ORIGINAL ARTICLE

COMPARISON OF THE MEAN LENGTH AND WIDTH OF ANTERIOR FONTANEL AMONG NEWBORNS IN UNIVERSITY OF GONDAR COMPREHENSIVE SPECIALIZED HOSPITAL

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ABSTRACT

Background: *Fontanel can be defined as a space where two or more sutures meet. There are six fontanels in the newborn skull, namely anterior, posterior, two mastoid, and two sphenoid fontanels. The anterior fontanel is the most important for clinical evaluation. In Ethiopia, there is a paucity of information regarding the size of anterior fontanel dimensions . Thus, this study aimed to determine and compare the average values of the length and width of the anterior fontanel and to identify the factors that affect the dimensions.*

Method: *An institution-based cross-sectional study was conducted on three hundred eighty-four healthy and term newborns. A systematic sampling technique was used to select study subjects. The data were collected using interviewer-administered questionnaire by interviewing the mothers of the neonates. The examination included assessment of the length and width of the anterior fontanel, birth weight, and head circumference. Socio-demographic, pregnancy, and labor variables were also recorded. Descriptive analysis, simple linear and multiple linear regression analysis were applied to analyze the data.*

Result: *The mean length and width of the anterior fontanel was 3.07 ± 0.69 cm and 2.92 ± 0.61 cm, respectively. Cesarean mode of delivery (ABC (Adjusted B-Coefficient) = 0.09, 95% CI: 0.002, 0.18)), being daily laborer (ABC = -0.23, 95% CI: -0.41, -0.05), width of anterior fontanel (ABC = 0.91, 95% CI: 0.84, 0.98), and head circumference (ABC = 0.03, 95% CI: 0.001, 0.050) were independently associated with length of anterior fontanel. Age of the newborn (ABC= 0.01, 95% CI: 0.008, 0.02) was associated with width of the anterior fontanel.*

Conclusion: *At birth, the mean length of the anterior fontanel was larger than the mean width of the anterior fontanel. This study provides an insight on the mean length and width anterior fontanel for term neonates in the study area. which can serve as a baseline for future larger sample size studies to set reference values for the area..*

Keywords: *Length of anterior fontanel, width of anterior fontanel, comparison, newborns.*

INTRODUCTION

Fontanels are fibrous gaps formed when more than two cranial bones are juxtaposed[1-5]. Sutures are narrow ridges of connective tissue joining the flat bones of the cranium[1, 2]. In the newborn cranium six fontanels are found, namely; anterior, posterior, two mastoid, and two sphenoid fontanels[4, 6-8]. Of six, the prominent fontanels are a triangular posterior fontanel that is located at the junction of the parietal and occipital bones that can admit the tip of a finger or maybe closed at birth, and the largest rhomboid anterior fontanel is located between the two frontal and two parietal bones[3, 4, 6].The mean time of the closure of anterior fontanel is eighteen months but

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usually closes by twelve months[9-11]. However, the closure of the anterior fontanel may happen as early as three months of age, but careful monitoring of head circumference in such cases is crucial to exclude a pathologic condition[4]. The key feature of the anterior fontanel is the variation in size and closure time[4, 5, 12]. Even if the clinical contribution of anterior fontanel examination is essential, anterior fontanel measurement has not been usually undertaken as part of the newborn examination[6, 9, 13]. The anterior fontanel is an integral component of the human infant craniofacial system[2, 4, 6, 7]. It is a space where two or more sutures meet[3, 12]. The sutures and fontanels in the normal cranium, especially the anterior fontanel, permit the growth of the brain relative to the cranial bone growth[2, 4, 14].Besides, the bones of the cranium overlap each other during the labor process for successful delivery [2, 4]. Since the bones of the skull develop in the membrane, the fontanels are important indicators of the process of membranous ossification[7, 15].

Importantly, the diagnosis of an abnormal fontanel needs to recognize the variation of the normal fontanel[3, 4, 7, 9].Understanding the anterior fontanel value is essential to identify many disorders such as craniosynostosis and abnormal brain development that are associated with a very small fontanel or early fontanel closure at birth[3, 13]. Large anterior fontanel size can be correlated with multiple disorders. These include endocrine disorders, congenital infections, chromosomal defects and dysmorphogenesis syndromes, drug and toxin exposure, fetal hydantoin syndrome, aminopterin-induced malformations, aluminum toxicity, and skeletal disorders[4, 9, 10]. Disorders like increased intracranial pressure, dehydration, cardiac diseases, and hydrocephalus are related to the status of anterior fontanel[3, 4, 9,16-18].

Studies conducted elsewhere reported the mean size of anterior fontanel in the first day of the life of newborns [7, 9, 19, 20], the normal range of anterior fontanel dimensions (length and width of anterior fontanel)[20-22],and presented various local reference ranges[23-29]. Since the value of the anterior fontanel is highly variant in human newborns[2], the establishment of appropriate local reference in a specific society is mandatory[3, 6, 29].Notably, abnormal fontanel can indicate a serious medical condition. Thus, it is important to recognize the normal variations of anterior fontanel in different ages, sex, region, and racial groups. This provides a potential clue for the recognition of different medical disorders and abnormal skeletal morphogenesis[4, 9].

Therefore, the present study aimed to determine and compare the average values of the length and width of the anterior fontanel and to identify the factors that affect the dimensions of anterior fontanel among newborns.

METHOD

Study Area, Design, and Period: The research was conducted at the Maternity and Labor/Delivery Ward of the University of Gondar Comprehensive Specialized Hospital (UoGCSH), Gondar, Northwest Ethiopia, using an institution-based analytical cross-sectional study design. This university hospital has over 600 beds in various wards and serves as a referral center for a number of district hospitals in the area. It serves a population of more than seven million people in the surrounding area.

Sample Size determination and Sampling Technique: The sample size was calculated using a single population mean formula by considering the standard

deviation (S) of the mean value of 0.5, 95% of the confidence interval, and 5% margin of error (d). $n = \frac{(Z\alpha/2)^2 * (S)^2}{d^2}$, $= \frac{(1.96)^2 * (0.5)^2}{(0.05)^2}$, n = 384.16. The final sample size of this study was 384 mother-newborns. A systematic random sampling technique was used to select study mother-newborn pairs.

Inclusion and Exclusion Criteria: The research included all apparently healthy term newborns at birth and newborns with a gestational age of 37 to 42 weeks, a birth weight of 2,500 to 4,000 grams, and no pathology affecting the size of the anterior fontanel.

All newborns with extreme molding, cephalohaematoma, caput succedaneum, cranial hemorrhage, apparent chromosomal anomalies, and birth injury of the head region affecting the size of the anterior fontanel were excluded from the study. Multiple pregnancies, newborns of smokers, newborns of drug-using mothers, and maternal illness that could affect fetal development were all omitted from the research.

Variables of the Study: The mean value of the length of the anterior fontanel and the mean value of the width of the anterior fontanel were dependent variables.

Of the independent variables, maternal age, place of residence, marital status, educational status, occupation, and monthly income are socio-demographic variables, and birth order, the onset of labor, duration of labor, mode of delivery, sex of newborn, gestational age, birth weight, and head circumference were pregnancy, labor, outcome, and newborn-related variables.

Data Collection Tools, Techniques, and Procedures: The data wee gathered through an interviewer-administered questionnaire by a direct face-to-face interview with the mothers. Furthermore, the data collection questionnaire was written in English and then translated into Amharic, before being returned to English to ensure continuity and accuracy of meaning. Midwifery health professionals working in the Maternity and Labor/Delivery Ward collected the data, including the measurement of the length and width of the anterior fontanel. The conditions during delivery, maternal socio-demographic variables, birth order, the onset of labor, duration of labor, and mode of delivery were obtained from the mothers and/or attending physicians. The gestational age of newborns was determined by the first date of the last normal menstrual period as reported by the mother and new Ballard score assessment.

The data of birth weight, head circumference, the length of the anterior fontanel, and the width of the anterior fontanel were measured at birth (within twenty-four hours of birth). A balance beam neonate scale was used to measure the weight of newborns. Head circumference was measured using a calibrated non-elastic plastic tape for each newborn. The length and width of the anterior fontanel were measured by inserting the index finger into each of the four vertices and making a small circular mark on the skin distal to the finger with washable ink. Following that, a piece of white paper was firmly put over the fontanel, as described by Davies, et al., to trace the four dots onto the paper[30]. We measured the difference between the anterior and posterior points, as well as between the transversal points, with a new/fresh ruler. The gap between the anterior and posterior points of the anterior fontanel was the length of the anterior fontanel (anterior-posterior dimension). The horizontal gap between the two transverse points of the anterior fontanel was the width of the anterior

fontanel (transverse dimension). The length and width averages were then calculated and compared.

Data Analysis: The collected data were analyzed using Stata Version 14 Statistical Software. Coding and missing values were considered before the analysis. Descriptive analysis was done to describe the frequency and percentage of dependent and independent variables. The mean, standard deviation (SD), median, and interquartile range (IQR) of the two dimensions were analyzed for the independent variables. The mean and SD were calculated for normally distributed continuous variables. The scatter plot was used to present the relationship between the length and width of the anterior fontanel. The percentiles and frequency distributions for the length and width of the anterior fontanel were also calculated. Simple linear regression analysis and multiple linear regression analysis were undertaken to explain the association between the predicted and predictor covariates and independent predictors of the length and width of the anterior fontanel. A crude B-coefficient and adjusted B-coefficient were used to test the associations between independent and dependent variables. Variables that have a P-value of less than or equal to 0.2 at the bivariable analysis were included in the multiple linear regression analysis to control all possible confounding factors simultaneously, AP-value $\leq$ 0.05 was considered statistically significant for all analyses.

RESULT

Characteristics of Study Participants: A total of 384 newborns were involved in the study. Of all newborns, 206 (53.6%) were males and 282 (73.4%) had spontaneous vertex delivery. Of 384 mothers, 166 (43.2%) were in the age group of 26 to 30 years old, 284 (74%) were urban residents, 366 (95.3%) were married, 193 (50.3%) had educational levels from six to twelve grades, and 201 (52.3%) were housewives.

The mean value of the length of anterior fontanel in urban residents was 3.05 cm (± SD, 0.65 cm). The mean value of the width of the anterior fontanel in urban residents was 2.90 cm (± SD, 0.60 cm). The average length of anterior fontanel in males was 3.19 cm and the width of anterior fontanel in males was 3.01 cm. The mean value of the length in cesarean delivery was 3.34 cm and the value of the width in cesarean delivery was 3.15 cm (Table 1).

Continuous variables were checked for the presence of normal distributions. If they were normally distributed, we used the mean and SDs as summary measures. However, if they were not normally distributed, we used the median and IQR as summary measures. The mean age of the mothers was 27 years, and the median age of the newborns after delivery was four hours (Table 2).

The Mean Size of the Length and Width of the Anterior Fontanel: The mean value of the length of the anterior fontanel was 3.07cm (± SD, 0.69 cm with a range of 4.40 cm). Its minimum and maximum values were 1.6 cm and 6.0 cm, respectively. The mean value of the width of the anterior fontanel was 2.92 cm (± SD,0.61 cm with a range of 3.60 cm). Its minimum and maximum values were 1.6 cm and 5.2 cm, respectively. Almost half (49.2) of the newborns had a length size between 3.0 and 3.99 cm. Around 54% of the newborns had a width size between 2.0 and 2.99 cm (Table 3).

Percentile Distribution and the Relationship of the Length and Width of the Anterior Fontanel: Less than five percent of the newborns had the value

of the length of anterior fontanel below 2.1 cm and five percent had the value of the length of anterior fontanel above 4.3 cm. This indicated that ninety percent of the newborns had the length of anterior fontanel between 2.1 and 4.3 cm. Related to the value of the width of anterior fontanel, however, ninety percent of the newborns had the size of the width between 2.0 and 4.0 cm (Table 4).

Table 1: The mean and SD of socio-demographic, pregnancy, labor, and newborn-related characteristics of the dimensions at UoGCSH, Gondar , Northwest Ethiopia

Variables	Mean ± SD of AF length	Mean ± SD of AF width
Place of residence		
Urban	3.05 ± 0.65	2.90 ± 0.60
Rural	3.13 ± 0.78	2.97 ± 0.64
Marital status		
Married	3.08 ± 0.70	2.92 ± 0.62
Divorced	3.08 ± 0.34	2.89 ± 0.38
Single	2.95 ± 0.55	2.88 ± 0.41
Educational level		
Unable to read and write	2.89 ± 0.67	2.77 ± 0.52
Only able to read and write	3.12 ± 0.79	2.93 ± 0.65
From 6-12 grades	3.12 ± 0.72	2.97 ± 0.63
Certificate holder	2.99 ± 0.38	2.94 ± 0.37
Diploma holder	3.08 ± 0.64	2.88 ± 0.64
Degree holder and above	3.19 ± 0.62	3.04 ± 0.60
Occupation		
Housewife	3.14 ± 0.70	2.97 ± 0.62
Merchant	3.03 ± 0.60	2.94 ± 0.58
Government employee	3.17 ± 0.63	2.98 ± 0.60
Daily laborer	2.53 ± 0.55	2.58 ± 0.53
Farmer	2.95 ± 0.84	2.75 ± 0.65
Student	2.93 ± 0.47	2.84 ± 0.29
Monthly income (in birr)		
≤ 600	3.08 ± 0.49	3.05 ± 0.19
601 - 1650	2.86 ± 0.78	2.73 ± 0.61
1651 - 3200	2.98 ± 0.70	2.77 ± 0.60
3201 - 5250	3.12 ± 0.61	3.09 ± 0.65
5251 and above	3.35 ± 0.76	3.09 ± 0.68
Other (no income)	3.11 ± 0.69	2.95 ± 0.60
Onset of labor		
Spontaneous	3.05 ± 0.71	2.92 ± 0.63
Induced	3.16 ± 0.58	2.94 ± 0.52
Mode of delivery		
Spontaneous vertex delivery	2.98 ± 0.59	2.84 ± 0.53
Cesarean section	3.34 ± 0.86	3.15 ± 0.73
Sex		
Male	3.19 ± 0.73	3.01 ± 0.63
Female	2.93 ± 0.62	2.82 ± 0.56

***Key: AF=** Anterior Fontanel; **SD**=Standard Deviation.*

Table 2: The mean, SD, median, and IQR for continuous variables at UoGCSH, Gondar, Northwest Ethiopia

Characteristics	Mean ± SD	Median (IQR)	Min, max value
Age of the respondents (in years)	27.0 ±4.2	-	17.0, 40.0
Birth weight	3.063 ± 0.35	-	2.5, 4.0
Newborn age in hours	-	4.0 (2.0, 7.0)	1.0, 24.0
Head circumference	35.70 ± 1.64	-	31.0, 39.0
Parity /birth order	-	2.0 (1.0, 2.0)	1.0, 11.0
Gestational age	39 ± 1.59	-	37.0, 42.0
Duration of labor	-	9.0 (6.0, 14.0)	1.0, 24.0

***Key: SD**, Standard Deviation; **IQR**, Interquartile Range; **Min**, Minimum Value; **Max**, Maximum Value*

Table 3: The frequency distribution of the dimensions among term newborns at UoGCSH, Gondar, Northwest Ethiopia

Frequency distributions or dimensions	Length of the anterior fontanel Frequency (%)	Width of the anterior Fontanel Frequency (%)
1.00-1.99	11 (2.86)	12 (3.13)
2.00-2.99	147 (38.28)	207 (53.91)
3.00-3.99	189 (49.22)	140 (36.46)
4.00-4.99	26 (6.77)	20 (5.21)
5.00-6.00 cm	11 (2.86)	5 (1.30)
Total	384 (100.0)	384 (100.0)

Table 4: Percentiles of the dimensions of the newborns at UoGCSH, Gondar , Northwest Ethiopia

At birth	Percentiles						
	5^{th}	10^{th}	25^{th}	50^{th}	75^{th}	90^{th}	95^{th}
Length of anterior fontanel	2.1	2.3	2.7	3.05	3.3	3.9	4.3
Width of anterior fontanel	2.0	2.2	2.5	2.9	3.1	3.6	4.0

In the present study, there was a direct positive relationship between the mean value of the length and width of the anterior fontanel. This showed that when the value of the length of the anterior fontanel increases, the value of the width of the anterior fontanel also increases (**Figure 1).**

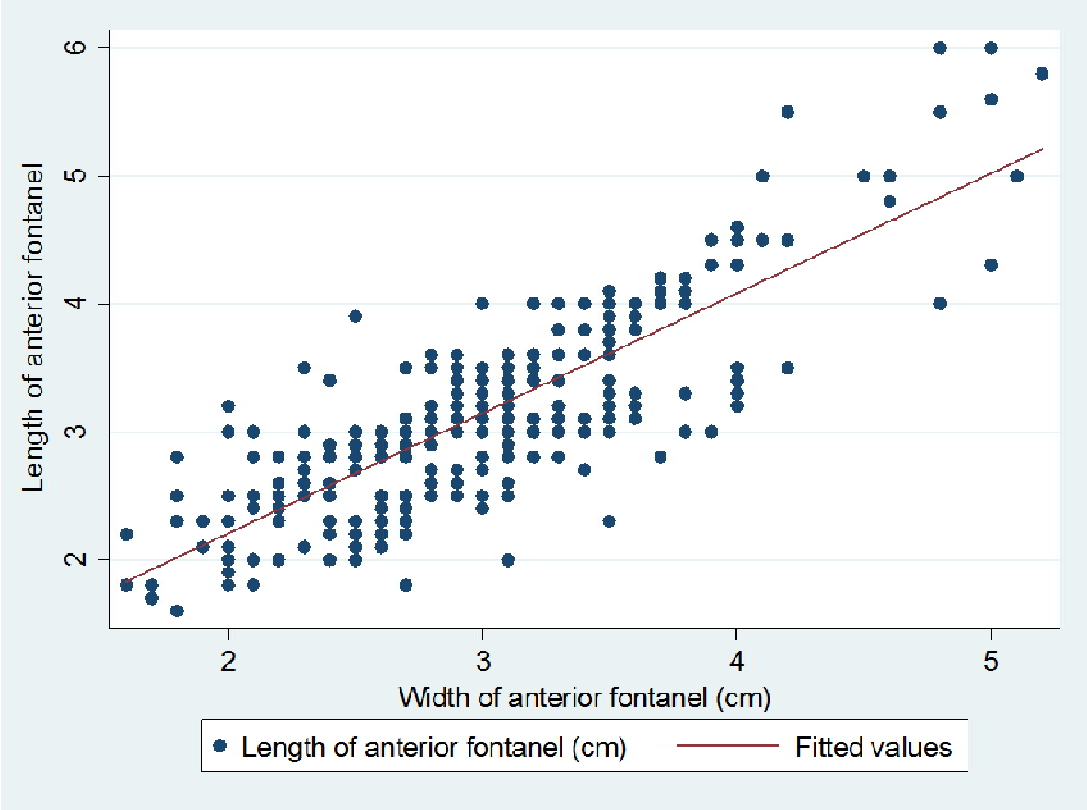

Figure 1: *The scatter plot showing the relationship between the length and width of anterior fontanel among newborns at UoGCSH,* Gondar , Northwest Ethiopia

Factors Associated with the Length of the Anterior Fontanel

Test of Assumptions for Multiple Linear Regression of the Length: In this study, the linearity assumptions were checked using the scatter plot matrix. In normality assumption, the residuals followed a normal distribution. This was checked by using a kernel density plot of the histogram. There were no patterns to the residuals plotted against the fitted values in the equality of the variance assumptions. The mean VIF (Variance Inflation Factor) was 1.1, which is less than five, and it indicates there was no multicollinearity between variables. Other assumptions like the independence of residuals and the outlier observations were checked and fulfilled. Model summary: Adjusted R square value was 0.69; so, the model had a good fit. Based on the adjusted R square (0.69) value, the model has explained 69% of the original variability, but the remaining 31% is the residual variability. Therefore, the adjusted R-square implies that about 69% of the variation in the value of the length of the anterior fontanel was explained by the regression model. In the ANOVA (Analysis of Variance) table, the F test was 87.6 and the P-value was less than 0.0001. Thus, we can say that the regression model is better than the one-way ANOVA model and at least one of the coefficients was different from zero.

Simple linear regression analysis showed that the educational level, occupation, mode of delivery, sex (for instance, the average value of the length in females was 0.26 times lower than in males), birth weight, the width of anterior fontanel, head circumference, and the age of the newborn were factors

associated with the value of the length of anterior fontanel. Variables that show statistically significant association in simple linear regression were entered in to a multiple linear regression to rule out the confounders. Therefore, the average size of the length of anterior fontanel in cesarean delivery was 0.09 times higher as compared to the size of spontaneous vertex delivery, after adjusting for covariates. The length of anterior fontanel in newborns of the daily laborer mothers was decreased significantly by 0.23 as compared to the length of anterior fontanel in their counterparts, by keeping all other variables constant. For a unit (cm) increase in the size of the width of the anterior fontanel, the expected size of the length of the anterior fontanel increases, on average, by 0.91 cm. The length of the anterior fontanel of the newborn was increased significantly by 0.03 cm for each additional unit of the size of the head circumference, by keeping all other variables constant (Table 5).

Factors Associated with the Width of the Anterior Fontanel

Test of Assumptions for Multiple Linear Regression of the Width: The regression model assumptions of the width of the anterior fontanel were checked similarly to the model assumptions of the length of the anterior fontanel. Assumptions were fulfilled to do a multiple linear regression analysis. The mean VIF was 1.5, which is less than five, indicating there was no multicollinearity. In model summary: the value of the adjusted R square was 0.691, the model had a good fit. Therefore, the adjusted R square implies that the regression model explained about 69.1% of the variation in size of the width of the anterior fontanel. In the ANOVA table, the F test was 58 and the P-value was less than 0.0001. Thus, we can say that the regression model is better than the one-way ANOVA model.

Simple linear regression analysis showed that the educational level, occupation, mode of delivery, sex, the length of anterior fontanel, head circumference, and the age of the newborn were factors associated with the size of the width of anterior fontanel. Variables that show statistically significant association in simple linear regression were entered into a multiple linear regression analysis to rule out the confounders. After adjusting for covariates, the average size of the width of anterior fontanel in the newborns was increased significantly by 0.01 for each additional one unit (hour) of the age of the newborn after birth. For a unit (one cm) increase in the size of the length of the anterior fontanel, the expected size of the width of the anterior fontanel of the newborn increases, on average, by 0.70 cm, by keeping all other variables constant (Table 6).

Table 5: Multiple linear regression analysis on the length of the anterior fontanel at UoGCSH, Gondar , Northwest Ethiopia

Variables	B-Coefficient (95% CI)	Adjusted B-Coefficient (95% CI)
Age of the respondent	0.001 (-0.016, 0.017)	-
Place of residence		
Urban	1.00	-
Rural	0.08 (-0.08, 0.24)	-
Marital status		
Married	1.00	-
Divorced	-0.001 (-0.49, 0.49)	-
Single	-0.13 (-0.56, 0.31)	-
Educational level		
Unable to read and write	1.00	1.00
Only able to read and write	0.23 (-0.11, 0.57)	0.08 (-0.11, 0.28)
From 6-12 grades	0.23 (0.05, 0.42)*	0.05 (-0.06, 0.16)
Certificate holder	0.10 (-0.38, 0.58)	-0.01 (-0.30, 0.27)
Diploma holder	0.19 (-0.06, 0.43)	0.05 (-0.11, 0.21)
Degree holder and above	0.30 (0.02, 0.58)*	0.003 (-0.21, 0.22)
Occupation		
Housewife	1.00	1.00
Merchant	-0.10 (-0.33, 0.13)	-0.06 (-0.19, 0.07)
Government employee	0.03 (-0.15, 0.22)	0.01 (-0.09, 0.12)
Daily laborer	-0.60 (-0.92, -0.28)*	-0.23 (-0.41, -0.05)*
Farmer	-0.19 (-0.43, 0.05)	0.07 (-0.07, 0.21)
Student	-0.21 (-0.53, 0.11)	-0.10 (-0.29, 0.08)
Monthly income (in birr)		
≤ 600	1.00	-
601 - 1650	-0.22 (-0.69, 0.25)	-
1651 - 3200	-0.10 (-0.54, 0.34)	-
3201 - 5250	0.04 (-0.42, 0.50)	-
5251 and above	0.26 (-0.31, 0.84)	-
Other (no income)	0.03 (-0.39, 0.44)	-
Onset of labor		
Spontaneous	1.00	-
Induced	0.10 (-0.07, 0.28)	-
Mode of delivery		
Spontaneous vertex delivery	1.00	1.00
Cesarean section	0.37 (0.21, 0.52)*	0.09 (0.002, 0.18)*
Sex		
Male	1.00	1.00
Female	-0.26 (-0.40, -0.13)*	-0.06 (-0.14, 0.02)
Birth weight	0.24 (0.05, 0.44)*	0.07 (-0.06, 0.20)
Age in hours	0.02 (0.005, 0.03)*	-0.01 (-0.01, 0.002)
Width of anterior fontanel	0.94 (0.88, 1.004)*	0.91 (0.84, 0.98)*
Head circumference	0.08 (0.03, 0.12)*	0.03 (0.001, 0.050)*
Birth order	0.05 (-0.01, 0.12)	-
Gestational age	0.003 (-0.04, 0.05)	-
Duration of labor	-0.008 (-0.02, 0.004)	-

Key: * *statistically significant at P-value ≤ 0.05 in simple linear and multiple linear regression analysis.*
CI, Confidence Interval

Table 6: Multiple linear regression analysis on the width of the anterior fontanel at UoGCSH, Gondar, Northwest Ethiopia

Variables	B-Coefficient (95% CI)	Adjusted B-Coefficient (95% CI)
Age of the respondent	-0.001 (-0.02, 0.01)	-
Place of residence		
Urban	1.00	-
Rural	0.07 (-0.07, 0.20)	-
Marital status		
Married	1.00	-
Divorced	-0.04 (-0.46, 0.39)	-
Single	-0.04 (-0.43, 0.34)	-
Educational level		
Unable to read and write	1.00	1.00
Only able to read and write	0.16 (-0.14, 0.46)	-0.03 (-0.20, 0.14)
From 6-12 grades	0.19 (0.03, 0.36)*	0.02 (-0.08, 0.12)
Certificate holder	0.17 (-0.25, 0.59)	-0.005 (-0.25, 0.24)
Diploma holder	0.11 (-0.10, 0.32)	-0.04 (-0.18, 0.11)
Degree holder and above	0.27 (0.02, 0.51)*	0.06 (-0.13, 0.24)
Occupation		
Housewife	1.00	1.00
Merchant	-0.02 (-0.23, 0.18)	0.04 (-0.08, 0.16)
Government employee	0.01 (-0.15, 0.18)	-0.04 (-0.17, 0.10)
Daily laborer	-0.38 (-0.67, -0.10)*	0.02 (-0.14, 0.18)
Farmer	-0.22 (-0.43, -0.003)*	-0.10 (-0.24, 0.03)
Student	-0.13 (-0.41, 0.15)	0.05 (-0.12, 0.21)
Monthly income (in birr)		
≤ 600	1.00	-
601 - 1650	-0.32 (-0.73, 0.09)	-
1651 - 3200	-0.28 (-0.67, 0.10)	-
3201 - 5250	0.04 (-0.36, 0.44)	-
5251 and above	0.04 (-0.47, 0.54)	-
Other (no income)	-0.10 (-0.47, 0.26)	-
Onset of labor		
Spontaneous	1.00	-
Induced	0.03 (-0.12, 0.18)	-
Mode of delivery		
Spontaneous vertex delivery	1.00	1.00
Cesarean section	0.31 (0.17, 0.44)*	0.04 (-0.04, 0.12)
Sex		
Male	1.00	1.00
Female	-0.20 (-0.32, -0.08)*	-0.02 (-0.09, 0.05)
Birth weight	0.13 (-0.04, 0.31)	-
Age in hours	0.03 (0.02, 0.04)*	0.01 (0.008, 0.02)*
Length of anterior fontanel	0.73 (0.68, 0.78)*	0.70 (0.65, 0.76)*
Head circumference	0.05 (0.02, 0.09)*	0.0005 (-0.02, 0.02)
Birth order	0.04 (-0.02, 0.09)	-
Gestational age	-0.003 (-0.04, 0.05)	-
Duration of labor	-0.006 (-0.02, 0.005)	-

***Key:** * statistically significant at P-value ≤ 0.05 in simple linear and multiple linear regression analysis. CI, Confidence Interval*

DISCUSSION

This institution-based study was employed to determine the mean value of the length and width of the anterior fontanel and to identify factors associated with the length and width of the anterior fontanel at UoGCSH. This study used the Popich and Smith method for measuring the length and width of anterior fontanel in apparently healthy term newborns on the first day of life. This study intended to identify the presence of mean size difference between the length and width of anterior fontanel and their associations with variables were analyzed. The mode of delivery, occupational status, the width of the anterior fontanel, and head circumference were significantly associated with the length of the anterior fontanel. The age of a newborn and the length of the anterior fontanel were positively associated with the size of the width of anterior fontanel. The mean size of the length of the anterior fontanel had a significant positive relationship with the size of the width of the anterior fontanel in newborns.

In the present study, the mean value of the length of the anterior fontanel was 3.07 ± 0.69 cm. The mean value of the width of the anterior fontanel was 2.92 ± 0.61 cm. The range value of the length was 4.4 whereas it was 3.6 for the value of the width. This shows that the mean value of the length of the anterior fontanel was larger by 0.15 cm than the mean value of the width of the anterior fontanel. Besides, t he size of the length of the anterior fontanel had a positive relationship with the size of the width. These values of the length and width of the anterior fontanel are in line with the different studies conducted elsewhere[12, 19-22]. The mean anterior-posterior and transverse dimensions were calculated in the study conducted in Sri Lankan term newborns and reported the mean value of the length and width of the anterior fontanel was 2.60 cm and 2.49 cm, respectively. They reported that the length of the anterior fontanel is greater than the width of the anterior fontanel for both sexes[19]. A study conducted in Caucasian Americans laid the foundation for the size of anterior fontanel and reported greater variation of measurement from newborn to newborn living in the same environment. The mean anterior-posterior and transverse dimensions were taken into accounts and the mean size of the length was greater than the width of the anterior fontanel[23]. Besides, a study done on black and white term newborns in the United States of America revealed a significant difference in the mean size of the dimensions and reported the mean size of the dimensions for the white and black newborns[25].

An Asian study between hilly and non-hilly Indian newborns, which was determined according to the Popich and Smith methods, indicated the presence of significant difference in the size of the dimensions of anterior fontanel [31]. In Southeastern Nigeria, Igbo, the size of anterior fontanel in healthy term newborns was determined after taking the measurements using a well-known technique designed by Popich and Smith and reported the mean anterior-posterior dimension was significantly longer than the mean transverse dimension of anterior fontanel[32].A study conducted in Jimma University Medical Center reported, as the current study, that the mean anterior-posterior dimension was greater than the transverse dimension. Besides, a statistically significant difference was detected between the two dimensions [12].

In the current study, socio-demographic, pregnancy, labor, outcome, and newborn-related factors were

assessed for their association with the length and width of anterior fontanel size. The mean size of the length of the cesarean section group was significantly higher by a factor of 0.09 than the spontaneous vertex delivery group and the difference may be due to the effect of molding. This finding is strongly supported by the study conducted in Iran[9]. The length of anterior fontanel showed a significant negative relationship in newborns of daily laborer mothers. Similarly, a significant difference among the groups of occupational status was found in the study conducted in Jimma University Medical Center [12].The difference in a relationship between the groups may be due to the difference in the level of knowledge to accomplish their daily living activities (difference in lifestyle). Nutrition has also an impact on the size of anterior fontanel in newborns.For a unit increase in the value of the width, the expected size of the length of anterior fontanel in the newborn increases. This indicated that there is a direct relationship between the two dimensions. As the length of the fontanel of the newborn increases, the value of the head circumference increases (significant direct correlation between the value of fontanel and head circumference) .This finding is strongly supported by the findings of the previous studies[3, 12, 13, 26, 33].As the age of the newborn increases in hours, the value of the width of the fontanel increases. This finding showed that the effect of molding decreases after birth as the age of the newborn advances.

CONCLUSION

In the present study, the mean value of the length and width of the anterior fontanel for the study participants was determined. After adjusting for covariates, factors like the mode of delivery, the occupational status of the respondent, the width of the fontanel, and the head circumference were independently associated with the value of the length of the anterior fontanel. The age of the newborn after delivery and the value of the length of the fontanel were independently and positively associated with the value of the width of the anterior fontanel. The value of the length of the fontanel had a significant positive relationship with the value of the width of the anterior fontanel. When we compared the length of the fontanel with the width of the anterior fontanel, the length of the anterior fontanel has almost similar to the value of the anterior fontanel in all aspects.

This study provides the mean value of the length and width of the anterior fontanel for term neonates in the study area, which can serve as the local reference value for clinical use. There may also be variations in fontanel dimension size in different regions of Ethiopian neonates. Therefore, we recommend that it is important to determine appropriate local references of fontanel size in different regions of Ethiopia to establish a national reference standard of fontanel size in order to avoid errors in interpretation.

Abbreviations: ABC: Adjusted B-Coefficient, ANOVA: Analysis Of Variance; CI: Confidence Interval; IQR: Inter-quartile Range; SD: Standard Deviation; UoGCSH: University of Gondar Comprehensive Specialized Hospital; VIF: Variance Inflation Factor.

Ethical approval and consent to participate: The School of Medicine, College of Medicine and Health Sciences, University of Gondar Ethical Review Committee granted approval letter for ethical clearance. All measurements were taken without causing any harm to the baby. Following a thorough description

of the study's goals to all newborns' mothers (or legal guardians), written informed consent was taken, and details were kept confidential, and records were kept under password protection. The research was carried out in compliance with the Helsinki Declaration.

Availability of Data and Materials

The data sets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for Publication: "Not applicable".

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