INTRODUCTION

Cephalic index is one of the important craniofacial parameters which is commonly used for investigating the length and breadth of the head. Cephalic Index (CI) is defined as the ratio between maximum breadth of the head and the maximum length of the head multiplied by 100. Maximum breadth is measured by considering the distance between the two parietal eminence of the skull. The maximum length of the head is measured by taking in consideration the distance between the glabella and the inion on the external occipital protuberance. Craniofacial measurements are essential for determining various shapes of head and face. Craniometry is an important branch of anthropometry through which cranial dimensions can be measured. Skull index information is one of the important criteria for studying and comparing the skulls of people with various essential differences in nutrition, race, geography, and ethnicity.

Body mass index (BMI) is derived from the mass (weight) and height of a person. BMI is defined as the body mass divided by the square of the body height, expressed in kg/m². BMI is a convenient rule of thumb which is used...
to broadly categorize an individual under different category of underweight, normal weight, overweight, or obese based on the tissue mass (i.e., muscles, fats, and bones) and height. The most commonly accepted BMI reference ranges are underweight (< 18.5 kg/m²), normal weight (18.5 - 25), overweight (25 - 30), and obese (> 30).4

BMI is also utilized to determine the quantitative factor that may cause serious impairment of growth including growth and development of craniofacial parameters.5 The pathophysiology of bone disease across all ages is greatly influenced by the genetic, environmental, and the hormonal factors. The composition of the body, especially in individuals at extremes of the weight spectrum, exerts a significant effect on growth of bone, geometry, and subsequent fracture risk.6 As the children grow, the amount of fats in the body changes and naturally their BMI as well. Some diseases such as infection, chronic and genetic disease may be influencing their process of growth and development in children. BMI may mark the growth and development and health development has been well documented to show that the two are closely related to the child’s physical as well as mental condition.7

Based on the above information it is reasonable to correlate the growth of skull (i.e., CI) in relation to the BMI of the children. This association can demonstrate influence of nutritional status of the children on the growth of skull and intellectual development of children.

MATERIALS AND METHODS

Study setting
This was a cross-sectional study conducted from April 2021 to June 2021 with a sample size of 200 children (N=200) of age groups 5-8 years from Ramnagar Gaupalika of Sarlahi district Province 2 of Nepal. The following are the criteria to include and exclude participants.

Inclusion criteria
Apparent healthy children.

Exclusion criteria
Children with confirmed Craniofacial deformity.

Data collection method
We used a structured questionnaire to record the age, mode of delivery, breast feeding status, major staple foods and alcohol consumption by mother during pregnancy. Then a standard digital weighing machine was used to measure weight (in kg) and a tape to measure height (in cm) of the child. BMI was calculated from the height and weight of the child. We used the following criteria to categorize BMI:

- Underweight (< 18.5 kg/m²),
- Normal weight (18.5 - 25),
- Overweight (25 - 30), and
- Obese (> 30).4

In order to measure the Cephalic Index (CI), the subjects were asked to sit on a chair in Anatomical position of head considering the Frankfurt’s line. The measurement of CI was done by using the digital Vernier Caliper. The antero-posterior diameter of the head was measured from the Glabella anteriorly to the Inion posteriorly. The transverse diameter was measured by taking the two parietal eminence of both the sides of head. Then the CI was calculated by using the formula,

\[ \text{Cephalic Index (CI)} = \frac{\text{Transverse diameter}}{\text{Antero-posterior diameter}} \times 100. \]

Various types of Cephalic Index with reference are Dolicocephalic (<74.9), Mesocephalic (75-79.9), Brachycephalic (80-84.9) and Hyperbrachycephalic (85-89.9).

Ethical approval and informed consent
Ethical approval was obtained from the Institutional Review Committee of Nobel Medical College, Biratnagar. An informed consent was obtained from the guardians/parents of all the children after providing them brief information about the study.

Statistical analysis
Data was entered into MS Excel and raw data were cleaned. The cleaned data was entered into SPSS version 16 to generate descriptive statistics. Association between the independent variables and cephalic index was assessed using chi-square test. Correlation analysis was done to assess relationship between BMI and CI.

RESULTS
A total of 200 children (N=200) aged 5-8 years of old were enrolled in the study. The mean age of the participants was 6.56 years, BMI of 18.09 and cephalic index (CI) of 81.82. The mean CI in males and females were 82.05 and 81.59 respectively, but they were not significantly different (p-value=0.548) as represented in Table 1. Of total, 53% of the children were mesocephalic (the classification of the children based on CI is given in Figure 1).

Our results show significant association between BMI category and CI category (chi-square test, p-value=0.000), mode of delivery and BMI category (chi-square test, p=0.042) and significant negative correlation between BMI and CI (Pearson’s R=-0.591, p=0.037) (as shown in Figure 2). However, when the participants were grouped...
by their BMI (either low or normal BMI), the males and females had significantly different CI (Table 2).

**DISCUSSION**

Our study aimed to assess the association between cephalic index and BMI in 5–8 years children in a rural municipality of Sarlahi district, Nepal. Our study found that the mean cephalic index in males and females are 82.05±5.9mm and 81.59±4.9mm respectively. While computing the CI of the subjects of the normal BMI, the mean CI of males was 77.65 and the mean BMI as 21.42 and that of the females, mean CI was 78.17 and the mean BMI as 21.18 which is in accordance with the study done by Esomonu and Badamasi et.al., where they stated that there was statistically significant difference in the cephalic index of male and female. In the present study it was observed that the majority head type among the children was mesocephalic.

On the other hand, it was observed that the majority of the subjects showed the mesocephalic type of skull in children with normal BMI. This is in accordance with the study done by Emma Rachmawati et al., according to them the most prevalence type of skull among the low BMI subjects were hyperbrachcephalic type which did not altered the thinking capacity of the subjects. Several study conducted on cephalic index in correlation with the BMI on other parts of the world had revealed that the cephalic index of the subjects slightly varies with the BMI without altering the intellectual capacity of an individual. A study done among adults in Gurung community of Nepal also showed the maximum of brachycephalic head type in their population (mean CI=84.6±5.14). A study done by Pandey et. al. among the adults showed that dolichocephalic was predominant in her study done in Nepalese females (CI = 78.36).

As the present study is done in the children of Madheshi community, the CI may be altered in the adult age in other ethnicity of Nepal. Several researchers were interested in comparing several anthropological factors with intelligence where as some were comparing the data of newer generations with older generations and also some were comparing the indices in different groups and ethnicity in similar country. In this study, we particularly focused on the correlation of BMI and CI. Our findings demonstrate that the BMI influences the growth of size of the skull and CI as well.
CONCLUSION

Our findings show that the common pattern of cephalic index was hyperbrachycephalic in the subjects of low BMI whereas the pattern of cephalic index in case of the normal BMI was mesocephalic type in both the male and female subjects. It confirms that the sexual dimorphism exists in case of the low BMI and normal BMI. It also concludes that the growth of the skull and crania are influenced by the body mass index. A large scale study is needed to confirm the relationship including diverse ethnic groups of Nepal.

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