Differences in head size and shape during the growth of Deutero Malay children

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ABSTRACT

Introduction: The growth periods of 0-18 years old can be studied with anthropometry by identifying the head size and shape of the human head. Study on vertical, transverse, and horizontal cephalic indexes can understand differences and growth between sexes and age groups. This study was aimed to analyse the averages and differences in the head size and shape of Deutero Malay children in different age groups. **Methods:** This research was a descriptive analytic study with cross-sectional design. The sample of 192 Deutero Malay children consisted of boys and girls with an age range of 7-18 years old. Measurement of head height, length, and width was performed to calculate the differences of vertical, transverse, and horizontal cephalic index values by sex and age group, and the classification of the head shape based on the cephalic index values. **Results:** There was a difference of vertical, transverse, and horizontal by age group, with $p = 0.000$ ($p < 0.05$). The average of vertical, transverse, and horizontal cephalic index values was significantly higher in each age group. The average horizontal cephalic index was significantly higher in boys and girls. There was no significant difference in the head shape by the vertical and horizontal cephalic index in all age groups. The highest vertical cephalic index found was chamaecephalic (68%). The highest transverse cephalic index was tapeiocephalic (99%). The highest horizontal cephalic index was hyperbrachycephalic (80%). **Conclusion:** There is similar head shape of Deutero Malay children, although there may be increasing head size along with age.

Keywords: Deutero Malay, head shape, cephalic index, transverse cephalic index, horizontal cephalic index, vertical cephalic index.

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INTRODUCTION

Anthropometry is a branch of the science of physical anthropology that studies measurement techniques of the human body that includes a way to measure and make observations the form of skeletal bones and organs of the human body with specific methods and tools. Anthropology is also used in following postnatal growth and development, detecting abnormalities, and predicting future growth in adult. Dental

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anthropology was popularised by Brothwel whose study was focusing on the neck and head, especially the teeth (cranio-dento-facial).[1] Anthropometry is usually more likely to focus on the dimensions of the dead human body for identification or attempting to change its original identity.[2] The science of anthropometry develops mainly in the context of anthropology that studies the classification and identification of racial and gender differences, the effects of diet and environmental conditions on growth.[3] The word anthropometry is derived from the Greek word 'anthropos' means human, and 'metrein' means to measure.[4]

Head anthropometry measurements can be used in conjunction with cephalometry, Computerized Tomography Scan (CT Scan) and Magnetic Resonance Imaging (MRI) in the preparation of plastic surgery and reconstructive surgery patients.[5] One of the most important anthropometric branches is the craniometry used in orthodontics and cephalometry whose calculations use cephalic index. The cephalic index was introduced by Anders Retzius, an Swedish anatomist with the purpose to classify populations.[1] Cephalic index (CI) and head shape are greatly affected by geograpical, sex, age, and racial factors. CI can be used as marker of ethnicity.[6] CI is commonly used to describe individuals' appearances and for estimating the age of fetuses for legal and obstetrical reasons. CI can be used widely in various forensic investigations.[7]

Morphological changes and growth in each individual occur at 8-17 years old. After that age morphological changes and growth do not occur again. Head growth patterns vary widely by age and sex, and stops at age 18-20 years old.[8] After birth, the head grows faster than other part of the body so the head becomes very dominant. Differences in the growth of the upper and lower head components are important in determining the type of head, the shape of the dental arch and first incisor.[1]

Measurement of human head shape can use cephalic index method. The cephalic index is a measure the ratio (in percent) of the maximum length, height and width of the skull bone.[1,9] Head shape based on vertical cephalic index: chamaecephalic, orthocephalic, lowhypsicephalic, moderate hypsicephalic or high hypsicephalic; based on transverse cephalic index: tapeiocephalix, metriocephalic or acrocephalix; based on horizontal cephalic index: dolicocephalic, mesocephalic, brachycephalic or hyperbrachycephalic. The cephalic index is also an important parameter in evaluating race and gender differences.[9]

Race is an important concept for studying human variations because humans differ from one another.[10] Indonesia is a multiracial and multiethnic nation. The Indonesian originally came from the Mongoloid and Australomelanesid races. The fusion between Mongoloid and Austromelanesid produced Proto Malay and Deutero Malay race.[1,11] Deutero Malay or known as young Malay came from the Yunan region (South China) around 500 BC. Deutero Malay has a more advanced civilization compared to Proto Malay. The ethnic groups in Indonesia which are included in the Deutero Malay are Aceh, Minangkabau, Javanese, Sundanese, Malay, Betawi, Manado, Bali, Madura. Most of the population of Sumatera Utara is Deutero Malay.[1]

Many studies of head shape are associated with race and sex using horizontal cephalic index and various head forms are conducted.[3] Based on the results of the study showed that some differences based on the result of cephalic index and some equations based on head size and shape on three ethnic groups in Nigeria.[9] Different ethnic groups tend to have different skull and jawbone size even though they are often influenced by individual variation.[12] Based on the results of a study conducted by Ligha, there was a difference in the cephalic index results between boys and girls aged 7-10 years old and 11-14 years old.[13] This result suggested that there were variations in the cephalic index or head shape by age group between sexes.[13]

Based on the description above, study on differences of head size and shape in the age group of 7-18 years old by using vertical, transverse, and horizontal cephalic index to determine differences between age group and to determine the average size of Deutero Malay head can be conducted because there is no data about it yet. It will be an interesting study object regarding differences in the head size between growing period age groups. This study was aimed to analyse the averages and differences in the head size and shape of Deutero Malay children in different age groups.

METHODS

The study was conducted at Namira School Jalan Pasar 1 Kelurahan Tanjung Sari Medan, Sumatera Utara. The study was conducted after obtaining approval from the Ethics Commission of the Faculty of Medicine, Universitas Sumatera Utara, and informed consent was obtained from the parent/ guardian of the subject. The type of study was descriptive analytic with cross sectional design.

The population of this study were student of primary school, junior high school, and senior high school 7-18 years old in Namira School. The sampling method was purposive sampling that subject was selected based on inclusion and exclusion until reaching the amount of sample determined. Minimal sample was needed 186 subject, to make it easy, the amount of sample was based on age grouping, the sample used was 192 people with a division of 48 people 7-9 years old (24 boy and 24 girl), 48 people 10-12 years old (24 boy and 24 girl), 13-15 years 48 people (24 boy and 24 girl), and 48 people 16-18 years old (24 boy and 24 girl). Inclusion criteria were 7-18 years old, Deutero Malay (up 2 generation) and normal head shape. Exclusion criteria were undergone orthodontic treatment, maxillofacial surgery, craniofacial malformation and history/signs of craniofacial syndromes. Measurement tools used in the study were curved calipers, digital calipers, and rulers.

All subjects were asked to sit in a chair with an upright position, lean the body in perpendicular position. The head length was measured from the glabella (g) to the inion. The maximum length of the head was measured by placing the tip of the caliper at the point of the glabella and the inion. The distance of the two ends of the calipers was measured using a ruler, and the size was recorded as the maximum length of the head.

The head height is measured from the nasion (na) to gnation (gn). The nasion is the point on the nasofrontal suture in the medio-saginal plane whereas gnation is the point on the underside of the lower mandible of the medio-sagittal. The head height was measured by placing the tip of the digital caliper at the nasion and gnation points. The distance of the two ends of the caliper was measured using a digital caliper and the size was recorded as the width of the head.

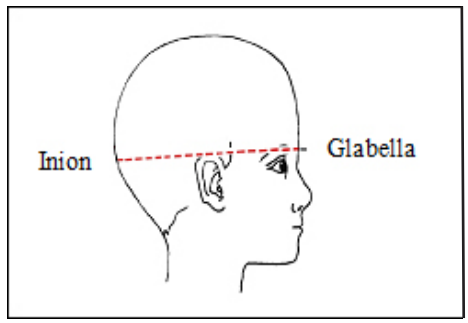

Figure 1. Measurement of head length from glabella to inion using curved caliper.[14]

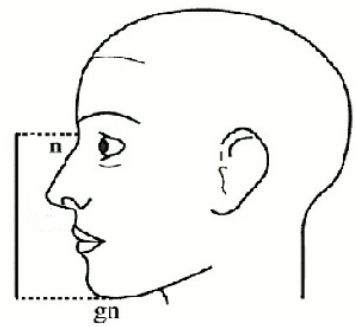

Figure 2. Measurement of head height from nation to gnation using digital caliper.[14]

The head width was measured the distance between parietal eminence or eurion to eurion (eu-eu). Eurion is the most lateral point of the cranium, by placing a ruler on the parietal region of the head (above the ear) perpendicularly and then the ends of the curved caliper are placed on both the left and right eurion points. The distance of both ends of the curved caliper was measured using a ruler and the size was recorded as the maximum head width.

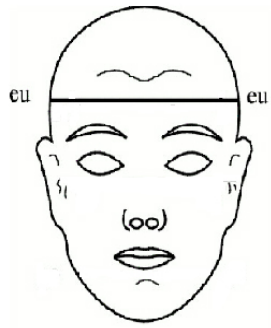

Figure 3. Measurement of the head width of eurion-eurion using curved caliper.[14]

Data recording was the length, height and width of the head on the subject questionnaire. The following cranial indices were calculated using the above measurements: Vertical cephalic

index = Head height (nation to gnation) x 100 / Head length (glabella to inion).

According to the vertical cephalic index head shapes were chamaecephalic (< 57.9), orthocephalic (58.0 - 62.9), low hypsicephalic (63.0 - 67.9), moderate hypsicephalic (68 - 72.9), and high hypsicephalic (73 >).Transverse cephalic index = Head height (nation to gnation) x 100 / Head width (linear line between parietal eminence). According to the transverse cephalic index head shapes were tapeiocephalic (< 78.9), metriocephalic (79.0 - 84.9) and acrocephalic (85 >). Horizontal cephalic index = Head width (linear line between parietal eminence) x 100 / Head length (glabella to inion). According to the horizontal cephalic index head shapes were dolicocephalic (< 74.9), metriocephalic (75 - 79.9), brachycephalic (80.0 - 84.9), and hyperbrachycephalic (> 85).

RESULTS

In this study, we determined the average difference in vertical, transverse and horizontal cephalic indexes by age group 7-18 years old in Deutero Malay race in boys and girls.

Table 1. Mean of head height, length and width of 7-18 years old Deutero Malay race between boys and girls by age group

Age group (years old)	Boy (cm)			p-value	Girl (cm)			p-value
	Head height ($\bar{x}$ ± SD)	Head length ($\bar{x}$ ± SD)	Head width ($\bar{x}$ ± SD)		Head height ($\bar{x}$ ± SD)	Head length ($\bar{x}$ ± SD)	Head width ($\bar{x}$ ± SD)	
7-9	8.66 ± 0.27	17.01 ± 0.41	14.25 ± 0.11	0.00*	8.82 ± 0.31	16.56 ± 0.65	14.26 ± 0.26	0.00*
10-12	9.80 ± 0.50	16.56 ± 0.65	15.87 ± 1.11		9.71 ± 0.41	17.77 ± 1.02	15.58 ± 0.44	
13-15	10.12 ± 0.64	17.85 ± 0.58	15.64 ± 0.55		10.10 ± 0.33	17.65 ± 0.70	15.66 ± 0.61	
16-18	10.60 ± 0.48	17.65 ± 0.59	15.47 ± 0.68		10.21 ± 0.43	16.63 ± 0.60	15.23 ± 0.57	

***significant (p<0.05)**

Based on Table 1, the ANOVA analysis showed that the mean of head height, length, width of 7-18 years old based on age group in boy was significant differences (p < 0.05).

Table 2. Mean of vertical, transverse, horizontal cephalic index of 7-18 years old on Deutero Malay race between boys and girls by age group

Age group (years old)	Boy (cm)			p-value	Girl (cm)			p-value
	Vertical cephalic index ($\bar{x}$ ± SD)	Transverse cephalic index ($\bar{x}$ ± SD)	Horizontal cephalic index ($\bar{x}$ ± SD)		Vertical cephalic index ($\bar{x}$ ± SD)	Transverse cephalic index ($\bar{x}$ ± SD)	Horizontal cephalic index ($\bar{x}$ ± SD)	
7-9	50.91 ± 1.86	61.29 ± 2.27	83.66 ± 1.85	0.00*	53.29 ± 2.19	61.87 ± 1.80	86.04 ± 2.36	0.00*
10-12	54.27 ± 2.74	62.16 ± 4.09	87.70 ± 4.68		54.29 ± 3.15	61.70 ± 2.59	87.83 ± 4.85	
13-15	56.75 ± 3.59	64.62 ± 3.94	87.58 ± 3.17		57.29 ± 2.82	64.62 ± 3.41	88.79 ± 3.64	
16-18	60.04 ± 3.19	68.75 ± 4.95	88.25 ± 3.65		61.41 ± 2.65	67.00 ± 3.36	91.62 ± 3.10	

***significant (p<0.05)**

Based on Table 2, ANOVA analysis showed that the mean of vertical, transverse, horizontal cephalic index head shape of 7-18 years old based on age group in boy was significant differences (p < 0.05). ANOVA analysis showed that the mean of vertical, transverse, horizontal cephalic index head shape of 7-18 years old based on age group in girl was significant differences (p < 0.05). The mean vertical cephalic index of 7-18 years old in this study, boy was smaller than girl.

After obtaining the vertical, the transverse, and the horizontal cephalic index size, the results can be classified on the vertical cephalic head shape index of each sample based on the age group of 7-18 years old as presented in Table 3. The highest vertical cephalic index found was the chamaecephalic (68%). The highest transverse cephalic index was the tapeiocephalic (99%). The highest horizontal cephalic index was the hyperbrachycephalic (80%).

Table 3. Distribution of vertical, transverse, and horizontal cephalic index head shape within group 7-18 years old

Cephalic index	Head shape	n (%)	Total
Vertical	Chamaecephalic	130 (68%)	
	Orthocephalic	48 (25%)	192 (100%)
	Low Hypsicephalic	14 (7%)	
Transverse	Tapeiocephalic	191(99%)	
	Metriocephalic	1 (1%)	192 (100%)
	Acrocephalic	0 (0%)	
Horizontal	Hyperbrachycephalic	153 (80%)	
	Brachycephalic	36 (19%)	192 (100%)
	Mesocephalic	3 (1%)	
	Dolicocephalic	0 (0%)	

DISCUSSION

In this study, ANOVA analysis showed that the mean of head height, length, width of 7-18 years old based on age group in boy was significant differences ($p < 0.05$) and so did in girl. Nutritional status (diet), economy, habits and living environment are the factors that influence growth and morphological changes of the head. Head growth is strongly influenced by genetic factors in addition to other factors like environment, nutrition, degree of physical activity and health and disease. Genetic factors are the basic capital in achieving the end result of the child's development process, through the genetic instruction contained in the fertilized ovum, can be determined the quality and quantity of growth. Characterized by the intensity and speed of cleavage, the degree of tissue sensitivity to stimulation, the age of puberty and the cessation of bone growth.[1] The size of the head is also affected by genetics, ecology, geography, race, gender and age. Factors that greatly affect head growth are nutritional and environmental factors. The nutritional status (diet) of each sample varies greatly, where diet is an important factor affecting head growth. Environmental factors also affect head growth, people living in cold climates tend to have round heads than those living in hot areas.[9]

ANOVA analysis also showed that the mean of vertical, transverse, horizontal cephalic index head shape of 7-18 years old based on age group in boy was significant differences ($p < 0.05$), and so did in girl. There is an increasing variation in cephalic index in each age group in this study. Study conducted by Ligha on cephalic index on Nigerian children obtained the value of cephalic index of age 3-6 years old (79.06), age 7-10 years old (79.07), age 11-14 years old (80.26) and age 15-18 years old (80.54).[13] Postnatal growth in spheno-occipital synchondrosis is a major factor of contributing to cranial base growth and also is a guide rail for development of the maxilla, midface and mandible, which persists until adult.[15] Spheno-occipital synchondrosis is the last syncope of the joint, starting on the cerebral surface of the 12-13 years old girls and 14-15 years old boy and perfect ossification on the outside surface at 20 years old. According to Todd, morphological changes and actual growth in each individual occurs between 8-17 years old and after that age morphological changes and growth do not occur again.[8]

The mean vertical cephalic index of 7-18 years old in this study, boy was smaller than girl. The result of this study is different to the result of study done by Salve about vertical cephalic index study at the age of 20-25 years in India where mean vertical cephalic index in boy (74.08) and girl (73.03).[16] However, the samples used in both studies took an adult sample and there was no growth of the head.

This present study shows that the size and length of the Deutero Malay race head is smaller than Indians when measured using a vertical cephalic index. Identification of gender from cranial can be done with measurement with 80-90% accuracy. Between the bone character on the head that distinguishes boy and girl is cranial capacity, forehead or frontal bone, zygomaticus bone, mandible, gonion and chin angle or gnation.[17] Boys heads and faces are generally larger than girls. The cranial capacity in boys is also 10% larger than girls. The forehead or frontal bone in the boy is flat, while the girls are more rounded.[17,18] Only the

structure and size can significantly differentiate boy and girl but the cephalic and head shape can not significantly differentiate gender.[18] In the Salve study, the largest vertical cephalic index head shape was hypsychephalic (100%) and the largest transverse cystic head shape was acrocephalic (100%).[16] The results were different from the studies that have been done, possibly because of racial differences where the ethnic India is a Caucasian race while ethnic Malay is Mongoloid race or can be caused by other factors such as growth, genetic or environment so that need further study.

In this study, the highest vertical cephalic index of Deutero Malay children 7-18 years old is chamaecephalic (68%). The highest transverse cephalic index of Deutero Malay children 7-18 years old was tapeiocephalic (99%). The highest horizontal cephalic index of Deutero Malay children 7-18 years old was hyperbrachycephalic (80%). The results were in accordance with the results on cephalic index study on Malaysian students, there were found Malay ethnic heads in the highest horizontal cephalic index were hyperbrachycephalic (55.6%) while mesocephalic (0%) and brachycephalic (44.4%). Generally, the shape of the head is hyperbrachycephalic (80%). It is appropriate with our study because it belongs to the same of race (Mongoloid). Mongoloid race divided into two, namely, Asian Mongols and Indians. The Asian Mongoloid consists of Chinese subcontinent (composed of Japanese, Taiwanese, Vietnamese, Chinese) and Malay subtitles (consisting of Malaysians, Indonesians and Filipinos). The Mongoloid Indians are made up of Indians in America. Mongoloid race has yellow to brown skin features, straight hair, slight body hair, rounded forehead, wide and flat face and narrow eyes (especially Asian Mongoloid). Mongoloid race has a brakhophyllal head shape with a cephalic index > 80. Study shows boys and girls in each race show the same head shape but head width, head length, and mean of cephalic index for each race in girls is higher than boys.[19,20]

This study had only seen growth by sex and age groups of different people at the present time. Therefore, this study still had shortcomings, so it is necessary to do long-term study for further study such as follow the development and growth of a person from birth to adulthood and use a sample that has the same nutritional status (diet), economy, customs and environment.

CONCLUSION

There is similar head shape of Deutero Malay children, although there may be increasing head size along with age.

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