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Study on anthropometric measurements of head in medical faculty students and their relation with intelligence quotient

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Abstract

Questions about intelligence have always occupied scientists' minds, and many types of research have been conducted to find answers to these questions. Although inheritance and environmental factors together are influential in the development of intelligence, the belief that intelligent people are biologically and physically different is a common presentation. There are a significant number of studies which aim to find the association between cognitive abilities and anthropometric measurements. The purpose of this study is to research whether there is association between anthropometric measurements taken from the head regions of university students and their IQ values. Our study was conducted with 84 right-handed male students studying at İnönü University Faculty of Medicine. The students were first given R.B. Cattell Culture Free Intelligence Test. After their ages, heights and weights were recorded, and head circumference, bigonial breadth, morphological facial height, head height, head breadth, frontal breadth, maximum head diameter, nose to back of head, distance between gnathion-traction and skull height measurements from the head region were taken. IBM SPSS Statistics 22.0 program was used for the statistical analysis of the results. $p<0.05$ was considered as statistically significant. Negative correlation was found between IQ and morphological facial height ($r= -0.322$, $p= 0.015$), frontal breadth ($r= -0.307$, $p= 0.02$) and maximum head diameter ($r= -0.342$, $p= 0.009$). Positive correlation was found between IQ and head breadth ($r= 0.287$, $p= 0.03$) and skull height ($r= 0.269$, $p= 0.043$). No correlation was found between head circumference and IQ ($r= 0.127$, $p= 0.348$). Unlike most studies, we did not find a relationship between head circumference and IQ. But we think that other results of the study will contribute to the literature about intelligence and head anthropometry.

Keywords: Head anthropometry, intelligence, R B cattell intelligence test

Introduction

Questions about intelligence have always occupied human beings' minds and a great number of researches have been conducted to find answers to these questions. Due to being an abstract concept, intelligence is an issue on which there is no consensus. It has many different definitions and assessment criteria. For educators, it is the ability to learn, for biologists, it is the ability to adapt to the environment, and for psychologists, it is the ability to get results by reasoning [1]. As a standard definition, we call intelligence the brain's ability to comprehend, to learn what it contains, to make use of what it determines and to be able to convert what it learns to a new situation. Intelligence development of individuals who are born with a specific intelligence potential resulting from inheritance is influenced by the physical and social environment they belong to [2]. Due to the effect of heritage on intelligence, it is a general acceptance in the society that knowledgeable individuals are also biologically different.

There are a significant number of studies aiming to establish an association between cognitive skills and body compositions. Anthropometric measurements are made to find out the associations of body parts with each other by using specific measurement methods [3]. There are especially studies which examine the correlation between head circumference values in fetal period and newborns and the brain size [4,5]. There are also studies which examine the association between gender and racial differences and intelligence [6,7], between brain size and information [8,9], and between measurements such as height and weight and intelligence [10,11].

It does not seem too unreasonable to think that intelligence is associated with skull integrity, which includes the brain in which knowledge develops and continues its development. With its mass influence within the process of development and growth, the brain

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is one of the factors effective in shaping the skull. However, we did not come across too many studies examining the association between head area anthropometric measurements and intelligence. The purpose of the present study is to assess whether there is association between anthropometric measurements taken from the heads of university students and their IQ values.

Materials and Methods

Ethical board approval was taken from İnönü University Ethics Committee for Non-Invasive Clinical Research. We conducted the study with 84 medical faculty students from İnönü University. The students read and signed the voluntary consent form.

We chose our volunteers among healthy male individuals who were not smokers, who were not using alcohol or drugs, who did not have psychological diseases, who were right-handed, who had not undergone seizures in childhood and who had not undergone a head trauma or head surgery.

First, we recorded our volunteers' ages, heights, and weights. Later, we recorded anthropometric measurements including head circumference, bigonial breadth, morphological facial height, head height, head breadth, frontal breadth, maximum head diameter, nose to back of the head, distance between gnathion-trichion and skull height.

Head breadth is the breadth on a transverse plane between both euryon (eu) points which are the most outward points on both sides of the head. Frontal breadth is the breadth on transverse plane between frontotemporal (ft) points where two linea temporalis are closest to each other. Bigonial breadth is the distance between gonion (go) locations which are the most outward points to both sides of the mandible (Figure 1).

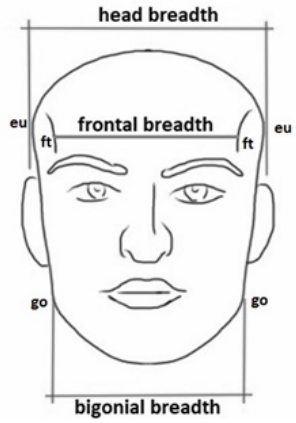

Figure 1. Head breadth, frontal breadth and bigonial breadth measurement

Nose to back of the head is the distance between opisthocranion (op) which is the farthest point to glabella on median line over the occipital bone and pronasale (prn) point which is the most outward to the front on median line of the tip of the nose. Maximum head diameter is the distance between opisthocranion (op) and gnathion (gn) which is the lowest point of mandible on median line (Figure 2).

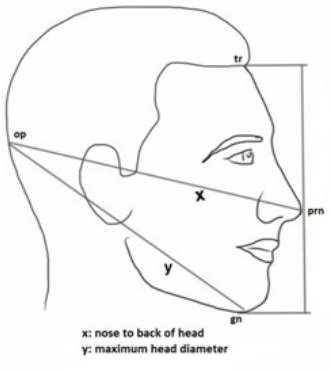

Figure 2. Nose to back of head distance and maximum head diameter measurement

Skull height is the distance between vertex (v) which is the peak point of the head on Frankfurt plane and nasion (n) point where nasal bone meets the frontal bone. Morphological facial height is the distance between gnathion (gn) and nasion (n) points. Head height is the distance between vertex (v) and gnathion (gn) points (Figure 3).

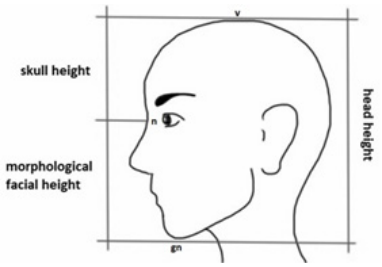

Figure 3. Skull height, morphological facial height, and head height measurement

Head circumference is the maximum circumference length of the head over the eyebrows and the most outward point of the occipital bone taken with a rigid tape measure (Figure 4).

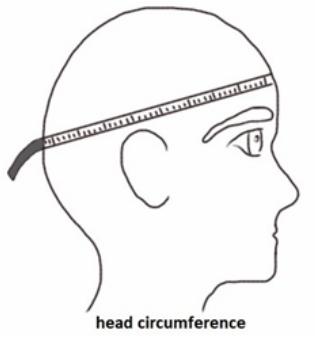

Figure 4. Measurement of head circumference

Later, R. B. Cattell 3A Culture Fair Intelligence Test was applied to our volunteers, and the IQ scores were recorded. Since this test is culture fair, it can easily be applied to all societies.

IBM SPSS Statistics 22.0 program was used for the statistical analysis of our results. Normality distribution of our data was conducted with Shapiro-Wilk test. Median and minimum and maximum values of data which were not normally distributed were used. Spearman's Rho correlation analysis was used for correlation analysis. $p<0.05$ value was considered as statistically significant.

Results

The median value of the ages of our volunteers was 22 (19-27), while the median value of their heights was 178 (165-197) cm, the median value of their weights was 74 (54-105) kg, and the median value of their IQ scores was 104 (68-162) (Table 1).

Table 1. Age, height and weight values of volunteers

Parameter	n	Median	Min-Max
Age	84	22	19-27
Height (cm)	84	178	165-197
Weight (kg)	84	74	54-105
IQ	84	104	68-162

We examined the association between our volunteers' age, height, and weight values with their IQ scores. We found a negative correlation only between age and IQ (Table 2).

Table 2. Correlation analysis results of IQ scores with age, height and weight

Parameter	Test Statistics	Age	Height	Weight
IQ	r	-0.361	-0.142	-0.174
	p	0.006	0.292	0.195
	n	84	84	84
	84	104	68-162	

The median values of the anthropometric measurements we got from our volunteers were as follows: head circumference 56 (53,5-61) cm, bigonial breadth 111,4 (100-120,8) mm, morphological facial length 124,7 (106-138,7) mm, head height 240,6 (131,5-259,4) mm, head breadth 149,5 (140,5-160,1) mm, frontal breadth 121,1 (83,3-141) mm, maximum head diameter 206,9 (178,3-231,5) mm, nose to back of head 205,2 (172,1-220,4) mm, distance between gnathion-trichion 184,8 (108,3-205,2) mm, skull height 112,6 (91,5-129,5) mm (Table 3).

Table 3. Median (min-max) values of anthropometric measurements taken from students

Parameter	n	Median	Min-Max
Head circumference (cm)	84	56.5	53.5-61
Bigonial breadth (mm)	84	111.4	100-120.8
Morphological facial length (mm)	84	124.7	131.5-259.4
Head height (mm)	84	240.6	131.5-259.4
Head breadth (mm)	84	149.5	140.5-160.1
Frontal breadth (mm)	84	121.1	83.3-141
Maximum head diameter (mm)	84	206.9	178.3-231.5
Nose to back of head (mm)	84	205.2	172.1-220.4
Distance between gnathion-trichion (mm)	84	184.8	108.3-205.2
Skull height (mm)	84	112.6	91.5-129.5

Table 4. Correlation analysis of IQ scores and anthropometric measurements

Parameter	n	IQ	
		r	p
Head circumference	84	0.127	0.348
Bigonial breadth	84	-0.041	0.761
Morphological facial length	84	-0.322	**0.015**
Head height	84	0.068	0.616
Head breadth	84	0.287	**0.030**
Frontal breadth	84	-0.307	**0.020**
Maximum head diameter	84	-0.342	**0.009**
Nose to back of head	84	-0.214	0.109
Distance between gnathion-trichion	84	-0.206	0.125
Skull height	84	0.269	**0.043**

Discussion

In childhood and adolescence, the brain grows in mass and size. During the second decade, this growth stops, and in the following years, it begins to regress [12]. If the brain grows, the skull it is in also grows. Since the growth of mind stops during the second decade, the skull size in that period is, in fact, the greatest extent the brain has. The size of a healthy neurological system is the indicator of the processing capacity of that system because a bigger brain means more neurons and more communication between these neurons [13]. There are not many studies in literature comparing anthropometric measurements of the head with cognitive capacity. There are studies comparing intelligence with brain size calculated from head circumference and radiological images. However, these studies are generally conducted on patient groups, children and old population. There are studies which show that children with low head circumference values in newborn and childhood periods have low intelligence in childhood [7,14]. However, there are also studies which show that there is no association between head circumference values at birth and intelligence [15,16]. The reason for these different results is the fact that brain development does not come to an end due to neural pruning and as a result of myelinization not being completed in neurons during childhood [17].

We come across a similar situation in adults. While a positive association is generally mentioned between cognitive functions and head size in studies conducted with adult and elderly population [18,19], there are also studies which report no statistically significant association [3]. The reason for this difference is the absence of information about the past lives and childhoods of the adults whose measurements are taken. Family circle, nutritional habits, and the social and cultural circle an individual is exposed to influence that individual's intelligence level [20]. Thus, the best age group to compare intelligence with the anthropometric measurements of the head is the second decade which constitutes our study group.

There are two kinds of bits of intelligence; fluid intelligence and crystallized intelligence [21,22]. Crystallized intelligence is the intelligence associated with the individual's level of knowledge and vocabulary. Fluid intelligence is the intelligence which

does not depend on knowledge and which shows the ability for abstract thinking and for solving problems quickly. Since we did not have information about the past experiences, education and socio-cultural environment of our volunteers, instead of the type of intelligence associated with level of knowledge, we based our study on fluid intelligence which is not based on experience and for this we used R B Cattell culture fair intelligence test.

Some of our results were in parallel with the thesis that "individuals who have a big brain are more intelligent." The head breadth and skull height and IQ results were found to be positively correlated. Both measurements show the areas the brain occupies in the skull and the participants whose head breadth and skull height values were high were also found to have high IQ values. Another result of our study that morphological facial height and IQ values were negatively correlated means an increase in favor of skull height in the proportioning of skull height and morphological facial height. Here is again an area occupied by the brain and its excellent means that the brain mass inside is also big. Head circumference is the most studied head area measurement both anthropometrically and in terms of radiological images [23,24,25]. Although a vast majority of these studies report a significant association between head circumference and intelligence, we could not find a statistically significant association. Also, we found a negative correlation between maximum head diameter, morphological facial length and frontal breadth measurements and intelligence. Although frontal breadth is an indication of the area occupied by the brain, the result that it is negatively correlated with intelligence is not in parallel with the thesis that "individuals with a big brain are more intelligent". It has scientifically been shown that grey matter and white matter rates of the brain are also associated with intelligence [26,27]. However, we could not find any studies in literature that we can compare these results with.

A positive correlation is reported in the literature between height and IQ in studies conducted with children [28] and young adults [29]. Unlike this hypothesis built on the thought that "good nutrition positively influences neurological development [30] and also has a positive influence on body development and height [31]", we could not find an association between height and weight values with IQ scores.

Conclusion

Unlike most studies, we did not find a relationship between head circumference and IQ. But we think that other results of the study will contribute to the literature about intelligence and head anthropometry.

Conflict of interest
The authors declare that there are no conflicts of interest.

Financial Disclosure
All authors declare no financial support.

Ethical approval
Ethical board approval was taken from İnönü University Ethics Committee for Non-Invasive Clinical Research. We conducted the study with 84 medical faculty students from İnönü University.

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