagents (Srilakshmi, 2014).[12] The parts of the body chosen for the clinical assessment of the subjects were; hairs, eyes, skin, lips, gums, thyroid gland, nails, joints and bones. These parts were selected because several studies have correlated their clinical features with malnutrition.

## Assessment of Intelligent Quotient (IQ)

The intelligent quotient (IQ) of the subjects were determined by using ***Kohs Block Design Test***. This test was recommended by psychologists upon consultation from the beginning of the study. . The **Kohs Block** test, also known as the **Kohs Block Design Test**, is a performance test designed to be an IQ test. The test consists of 16 colored cubes and 10 patterns or designs card. The subjects were asked to replicate the patterns displayed on design cards. IQ scores were assigned to the subjects based on completion time and number of moves on each design.




## Statistical Analysis

The statistical analysis was carried out using SPSS software version 17. The analysis carried out was correlation between the anthropometric indices and IQ scores. The IQ scores of the subjects were correlated with height-for-for-age z scores, weight-for-age z scores, MUAC-for-age z scores, and head circumference-for-age z scores.

# Results and Discussion

## Results on General Information

Based on the schools' record, 7% of the children were in the inferior Academic performance, 17% were in the average category and 76% were in the superior category. This means that majority of the randomly selected children were in the superior category in which 29% were boys and 47% were girls. None of the families of the selected children have monthly income below Rs. 2,750. 2% of the families have monthly income of Rs. 2,750 to 4,583, 6% have Rs. 4,583 to 7,400, 5% have monthly income of Rs. 7,400 to 12,500 and 87% have monthly income above 12,500. Based on height-for-age Z-scores of the study subjects, 6% were stunted because they have Z scores of -3. The remaining 94% of subjects were normal with Z scores of -2, 0, and +2.

## Results on anthropometric data

As can be seen from the Table 1, 6% of the study subjects were stunted because they have Z scores of -3. The remaining 94% of subjects were normal with Z scores of -2, 0, and +2. Length/height-for-age reflects attained growth in length or height at the child's age at a given visit. This indicator can help identify children who are stunted (short) due to prolonged under nutrition or repeated illness. Children who are tall for their age can also be identified, but tallness is rarely a problem unless it is excessive and may reflect uncommon endocrine disorders (WHO Training Course on Child Assessment, 2010).[13]

**Table 1:** Height-for-Age Percentile Distribution Among the Study Subjects with z scores

| **Height-for-Age (Percentile)*** | **No of Children (N=100)** | | | | | |
|---|---|---|---|---|---|---|
| | **Boys** | **Percentage (%)** | **Z score** | **Girls** | **Percentage (%)** | **Z score** |
| 1 | 03 | 3 | -3 | 03 | 3 | -3 |
| 3 | 10 | 10 | -2 | 05 | 5 | -2 |
| 50 | 41 | 41 | 0 | 30 | 30 | 0 |
| 97 | 06 | 6 | +2 | 02 | 2 | +2 |
| **Total** | 60 | 60 | | 40 | 40 | |

*__Source__: WHO 0-5 years height-for-age percentile classification with Z scores (WH0, 2006).

MUAC is the best case– detection method for severe and moderate malnutrition and that it is also simple, cheap and acceptable (Myatt *et al.,* (2006).[14] MUAC-for-Age percentile distribution among the study subjects is shown in Table 2. The table suggests that 12% of the study subjects (5% boys and 7% girls) were in 1st percentile, 34% (18% boys and 16% girls) were in 3rd percentile, 37% (15% boys and 22% girls) were in 50th percentile and 17% (11% boys and 6% girls) were in 97th percentile. This means that majority of the subjects (88%) were in 3rd, 50th and 97th percentiles which means they have normal MUAC. Only 12% of the subjects were malnourished according to this anthropometric index.

According to table 3, only 12% of the study subjects were underweight. Weight-for-age reflects body weight relative to the child's age on a given day. This indicator is used to assess whether a child is underweight or severely underweight, but it is not used to classify a child as overweight or obese. Z value above +2 indicates overweight. While Z score less than -2 indicates underweight..

Weight-for-length/height reflects body weight in proportion to attained growth in length or height. Weight-for-length/height charts help identify children with low weight-for-height who may be wasted or severely wasted. Wasting is usually caused by a recent illness or food shortage that causes acute and severe weight loss, although chronic undernutrition or illness can also cause this condition. These charts also help identify children with high weight-for-length/height who may be at risk of becoming overweight or obese. Z score above +2 indicates risk of obesity, while Z score below -2 indicates wasting (United Nation, 1990). [15]

From table 4, it can be concluded based on the Z scores that 19% of the study subjects were wasted while 13% were at the risk of becoming overweight or obese. The remaining 68% were normal.

**Table 2:** MUAC-for-Age percentile distribution among the study subjects

| **MUAC-for-Age (Percentile)ʷ** | **No of Children (N=100)** | | | | | |
|---|---|---|---|---|---|---|
| | **Boys** | **Percentage (%)** | **Z scores** | **Girls** | **Percentage (%)** | **Z scores** |
| 1 | 05 | 5 | -3 | 07 | 7 | -3 |
| 3 | 18 | 18 | -2 | 16 | 16 | -2 |
| 50 | 15 | 15 | 0 | 22 | 22 | 0 |
| 97 | 11 | 11 | +2 | 06 | 6 | +2 |
| **Total** | 49 | 49 | | 51 | 51 | |

ʷ**Source:** WHO 0-5 years MUAC-for-age percentile classification with Z scores (2006).

**Table 3:** Weight-for-Age percentile distribution among the study subjects

| **Weight-for-Age (Percentile)Œ** | **No of Children (N=100)** | | | | | |
|---|---|---|---|---|---|---|
| | **Boys** | **Percentage (%)** | **Z scores** | **Girls** | **Percentage (%)** | **Z scores** |
| 1 | 05 | 5 | -3 | 07 | 7 | -3 |
| 1 | 01 | 1 | -3 | 01 | 1 | -3 |
| 3 | 14 | 14 | -2 | 11 | 11 | -2 |
| 50 | 26 | 26 | 0 | 18 | 18 | 0 |
| 97 | 14 | 14 | +2 | 03 | 3 | +2 |
| **Total** | 60 | 60 | | 40 | 40 | |

Œ**Source**: WHO 0-5 years weight-for-age percentile classification with Z scores (2006).

**Table 4:** Weight-for-Height Percentile distribution among the study subjects

| **Weight-for-Height (Percentile)a** | **No of Children (N=100)** | | | | **Z score** |
|---|---|---|---|---|---|
| | **Boys** | **Percentage (%)** | **Girls** | **Percentage (%)** | |
| 1 | 11 | 11 | 08 | 08 | -3 |
| 3 | 15 | 15 | 10 | 10 | -2 |
| 50 | 22 | 22 | 21 | 21 | 0 |
| 99 | 09 | 09 | 04 | 04 | +3 |
| **Total** | 60 | 60 | 40 | 40 | |

ᵃ**Source**: WHO 0-5 years Weight-for-height percentile classification with Z scores (WH0, 2006).

Nutritional indicators are the most important independent variables that determine the head circumference. Children that have good nutritional status tend to have a rapid brain development and hence high head circumference (Daniza *et al.*,2004).[16] It can be clearly seen from the table 5 that 66% of the subjects were in 50th percentile (0 Z scores), 33% in 3rd (with -2 Z sores), 1% in 97th (with Z score of +2). None of the subjects was in 1st. This means all the study have normal head circumference.

**Table 5:** Head Circumference-for-Age percentile distribution among the study subjects

| Head Circumference-for-Age (Percentile) | No of Children (N=100) | | Z score | Percentage (%) |
|---|---|---|---|---|
| | Boys | Girls | | |
| 1 | 0 | 0 | -3 | 0 |
| 3 | 19 | 14 | -2 | 33 |
| 50 | 39 | 27 | 0 | 66 |
| 97 | 01 | 0 | +2 | 1 |
| **Total** | 59 | 41 | | 100 |

## Clinical profile distribution among the study subjects

About 95% of the subjects have normal hairs only 5% have dry and brittle hairs. This is an indication of protein or biotin deficiency. 100% of the subjects have normal eyes which indicates that the subjects were not suffering from vitamin A or Zinc deficiency. 100% of the subjects have a normal skin which indicates absence of vitamin A or Zinc deficiency. 100% of the subjects have normal lips, this indicates absence of vitamin A, C, Iron and B vitamins deficiency. 100% of the subjects have normal gums which shows absence of major mineral deficiencies. 100% of the subjects have a normal thyroid gland which means they were not suffering from Iodine deficiency. 98% of the subject were found to have normal nails, while 2% were found to have spooning nails which indicates iron deficiency. Finally, 100% of the subjects have normal joints and bones, this indicates absence of calcium and magnesium deficiencies. Clinical examinations assess levels of health of individuals or of population groups in relation to the food they consume. It is the simplest and practical method. When two or more signs characteristic of a deficiency disease are present simultaneously, their diagnostic significance is greatly enhanced. Symptoms are specific to a particular nutrient deficiency. This method is not very expensive and does not require elaborate apparatus and reagents (Srilakshmi, 2014).[12]

## Intelligent Quotient (IQ) scores distribution among the study subjects

About 50% of the study subjects got IQ scores between 0 to 2, 19% got 2 to 4, 9% got 4 to 6, 12% got 6 to 8 and 10% 8 to 10. Boys were observed with the highest IQ scores (Table 6). This indicates the superiority of boys in spatial abilities as the IQ test used was a performance test. Females showed superiority especially in measures of verbal fluency (vocabulary, listening, speaking, comprehension, fluency and spelling) and that male's showed superiority in mathematical and spatial abilities (Stump, 1995).[17]

**Table 6:** Intelligent Quotient (IQ) scores distribution among the study subjects

| IQ Score | No. of children (N=100) | | Percentage (%) |
|---|---|---|---|
| | Boys | Girls | |
| 0 to 2 | 30 | 20 | 50 |
| 2 to 4 | 11 | 08 | 19 |
| 4 to 6 | 05 | 04 | 09 |
| 6 to 8 | 05 | 07 | 12 |
| 8 to 10 | 07 | 03 | 10 |
| Total | 42 | 58 | 100 |

## Statistical outputs with interpretations

### Correlation between IQ scores and Weight-for-age Z-scores

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.289** |
| **Weight-for-age Z scores** | 17.57±1.41 | |

**Correlation is significant at the 0.01 level (2-tailed).

The above statistical output indicates that IQ and weight-for-age Z scores have a statistically significant linear relationship ($p < .001$). This leads to the rejection of the null hypothesis which says there is no significant relationship between IQ and weight-for-age Z score. The direction of the relationship is positive (i.e., IQ and weight-for-age Z scores are positively correlated), meaning that these variables tend to increase together.

Oktarina *et al.,* (2012) [18], found the relationship between weight-for-age and cognitive development to be significant in preschoolers.

**Correlation between IQ scores and Height-for-age Z-scores**

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.282^^ |
| **Height-for-age Z scores** | 105.63±1.41 | |

^^Correlation is significant at the 0.01 level (2-tailed).

From the output above it can be seen that IQ and height-for-age Z scores have a statistically significant linear relationship ($p < .001$). This leads to the rejection of the null hypothesis which says that there is no significant relationship between IQ and height-for-age Z score. The direction of the relationship is positive (i.e., IQ and height-for-age Z scores are positively correlated), meaning that these variables increase together.

Oktarina *et al.,* (2012),[18] found the relationship between height-for-age and cognitive development to be significant in preschoolers.

**Correlation between IQ scores and MUAC-for-age Z-scores**

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.313ϙ |
| **MUAC-for-age Z scores** | 16.28±1.52 | |

ϙCorrelation is significant at the 0.01 level (2-tailed).

From the statistical output above, IQ and MUAC-for-age Z scores have a statistically significant linear relationship ($p < .001$). This leads to the rejection of the null hypothesis which says that they are not related.. The direction of the relationship is positive (i.e., IQ and MUAC-for-age Z scores are positively correlated), meaning that these variables tend to increase together.

**Correlation between IQ scores and Head circumference-for-age Z-scores**

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.178ɣ |
| **Head circumference-for-age Z scores** | 50.20±2.43 | |

ɣCorrelation is significant at the 0.01 level (2-tailed).

The above statistical output points that IQ and head circumference-for-age Z scores have linear relationship which is statistically significant ($p < .001$). This leads to the rejection of the null hypothesis which says that they are not related. The direction of the relationship is positive (i.e., IQ and head circumference-for-age Z scores are positively correlated), meaning that these variables tend to increase together.

**Correlation between IQ scores and Weight-for-Height Z-scores**

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.243Ћ |
| **Weight-for-Height Z scores** | 16±1.78 | |

ЋCorrelation is significant at the 0.05 level (2-tailed).

The above statistical output indicates that IQ and weight-for-height Z scores have a statistically significant linear relationship ($p < .005$). This leads to the rejection of the null hypothesis which says that there is no significant relationship between IQ and weight-for-height Z score. The direction of the relationship is positive (i.e., IQ and weight-for-height Z scores are positively correlated), meaning that these variables tend to increase together.

Oktarina *et al.,* (2012)[18], found the relationship between height-for-age and cognitive development to be significant in preschoolers.

**Correlation between IQ scores and family income**

| | Mean±SD | Pearson's Coefficient of correlation |
|---|---|---|
| **IQ** | 4.24±2.29 | 0.091ɷ |
| **Family income** | 3.94±1.238 | |

ɷCorrelation is significant at the 0.05 level (2-tailed).

From the output above, IQ and family income have a statistically significant linear relationship ($p < .001$). This leads to the rejection of the null hypothesis which says that there is no significant relationship between IQ and family income. The direction of the relationship is positive (i.e., IQ and family income are positively correlated), meaning that these variables tend to increase together.

## Conclusion

Nutrition has been reported to influence the cognitive development of preschool children. Those with poor nutritional status i.e malnourished children, tend to have lower intelligent quotient (IQ) when compared to those that are normal. From the result of this study, it can be concluded that; anthropometric indices are strongly correlated to the mental ability of children. Malnourished children got the least IQ scores.

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