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Differences in Mean Cephalic Index Based on Sex of Timorese in Kupang City, NTT Province

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ABSTRACT: The cephalic index is one of the cephalometric indices that determines the morphological characteristics of the head. The cephalic index is used in different medical fields, including in forensic identification. The cephalic index value is measured based on the head width and length. The cephalic index is affected by sex, age, nutrition, genetics, environment, race and ethnicity. Sex affects the cephalic index by hormones and sexual dimorphism. The Timorese is one of the tribes in Kupang City where research on cephalic index had never been previously conducted.

KEYWORDS: Cephalic Index, Sexual Dimorphism, Anthropometry, Timorese Ethnic, Kupang City

INTRODUCTION

The human skull is an essential component of the body, serving a structural role and protecting the vital organs contained within it (1). Numerous factors contribute to variations in cranial morphology, one of which is sex. Sex-specific factors are particularly influenced by hormonal activity, which plays an important role in cranial growth between males and females. Thyroid hormone and testosterone work synergistically with growth hormone to stimulate cranial bone development, while estrogen acts to inhibit the activity of growth hormone (2,3). Characteristics of cranial variation can be further studied through physical anthropometry, specifically cephalometry(4). Cephalometric measurements emphasize the dimensions of the human head and face in order to determine distinctive craniofacial morphological characteristics (5,6).

The cephalic index is utilized across multiple fields, including identifying differences based on ethnicity, race, and sex; assisting in surgical planning; estimating fetal age; detecting cranial deformities; designing head-related devices; and describing individual appearance (7–10). Based on cephalic index values, head shapes can be classified into four categories: dolichocephalic, mesocephalic, brachycephalic, and hyperbrachycephalic. The cephalic index is directly related to head morphology and is influenced by genetics, age, race, ethnicity, nutrition, environment, disease, and sex (5,11).

Several studies have investigated cephalic index differences between males and females. Fauzan et al. (2019), in their study "Differences in the Mean Cephalic Index and Frontoparietal Index between the Minangkabau and Javanese Ethnic Groups", reported significant differences between male Minangkabau (77.41) and female Minangkabau (75.98) with P = 0.001, as well as between male Javanese (87.58) and female Javanese (86.10) with P = 0.002.(6) Akinbami (2014), in the study "Measurement of Cephalic Indices in Older Children and Adolescents of a Nigerian Population", found a significant difference between male Ogbia (77.21) and female Ogbia (76.5) with P = 0.04.(12) Similarly, Oris and Ibeachu (2016), in "Craniometric Indices of Nigerian Skulls", reported that the cephalic index was slightly higher in females (76.12) than in males (76.03).(8) Ananda et al. (2021) reported that the cephalic index value among the East Nusa Tenggara (NTT) ethnic group residing in Denpasar was 81.50% (13).

The Timorese are one of the major ethnic groups inhabiting Kupang City, Indonesia. The cranial characteristics of the Timorese include a relatively narrow zygomatic arch and mandible, a high facial index, a longer facial length relative to facial width, and a relatively broad frontal region of the skull.(14,15) Considering the important role of the cephalic index, the previously reported variations between males and females, and the findings from NTT ethnic groups in Bali, yet with no prior study specifically addressing sex-based cephalic index differences among the Timorese in Kupang, it is necessary to conduct research in this population. Such research may reveal whether significant differences exist when samples are drawn from individuals residing within the same geographic area as their ethnic origin.

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METHODS

This study employed a comparative analytic design with a cross-sectional approach, in which data on the studied variables were collected at a single point in time without temporal dimensions. The accessible population consisted of individuals of Timorese ethnicity residing in Kupang City, East Nusa Tenggara Province. A total of 100 participants were included, comprising 50 males and 50 females. Research instruments included a demographic data sheet and a spreading caliper. The study was conducted in Kupang City, East Nusa Tenggara, from August to September 2022. Data analysis was performed using the independent t-test, with a significance level set at $p < 0.05$. This study received ethical approval from the Health Research Ethics Committee, Faculty of Medicine, Universitas Nusa Cendana, under registration number: UN01220760.

RESULTS

The total number of respondents in this study was 100, consisting of 50 males and 50 females (Figure 1). Based on age distribution, there were 28 respondents in the late adolescent group, 24 in the early adult group, 24 in the late adult group, and 24 in the early elderly group (Figure 2). Figure 3 illustrates the distribution of respondents by residential area, with 24 respondents from Kelapa Lima District, 37 from Oebobo District, 12 from Maulafa District, 12 from Kota Raja District, and 15 from Alak District.

Table 1. Cephalic Index Based on Sex

	Sex	Mean
Cephalic Index	Male	84.00
	Female	83,68

Table 1 shows the mean cephalic index according to sex. Males had a mean cephalic index of 84.00, while females had a mean of 83.68.

Table 2. Bivariate Analysis

Sex	Mean Cephalic Index	SD	p-value
Male	84	±3.84	0,714
Female	83,68	±4.87	
Significance level p < 0,05			

Statistical analysis using the independent t-test revealed that the difference in mean cephalic index between males and females was not statistically significant, with a two-sided p-value of 0.714.

DISCUSSION

This study, conducted among the Timorese ethnic group in Kupang City with a total of 100 respondents from five districts, demonstrated that the mean cephalic index of males was 84.00, while that of females was 83.68. Although the mean cephalic index of males was slightly higher than that of females, bivariate analysis using the independent t-test yielded a p-value of 0.714 (Sig. > 0.05), indicating that the difference was not statistically significant.

The nonsignificant difference in cephalic index found in this study is consistent with the findings of Thomas and Rajan (2021) in "Regional and Gender Differences in the Cephalic Index among South Indian and North-East Indian Populations." Their study revealed no significant sex-based differences in cephalic index among 75 males and 75 females from both South and North-East India. Such nonsignificant differences may result from the interaction of other influencing factors, including genetics, environment, nutrition, and age.(14) Sexual dimorphism is often associated with differences in cranial morphology between males and females. For instance, males generally have a larger cranial capacity than females, female frontal bones tend to be rounder and more prominent, the male glabella is less pronounced, and the male occipital bone is more prominent (6,15).

Matamala et al. (2009), in "Sexual Dimorphism Determination from the Linear Dimensions of Skulls", reported that linear cranial dimensions were greater in males than in females (16,17). This finding aligns with the results in this study: the mean cranial length

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among Timorese males was 18.36 cm compared to 17.8 cm in females, while the mean cranial breadth was 15.41 cm in males compared to 14.87 cm in females. These larger linear dimensions in males contribute to their slightly higher cephalic index values. Hormonal factors also play an important role, particularly the interaction between sex hormones, growth hormone, and thyroid hormones (12). In males, growth hormone stimulates cranial bone development through osteoblast activity, which is further enhanced by testosterone and thyroid hormone. In females, estrogen inhibits growth hormone activity, which may explain the generally smaller cranial dimensions compared to males (2).

According to Orish CN (2018) in "Cephalic Index in Sexual Dimorphism and Racial Diversity: A Mini Review", cephalic index variation is influenced not only by sex but also by complex interactions with environmental factors (8). Nutrition also plays a significant role in cranial growth. Protein, for example, is essential for brain development; protein deficiency may impair brain and cranial growth by limiting osteogenesis and cranial expansion.(18) Fauzan (2019) reported significant sex-based differences in cephalic index among the Javanese ethnic group (male: 87.58, female: 86.10, $p = 0.002$) and the Minangkabau ethnic group (male: 77.41, female: 75.98, $p = 0.001$) (6). These findings may be attributable to the narrower age range of participants (18–25 years) compared to the broader age range (18–50 years) in the present study. Since age is one of the factors influencing the cephalic index, this difference in sampling could contribute to the contrasting results. Both age and nutritional status jointly affect cephalic index through the process of brachycephalization.

Nutritional improvement contributes to brachycephalization, whereby cranial breadth increases with better nutritional status. As cranial breadth increases, the cephalic index rises accordingly (19). Cranial length reaches its peak growth at around 14 years of age, but brachycephalization continues beyond this age (19,20). Ethnicity and race also play a role. While race and ethnicity are distinct concepts, both classify humans based on shared features. Race is defined primarily by physical characteristics, whereas ethnicity is shaped by cultural factors such as language, history, geographic origin, and traditions. Migration contributes to the mixing of races within an ethnic group, leading to greater diversity in cranial morphology. Among the Timorese in Kupang, migration may have introduced genetic diversity that affects cephalic index values and head shape (21).

Environmental factors further influence cranial morphology. Such factors include cranial trauma, food availability (which impacts nutrition and skull growth), and gene–environment interactions that regulate genetic expression and contribute to morphological adaptation. Consequently, individuals living within the same environment often exhibit similar cranial morphologies (22,23). The interplay of these factors may explain the lack of significant differences in cephalic index between male and female respondents in this study. Morphological adaptations to shared genetic, environmental, and nutritional factors especially among individuals born and raised within the same geographic and cultural context likely reduce variability between sexes. This reasoning aligns with the sample population of this study, consisting of Timorese individuals born and raised in Kupang City.

CONCLUSION

There is no significant difference in the mean cephalic index between males and females of the Timorese ethnic group in Kupang City.

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