VOLUME-8, ISSUE-6, JUNE-2019 • PRINT ISSN No. 2277 - 8160

Original Research Paper

Paediatrics

ASSESSMENT OF HEAD CIRCUMFERENCE AND CORE BODY TEMPERATURE IN RELATION TO BIRTH WEIGHT OF TERM EARLY NEONATES

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ABSTRACT Newborn babies are unique in their physiology and encountered health-related problems. Birth weight is generally used as a yardstick of maturity because of its sensitive correlation with gestation and is also considered to be an important determinant of child survival and development. An early identification and immediate direct interventions may result in high-risk infants catching up with their healthy contemporaries, which warrant the need for simple, alternate and reliable predictor(s) of birth-weight - especially during non-institutional deliveries with limited resources. This tertiary care-based observational study included recording and analysis of birth-weight, axillary temperature and head circumference of 500 apparently healthy, singleton, term early neonates. These three parameters significantly ($p<0.0001$) correlated with each other and thus the later two shows promise in serving the purpose. Considering the limitations inherent to the study, need for further exploration to set new standards of normal ranges for the said alternate predictors of birth weight is suggested.

KEYWORDS : Early term neonate, Core Body Temperature, Birth Weight, Head Circumference, Alternate Predictors

INTRODUCTION

As per India Demographics Profile (2018), the birth rate is recorded to be 19 per 1000 population, which corresponds to around 25 millions (according to July, 2017 estimate) of childbirths in India every year [1]. These newborn babies are unique in their physiology and health-related problems that they encounter. Neonatal period is referred to be the first 28 days after birth while the first week of life (i.e. <7 days of age) is considered to be the early neonatal period and the rest is known as late neonatal period. This neonatal period is characterized by transition to extra-uterine life and exquisitely rapid growth and development. This phase in life is also identified to be associated with the greatest risk of mortality, as almost 50% of under-five childhood death occurs during this neonatal period [1,2]. A term baby is referred to as any neonate born between 37 weeks (completed) and 42 weeks (completed) of gestation, irrespective of the birth weight [3]. Birth weight is generally used as a yardstick of maturity because of its correlation with gestation and ease of recording in hospital setting, and it is also considered to be an important determinant of child survival and development [4]. A neonate weighing 1.5 kg to less than 2.5 kg, irrespective of gestational age is referred to as 'Low Birth Weight (LBW)', while those weighing less than 1.5 kg are called as 'Very Low Birth Weight (VLBW)' [3,5].

Perinatal risk assessment by weight percentile criteria have been shown to be insufficient, which warrants additional proxy indicators to improve evaluation. An early identification and immediate direct interventions may result in high-risk infants catching up with their healthy contemporaries. Further in developing countries like India, where non-institutional deliveries still comprise to be a substantial portion and most of which are attended by traditional birth attendants (dais) or untrained family members, who neither are aware of the importance of recording birth-weight nor has access to a suitable weighing scale at the situation [4,6]. Many studies were carried out in different parts of the world in search of such surrogate markers for birth-weight to assess the health condition of newborns. Measurement of core body temperature and head circumference are suggested to be examples of such simple, alternate and reliable predictor of birth-weight [7,8,9].

On this background, the present study intends to assess the relationship of core body temperature and head circumference with birth- weight in a early neonatal population of northern region of West Bengal, India.

MATERIALS AND METHODS

Our study was a prospective cross-sectional hospital-based non-interventional one. It included a total number of 500 live, singleton, term neonates of both genders, randomly selected within their early neonatal period from the birth register of Malda Medical College & Hospital, Malda – a tertiary care institution situated in the northern part of West Bengal, India during the period of April, 2018 to March, 2019. Among these 500 early neonates, 260 were male and 240 were female. All these neonates were apparently healthy, sucking breast milk normally and were kept in the postnatal ward of Department of Gynaecology & Obstetrics, Malda Medical College & Hospital, along with their mothers for observation and promotion of 'Kangaroo Mother Care'. Preliminary information was taken from respective mothers and health education was given to them regarding appropriate and basic newborn care. Babies with any serious illness or congenital malformations and those born to mothers with diabetes, hypertension (Diastolic BP recorded to be more than 90 mm Hg on two occasions during antenatal period) and any other chronic illnesses were excluded. These data was collected between the time of birth to the day of discharge.

Measured neonatal parameters included birth weight, axillary temperature (considered to be accurate enough to estimate core body temperature) [10] and head circumference as per the recommended procedures [6,7,11]. Every measurement was recorded thrice within 12 hours of birth and the average value was taken as the final record. Care was taken to standardize the instruments regularly.

Birth-weight (BW) was recorded in kilograms(kg) by digital baby-weighing balance with a difference of ±10 gms.

Axillary Temperature (Temp) was preferred as it is safe, hygienic and reflects rectal temperature (if taken properly). It was measured during the daytime in degree Farenheit (^{0}F) using low-reading, standard, clinical, mercury-in-glass thermometer—the bulb of which was kept deep in the axillary pit with arm of the neonate retained in adducted position for 3 minutes. After each recording, the thermometer bulb was cleansed with alcohol and then wiped before using it for the next neonate.

Maximum occipito-frontal circumference (OFC) was taken as the **Head Circumference (HC)** [12]. It was recorded in centimetres (cm) by passing a standard, non-stretchable measuring tape over the occipital protuberance on the back and supraorbital ridges infront, while viewing the subject laterally also to ensure proper placement of the tape. The point of highest circumference is measured.

Approval (in prescribed format) from the concerned Institutional Ethics committee (IEC) was obtained before conduction of this study. The data obtained was computer-analyzed using 'Prism 5' (Graphpad Software Inc., San Diego, 2012) statistical package for Windows. Calculation & comparison of Mean and Standard Deviation (SD), independent samples t-test, one-way ANOVA test and Pearson's two-tailed correlation study were done (wherever applicable) for the data analysis. The results were considered to be of statistical significance when the p-value was less than 0.05.

OBSERVATION AND RESULTS

In this study, a population of total 500 early neonates (comprising of 260 males and 240 females) within the Birth weight -range of 1.3 to 4.25 kg (with mean of 2.66 ±0.47 kg), were selected and stratified into six groups (as shown in **Table 1**) based on their body-weight. Their axillary temperature and head circumferences were subsequently analyzed and compared as per plan of the study to meet the objectives.

Table 1: Distribution of total studied neonatal population according to birth weight and gender:

BW (kg)	Population		Gender wise population & %			
	Total	%	Male	%	Female	%
< 1.5	03	0.6	02	67	01	33
1.5 - 2	41	8.2	21	51.2	20	48.8
> 2 to 2.5	146	29.2	42	28.8	104	71.2
> 2.5 to 3	200	40	115	57.5	85	42.5
>3 to 3.5	91	18.2	70	77	21	23
>3.5	19	13.16	10	52.6	9	47.4
Total	500	100	260	52	240	48

Table 2: Distribution of Axillary Temperature (in ^{0}F) according to Birth Weight-groups

BW-Group (Kg)	Mean ± SD	Statistic values
<1.5 (n=3)	98.03 ± 1.46	p< 0.0001 (significant) F = 21.8
1.5 to 2 (n=41)	97.97 ± 0.4	
>2 to 2.5 (n=146)	98.4 ± 0.55	
>2.5 to 3 (n=200)	98.6 ± 0.36	
>3 to 3.5 (n=91)	98.69 ± 0.25	
>3.5 (n=19)	98.81 ± 0.41	

The mean axillary temperature & mean head circumference varied significantly in different birth weight-groups (as shown in Table 2 & Table 3, respectively).

Figure 1: Scatterplot showing correlation of Axillary Temperature (in ^{0}F) with increasing birth-weight

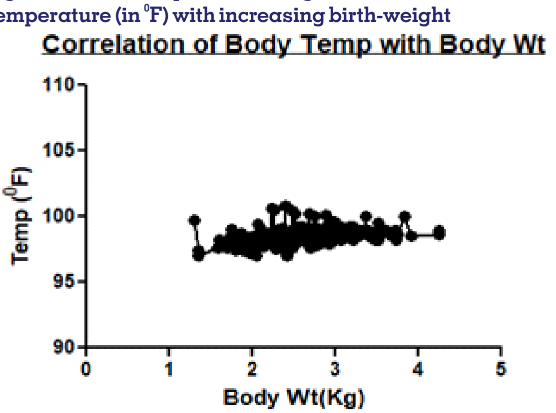
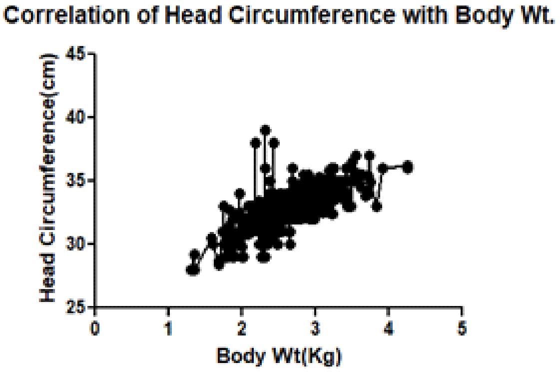


Table 3: Distribution of Head Circumference (in cm) according to Body Weight-groups

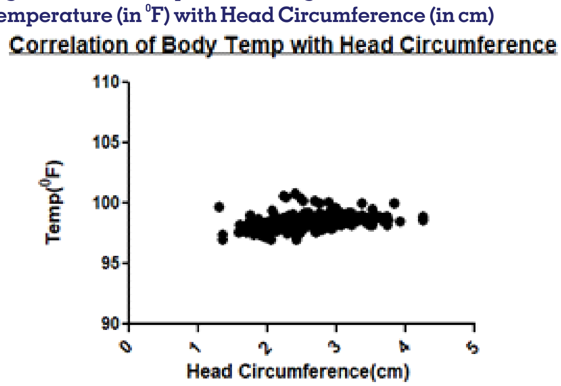
BW-Group (Kg)	Mean ± SD	Statistic values
<1.5 (n=3)	28.4 ± 0.69	p< 0.0001 (significant) F = 111.9
1.5 to 2 (n=41)	30.56 ± 1.27	
>2 to 2.5 (n=146)	32.23 ± 1.38	
>2.5 to 3 (n=200)	33.26 ± 0.9	
>3 to 3.5 (n=91)	34.3 ± 0.83	
>3.5 (n=19)	35.23 ± 1	

Figure 2: Scatterplot showing correlation of Head Circumference (in cm) with increasing birth-weight



A significant positive correlation existed individually between axillary temperature (r= 0.18, p<0.0001) and head circumference (r= 0.75, p<0.001) with increasing birth-weight (Fig.1 & Fig.2, respectively). Significant positive correlation (r= 0.39, p<0.0001) was also observed between axillary temperature and increasing head circumference (Fig. 3).

Figure 3: Scatterplot showing correlation of Axillary Temperature (in ^{0}F) with Head Circumference (in cm)



Thus in this study-population of clinically healthy , term early neonates, it is found that both axillary temperature & head circumference mostly shows gradually increasing trends along with rising birth-weight. Similar trend is also observed in variation of axillary temperature with increasing head circumference.

Table 4: Overall Comparison of Birth-weight (BW), Axillary Temperature (Temp) & Head Circumference (HC) among Low Birth weight (LBW) & Normal Birth weight(NBW) neonates

	LBW (n = 182) (Mean ±SD)	NBW (n = 315) (Mean±SD)	Statistic values
BW (kg)	2.2 ± 0.22	2.93 ± 0.32	p<0.0001, t= 27.28
Temp (^{0}F)	98.3 ± 0.54	98.63 ± 0.35	p<0.0001, t= 8.4
HC (cm)	31.84 ± 1.52	33.68 ± 1.08	p<0.0001, t= 15.66

Furthermore, it is also observed (**Table 4**) that the mean values of axillary temperature and head circumference of the studied neonatal population are decreased significantly in LBW(Low Birth Weight) Babies (BW of 1.5 kg to less than 2.5 kg), when compared to NBW(Normal Birth Weight) babies (BW of 2.5 kg or more).

DISCUSSION

This study revealed a progressive rise of core body temperature and head circumference along with increasing birth weight and such variations was statistically significant -- which is said to be normal and in tune with some other studies[12,13,14,15]. At the same time, the present study shows that both of the said parameters are highly correlated to each other as well as with the birth weight, which is a gold standard against all these parameters. Earlier studies done on similar issue in different geographical locations and on different neonatal populations showed similar results [2,4,6,7,14,16].

Newborn babies are prone to hypothermia as they have poor heat regulating mechanisms. The babies have larger surface area to their body weight, thin & permeable skin and lower subcutaneous fat. The head constitutes a significant portion of the newborn's surface area and can contribute significantly to overall heat loss. The babies have limited heat-generating mechanisms including brown fat. At birth, the transition from an intra-uterine to extra-uterine environment creates a significant thermal change that challenges the neonates' thermoregulatory ability. After birth, the babies are exposed to a comparatively cooler environment, which heralds heat loss from the newcomer through following four ways: (i) *Radiation* to surrounding environment not in direct contact with baby, (ii) *Convection* to air flowing in surrounding, (iii) *Conduction* to substances in direct contact with baby, and (iv) *Evaporation* of amniotic fluid and moisture from baby's skin to atmosphere[5,9]. Some other factors like inability to shiver, vulnerability to get exposed, dependence on others for early detection and rectification etc. aggravate the problem further [2,3]. In spite of all these threatening challenges, neonates become able to ward off the insult as reflected in our study. This is due to concerted heat-generating activities of different homoeostatic compensatory mechanisms [2,18], like (i) increasing body movements, (ii) hypothalamus-mediated mounting sympathetic surge (leading to cutaneous vasoconstriction, non-shivering thermogenessis in brown fat, etc.) and elevated cellular metabolic rate by stimulated Thyroxin release etc, (iii) Utilizing the Specific Dynamic Action (SDA) of breast milk taken frequently, (iv) increasing neural discharge to brown fat after eating and (v) maintaining the usual neonatal flexed posture. This probably explains that nutritional status (as reflected here by birth-weight) plays a role in maintenance of proper core body temperature in term early neonates and thus they are linked physiologically.

Occipitofrontal circumference (OFC) or head circumference represents growth of the brain [3,5]. As discussed above, the neonatal thermoregulatory mechanics is highly dependent on proper functioning of its' brain to initiate and coordinate different compensatory mechanisms to withstand different grades of thermal stress, it is not surprising that the brain-growth (as reflected here by head circumference) will be in sync with maintenance of proper core body temperature, which is further physiologically related to birth-weight [17,19].

CONCLUSION

This study suggested the existence of significant correlation of core body temperature and head circumference with birth weight in term, early neonates, and thus these two parameters can be used as simple, quick and alternate indicators for predicting birth weight and neonatal outcome in the community, provided they are measured following standard methods with precision instruments. But this study is probably not large enough to conclude the normal range of core body temperature and head circumference for the study population. Moreover, not considering the factors governing the birth weight and other anthropometric parameters further limits the scope of the study. Thus a more planned and elaborate study with greater control over the confounding variables should be undertaken to generate stronger evidence for the derived correlations, to explore mechanisms behind the results and to set normal ranges for studied parameters in the neonatal population.

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