Statistical characteristics of anterior fontanelle size at birth of term Sri Lankan new borns: a descriptive cross sectional study

P J Perera[1], **A R Wickramasinghe**[2], **N Ranathunga**[3], **M P Fernanado**[1], **D Warnakulasooriya**[3]

(Index words: anterior fontanelle, new born, birth weight)

Abstract

Introduction Assessing the anterior fontanelle size is an important component of routine neonatal examination. For meaningful interpretation of fontanelle size, normal reference values are essential. Normal values for the fontanelle size in Sri Lankan newborns are not available.

Objectives To investigate characteristics of anterior fontanelle size at birth in Sri Lankan babies.

Methods A descriptive cross sectional study was carried out between October and November 2010. Horizontal and vertical dimensions of the anterior fontanelle were measured in 2215 normal term babies, between 12 to 24 hours after birth. A practical and simple method was used to measure fontanelle size. Average fontanelle size was calculated by adding horizontal and vertical dimensions and dividing by two.

Results Mean of the average fontanelle size for the total sample was 2.55 cm (for males 2.57 cm and for females 2.52 cm). Longitudinal dimension was significantly higher than the horizontal in both sexes ($p<0.001$). Frequency distribution curves of fontanelle size followed a normal distribution in both sexes. The ninety seventh centile and third centile for the average fontanelle size were 4.5 cm and 0.9 cm respectively.

Conclusions Babies with an average anterior fontanelle size more than 4.5 cm or less than 0.9 cm need further follow up. Further studies are needed to evaluate the accuracy of these cut off values.

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Introduction

Assessing the anterior fontanelle size is an important component of routine neonatal examination. Size and shape of the anterior fontanelle varies widely at birth. Conditions such as hypothyroidism, hypophosphataemia, achondroplasia, raised intracranial pressure, chromosomal abnormalities, rickets and other skeletal dysplasia may give rise to a large anterior fontanelle [1]. Conditions that result in shrinkage of the brain such as birth asphyxia and congenital infections like rubella will result in small anterior fontanelle [2]. Hence, the size of the anterior fontanelle may be an useful clinical sign in early diagnosis of these conditions, for which the statistical characteristics of the normal anterior fontanelle should be known.

Some define the size of anterior fontanelle as the average of the longitudinal and horizontal dimensions while others define the anterior fontanelle size according to the surface area [3, 5]. Measuring the anterior fontanelle is not straight forward because its shape varies widely. Davies *et al* used a marker pen to mark the corners on the scalp which was later transferred to a paper. Mathur *et al* used a caliper with blunt ends to mark the corners [6]. Popich and Smith marked the corners on the scalp with a coloured pen and measured the distance using a steel tape [3]. A simple, repeatable and practical method is needed to measure the anterior fontanelle size, if it is to be used in clinical practice.

The fontanelle on the first day of life ranges from 0.6 cm to 3.6 cm, with a mean of 2.1 cm [3]. An Indian study which considered average of longitudinal and transverse diameters as the fontanelle size, reported a mean of 3.37 cm [6]. A similar study from Iran reported a mean anterior fontanelle size of 2.53 cm and showed that boys had a significantly larger fontanelle size than girls. The Iranian study also showed a significant negative correlation between fontanelle size and weight and length at birth, but no correlation with head circumference [7]. Another study has shown a negative correlation between fontanelle size and weight and length at birth [8].

As with other biological parameters, variations in fontanelle size reported in different studies may due to genetic and environmental factors or the method used to measure the fontanelle. There are no data available for fontanelle size in Sri Lankan babies. This study was carried out to describe the statistical characteristics of the anterior fontanelle size at birth of normal term Sri Lankan neonates, and to compare it with figures from other studies by studying a sample of babies born in hospitals in the Gampaha district of Sri Lanka.

Departments of [1]*Paediatrics,* [2]*Public Health and* [3]*Clinical Skills Laboratory, Faculty of Medicine, University of Kelaniya, Ragama, Sri Lanka.*

Correspondence: PJP, *e-mail: <priyanthaprr@gmail.com>.* *Received 14 December 2012 and revised version accepted 9 February 2013. Competing interests: none declared.*

Methods

Gampaha district has the second highest population density in Sri Lanka. It comprises 12% of the country's population. In 2007, 28,848 babies were born in the Gampaha district, 99% taking place in hospitals [9]. There are four main government hospitals and number of private hospitals in the district. Babies born during October and November 2011, in all four main government hospitals and six private hospitals were recruited for the study.

A sample of 2193 babies were required to estimate a mean fontanelle size of 2.5 cm with a standard deviation of 1.0 cm, assuming that simple random sampling will be used with an alpha error of 0.025 and there will be a 10% loss of babies. Babies who had gestational age confirmed by early ultrasonography and born after a gestational period of 37 weeks were recruited into the study. Babies with intra-uterine growth retardation, chromosomal abnormalities, multiple congenital abnormalities and excessive moulding were excluded. Multiple pregnancies and babies of diabetic mothers were also excluded. A total of 2215 babies who fulfilled the inclusion criteria were recruited consecutively into the study. Informed written consent was obtained from the mother.

During vaginal delivery skull bones move towards each other to facilitate the delivery, resulting in moulding of the skull. Mild to moderate moulding settles by 24 to 48 hours after birth. Severe moulding indicated by over-lapping skull bones may persist even few weeks [10, 11]. Babies born by uncomplicated normal vaginal deliveries are discharged from the hospital within 24 hours. Turning this into consideration and allowing maximum time for moulding to settle, fontanelle size was measured between 12 to 24 hours after the delivery. Babies with any degree of overriding skull bones by 24 hours were excluded from the study. With careful consideration to methods used in previous studies, following method was used to measure the fontanelle size. Two examiners examined each child. One examiner brought his index fingers along the anterior borders of the fontanelle. The meeting point of fingers was taken as the anterior corner of the fontanelle (Figure 1).

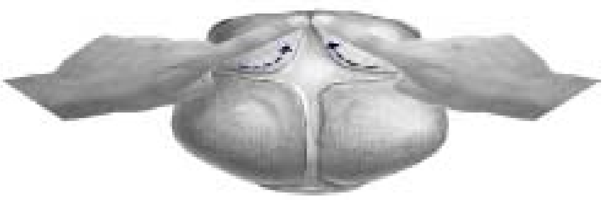

Figure 1. **Method used to identify the corners of the fontanelle.**

Other corners of the fontanelle were found in the same manner; one examiner marked the corners of the vertical and horizontal dimensions while the other measured the distance using a non-stretchable plastic tape. Measurement was recorded to the first decimal in centimeters. Birth weight was measured using a beam balance weighing scale and recorded to the 2nd decimal in kilograms, while length was measured to the 1st decimal in centimeters using a foldable infantmeter. Measurements were done by 8 pre-intern doctors, who had one week training on measurement under the principle investigator. During training each pre-intern doctor made ten measurements which were also measured by the principle investigator. Kappa scores were calculated to assess the agreement between the principle investigator and each pre-intern doctor. The Kappa scores varied between 0.88 and 0.92 indicating high degree of agreement between pre-intern doctors and the principle investigator. Each hospital was visited weekly during the study period by the principle investigator to ensure that the correct method was employed during measurements. Recorded measurements from each hospital were reviewed weekly to check for compatibility of data.

Descriptive statistics and frequency tabulations were generated using SPSS version 16. Independent student t-test was used to compare two means and Pearson correlation co efficiency was used to assess correlation between variables. Approval was obtained from the Ethics Review Committee of the Faculty of Medicine, University of Kelaniya.

Results

There were 1127 female and 1088 male babies in the sample. Of the 2,215 babies, 80 (3.6%) were born in private hospitals. There were 384 (17.3%) babies with period of gestation (POG) of 37 weeks and 62 (2.8%) babies with a POG of over 40 weeks. The rest had POG between 38 and 40 weeks (Table 1).

Table 1. Distribution of the sample according to the period of gestation at delivery

Period of Amenorrhoea	*Frequency (n=2215)*	*Percentage*
37	384	17.3
38	552	24.9
39	625	28.2
40	592	26.4
41	60	2.7
42	2	0.1

Mean longitudinal dimension was significantly higher than horizontal dimension in both sexes ($p<0.001$). Both longitudinal and horizontal dimensions were higher in males than in females, but the difference was not statistically significant. Longitudinal dimensions had a wider variation than horizontal dimensions in both sexes. The statistical characteristics of averages of longitudinal and horizontal dimensions by sex are given in Table 2. Characteristics of longitudinal and horizontal dimensions are also included separately.

Table 2. Statistical characteristics of anterior fontanelle dimensions by sex

	Total sample			*Females*			*Males*		
Measurement	*Longitudinal*	*Horizontal*	*Average*	*Longitudinal*	*Horizontal*	*Average*	*Longitudinal*	*Horizontal*	*Average*
Sample size	2215	2215	2215	1127	1127	1127	1088	1088	1088
Mean	2.60	2.49	2.55	2.59	2.46	2.52	2.62	2.53	2.57
SD	1.01	0.98	0.92	1.01	0.97	0.92	1.01	1.00	0.92
3rd centile	0.95	0.80	0.90	1.00	0.80	0.99	0.63	0.50	0.78
10th centile	1.50	1.30	1.50	1.40	1.40	1.50	1.50	1.20	1.35
25th centile	2.00	2.00	2.00	2.00	2.00	1.95	2.00	2.00	2.00
50th centile	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50
75th centile	3.20	3.00	3.15	3.10	3.00	3.05	3.20	3.00	3.25
90th centile	4.00	3.80	3.75	4.00	3.80	3.75	4.00	3.81	3.75
97th centile	4.50	4.50	4.50	4.62	4.50	4.50	4.50	4.50	4.32

Figure 2 shows the frequency distribution of average fontanelle size. Both longitudinal and horizontal dimensions of the total sample and by sex showed a similar distribution.

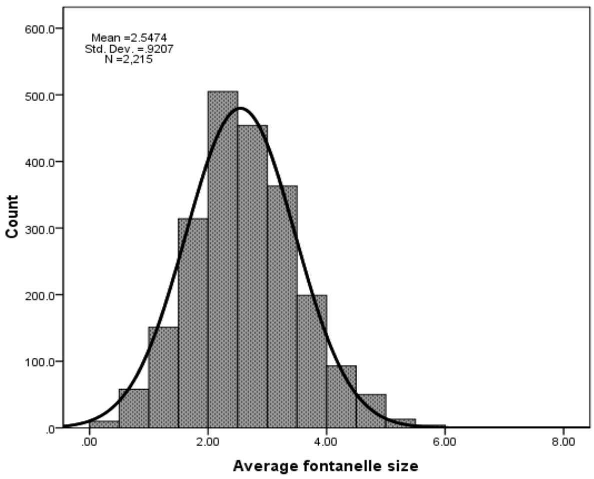

Figure 2. **Frequency distribution of anterior fontanelle size at birth.**

The length of babies at birth showed a statistically significant positive correlation with average fontanelle size (p=0.003). The positive correlation between birth weight and average fontanelle size was not statistically significant (p=0.06). The negative correlation between head circumference and average fontanelle size also not significant (p=0.386).

Discussion

Because of the large sample size, longitudinal and the horizontal dimensions and the average of the two were normally distributed. Both the longitudinal and the horizontal measurements were higher in males than in females but the differences were not statistically significant (p>0.05), which is similar to the findings of others [3]. The mean longitudinal measurement was significantly higher than the mean horizontal measurement in both sexes. The mean of the averages of longitudinal and horizontal measurements was 2.55 cm which is similar to that reported in an Iranian study, but was higher than the findings of Popich et al (2.1 cm) [7]. The difference of results in this study compared to that of Popich et al could be due to the difference in the method used by them to identify the corners of the fontanelle. In the study by Popich et al the examiner placed the index finger at each corner of the fontanelle to locate the edge. Mean fontanelle size described by Mathur et al (3.37 cm) is higher than results from other studies [6]. The high value obtained by Mathur et al could be due to the method of measurement, where a caliper with blunt ends was used. In some babies margins of fontanelle do not meet but simply merge with suture lines. If tips of a caliper were placed simply at the edges of the fontanelle in such a baby, it will result in a falsely higher measurement. Greater inter-observer variability is more likely with this method because different observers might place the tips at different sites. Significantly different values described by different studies indicate the importance of having an universally accepted method of measuring anterior fontanelle size, similar to ones used for measuring length and head circumference.

Compared to methods described in other studies to identify corners of the fontanelle, inter-observer error is possible in the method used in our study as well. High Kappa scores obtained with this method indicates that inter-observer variation is within acceptable limits. Our objective was to develop a practical method that is feasible in day to day clinical practice and during routine neonatal examinations. The method described in this study is easy to understand even for a primary health care worker and does not involve any instruments or complicated mathematical calculations, which makes it suitable for a busy postnatal setting. Using a caliper many results in the mother thinking that it might hurt the baby and also likely to cause higher inter-observer variation when margins of the fontanelle are not clear. Fontanelle size is used as a screening tool, not a diagnostic tool, therefore even minor inter-observer variations are not likely to do any harm. Having an objective method of measuring fontanelle with minor inter-observer variations is better than the present method of assessing fontanelle size, which is by simply feeling the fontanelle and deciding whether it is large or small.

All babies with large or small anterior fontanelle may not be abnormal. It is useful screening tool to decide which neonate needs further investigations. This is especially important in congenital hypothyroidism, where early diagnosis and treatment will prevent permanent neurological damage [12]. Clinical features of congenital hypothyroidism, at the time of birth, are minimal and difficult to identify [13]. In developed countries, neonatal screening is done to detect congenital hypothyroidism early. According to the incidence of congenital hypothyroidism, about 4000 babies should be screened to pick up one baby with hypothyroidism [12]. For a country like Sri Lanka with limited resources, screening all babies for hypothyroidism may be too expensive and not cost effective. However, screening babies with large anterior fontanelle for hypothyroidism is feasible and affordable, as this will reduce the number needed to be screened. As dimensions of anterior fontanelle are described by this study, a systematic study will show the cost effectiveness of screening babies with a large anterior fontanelle at birth for hypothyroidism and other associated disorders.

Expressing the size of the anterior fontanelle in terms of longitudinal and horizontal dimensions has a major limitation as the fontanelle is not a perfect rectangle. The margins of the fontanelle are curved lines. In some babies the curvature is less, while in others it is large. When comparing two babies with the same longitudinal and horizontal dimensions, a baby with greater curvatures will have a less overall surface area than a baby with lesser curvature. Measuring the surface area of the fontanelle involves complex mathematical calculations that are not suitable or practical in a clinical setting like a busy post-natal ward. As there is a statistically significant difference in longitudinal and horizontal dimensions, expressing the size of the fontanelle as the average of longitudinal and horizontal dimensions may be more appropriate.

Both Shajari *et al* and Duc *et al* found that fontanelle size at birth negatively correlated with birth weight and length. However, in this study we have found a positive correlation between fontanelle size and birth length. Reasons and the clinical significance of this observation are difficult to explain. In our study a negative correlation was observed between anterior fontanelle size and head circumference, but this was not statistically significant.

One of the main objectives of this study was to identify the cut off values for anterior fontanelle dimensions to be used as a screening tool. Based on statistical considerations and assuming that this cohort were normal babies, we would recommend that any baby with a longitudinal or a horizontal anterior fontanelle dimension of more than 4.5 cm (97th centile) and any baby with a longitudinal and a horizontal anterior fontanelle dimension less than 0.9 cm and 0.8 cm (3rd centile) respectively, should be followed up for a possible underlying abnormality. If average of the two dimensions are considered 4.5 cm and 0.9 cm can be used as upper and lower cut off values respectively.

Possible inter-observer variation was the main limitation in this study. High Kappa scores observed between principal investigator and pre-interns suggest this bias was minimal. Data from different centers were analysed separately and there was no significant difference in means, which further confirm the accuracy of data. Significant moulding can influence the size of the fontanelle. Duration taken for moulding to settle varies with degree of moulding [10]. As majority of babies born vaginally are discharged within 24 hours, measurements had to be taken within 24 hours. To minimise the error involved, we excluded babies with any degree of overriding skull bones by 24 hours after birth. Therefore, statistics given are applicable only to babies without significant moulding.

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Incidence and risk factors of falls among the elderly in the district of Colombo

A D Ranaweera[1], **P Fonseka**[2], **A PattiyaArachchi**[3], **S H Siribaddana**[4]

(Index words: elderly, falls, incidence, risk factors)

Abstract

Objectives To assess the incidence and risk factors of falls among the elderly in the District of Colombo.

Methods Incidence of falls was assessed by a community based descriptive study with prospective follow up. Risk factors for falls were assessed by a nested case control study. Participants above 65 years residing in 40 Grama Niladhari Divisions in the Colombo district (n=1200) were assessed for falls and followed up for four months. Those who had falls were selected as cases (n=151), while two controls per case were selected from others.

Measurements Tests for gait problems, disability, cognitive impairment and vision.

Results The incidence rate of falls was 492 per 1000 person years (95% CI 448-536). Risk factors for falls identified in the multivariate analysis were falls in the previous year (OR 4.67), high disability level (OR 2.04) and high house risk level (OR 1.68).

Conclusions The high incidence of falls among the elderly reported in this study and the preventable risk factors identify / indicate the necessity and feasibility of their prevention.

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Introduction

The Sri Lankan population is ageing rapidly. In 2001, 10% of Sri Lankans were over 60 years old and by 2030 it is expected to be 22% [1]. Falls are a leading cause of disability and death in the elderly [2]. Each year 28-35% of people over 65 years and 32-42% of people over 70 years fall [3]. The frequency of falls increases with age and frailty. Incidence of falls in United Kingdom, China and Japan are 22.4%, 19.3% and 20% per year respectively [3, 4]. In India the frequency of falls over six months was 14%.

Falls in the elderly result in fractures: mainly in hip, spine, arms, ankles, and legs [6]. The strongest single risk factor for fractures is falls not osteoporosis [7]. Falls are predictable and preventable, but if no precautions are taken, falls can occur repeatedly [8]. There is evidence that a number of interventions prevent falls [9].

Information on falls in the elderly is limited in Sri Lanka as well as other developing countries. A hospital based study of elderly in the district of Colombo found that, 23% of the people who were over 65 years fell in a year [10]. A hospital based study on hip fracture in the same district recommended community based studies on falls [11]. This study was conducted to assess the

[1]*Postgraduate Institute of Medicine, Colombo,* [2]*Department of Community Medicine, Faculty of Medical Sciences, University of Sri Jayawardanepura,* [3]*National Hospital of Sri Lanka and* [4]*Department of Medicine, Faculty of Medicine and Allied Sciences, University of Rajarata, Sri Lanka.*

Correspondence: ADR, *e-mail: <dranaweera90@gmail.com>.* *Received 7 January 2013 and revised version accepted 9 February 2013. Competing interests: none declared.*