Maternal Anthropometry and it's Relationship to Birth Weight

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Abstract

Introduction: Nutrition plays a major role in maternal and child health and it is perhaps the most influential non-genetic factor in foetal development. Understanding the relation between maternal nutrition and birth outcomes may provide a basis for developing nutritional interventions that will improve birth outcomes and long-term quality of life. Many research projects have studied maternal anthropometric indicators as predictors of birth weight; not many of them have focused on the question as to which is the best indicator for prediction of pregnancy outcomes with greater accuracy. Hence this study was taken up to assess the relationship between specific maternal anthropometric indicator including Mid-upper arm circumference (MUAC) and pregnancy outcome. The objective of the study was to assess the relationship between maternal anthropometric indicators and birth weight, crown-heel length and new-born's head circumference.

Methods: A cross-sectional study was conducted among mothers who come for safe confinement to District Hospital, Tumkur during June - August 2018. Data was collected using pre-tested, semi structured proforma. Anthropometric measurements like weight, height & MUAC of mother and new-borns' birth-weight & length was collected. Data was analysed using SPSS and linear regression analysis was used to assess the relationship between maternal & newborn anthropometric measures.

Results: There was a statistically significant positive correlation between: Birth-weight and maternal height ($r=0.301$), MUAC ($r=0.222$) & gestational weight-gain ($r=0.233$); Crown-heel length of new born and MUAC ($r=0.209$); Head circumference and MUAC ($r=0.475$) and gestational weight-gain ($r=0.263$).

Conclusion: MUAC as an indicator of maternal nutritional status is having a positive correlation with birth weight, and can be used as a predictor of new-born's anthropometry.

Keywords: Anthropometry, Birth-weight, Mid-upper arm circumference, Relationship

Introduction

Nutrition plays a major role in maternal and child health and is the most influential non-genetic factor in fetal development.¹ Maternal body composition, nutritional stores, diet and ability to deliver nutrients through the placenta determines nutrient availability for the fetus.¹ Prenatal nutrition influences fetal growth, normal development of physiological function and gestational weight gain (GWG).²

Poor maternal nutritional status has been related to adverse birth outcomes; however, the association between maternal nutrition and birth outcome is complex and is influenced by many biologic, socioeconomic, and demographic factors, which vary widely in different populations.³ Understanding the relation between maternal nutrition and birth outcomes may provide a basis for developing nutritional interventions that will improve birth outcomes and long-term quality of life and reduce mortality, morbidity, and health-care costs.

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World Health Organization (WHO) estimates that, 25 million low birth weight (LBW) babies are born annually worldwide and 95% occur in developing countries.⁴ One in three babies in India are born with moderate to severe malnutrition with birth weight of 2500 g or below.⁵ There are many anthropometric measures of antenatal mothers which affect the pregnancy outcome like pre-pregnancy weight, Height, Mid-Upper Arm Circumference (MUAC), gestational weight gain, etc.

MUAC is a good indicator of the protein reserves of a body, and a thinner arm reflects wasted lean mass, i.e. malnutrition.⁶ MUAC is the circumference of the left upper arm, measured at the mid-point between the tip of the shoulder and the tip of the elbow (olecranon process and the acromium).⁷

Many research projects have studied maternal anthropometric indicators as predictors of birth weight. However, fewer of them have focused on the best indicator for the prediction of pregnancy outcomes with greater sensitivity, specificity and accuracy.⁸ There are differences between developed and developing countries in determining the most appropriate cut-off points for anthropometric measurements. Furthermore, research is needed to evaluate whether the combined use of one or two easily measurable anthropometric indicators can have a high predictive power for risk of adverse birth outcomes. Médecins Sans Frontières (MSF) has developed a new universal MUAC strip which is awaiting field validation.⁹

Hence this study was taken up among the mothers coming for delivery at District hospital Tumkur, to assess the relationship between maternal anthropometric indicators and birth weight, crown-heel length and new-born's head circumference.

Objectives

The objective of the study was

- To assess the relationship between maternal anthropometric indicators and birth weight.
- To assess the relationship between maternal anthropometric indicators and crown-heel length and new-born's head circumference.

Materials & Methods

A cross-sectional study was conducted among mothers in post-natal ward who come for safe confinement to District Hospital, Tumkur during June - August 2018. A purposive sampling method was used.

The study was conducted after getting the IEC approval. Similarly, the permission from district surgeon of the study centre was obtained. Sample Size was 100 [$R = 0.399^8$].

All the mothers in the postnatal ward who gave informed consent, after fulfilling the inclusion & exclusion criteria were interviewed and the data was collected using pre-tested; semi-structured questionnaire. Data regarding pre-pregnancy weight of the mother, height, body mass index (pre-pregnancy weight/height²), gestational weight gain, and gestational age was collected by personal interview, anthropometric examination and by evaluating their medical records. UNICEF's new Mid-Upper Arm Circumference (MUAC) Measuring Tapes were used to measure mid-upper arm circumference of the mothers. The anthropometric measurements of newborn (birth-weight, crown heel length & head circumference) were recorded within 24 hours of delivery.

Inclusion Criteria

- Singleton term deliveries (38-42 weeks of gestation from last menstrual period and /or pediatric assessment of the gestational age) free of any obstetrical and medical complications known to affect fetal growth.
- The mothers who gave informed consent to participate in the study.

Exclusion Criteria

- Smokers, consumers of alcoholic beverages
- Gestational hypertension
- Gestational diabetes
- High risk pregnancies

Statistical Analysis

Data was entered in Microsoft excel and analysed using SPSS version 22. Mean and standard deviations were calculated for all variables. For the statistical analysis, bivariate and stepwise forward multivariate linear regression were conducted in SPSS program. Initially, univariate association between the dependent variables (birth weight, head circumference and crown heel length) and maternal anthropometric indicators (height, age, weight, gestational weight gain, arm circumference, pre-pregnancy weight) and gestational age as independent variables, were tested. Multivariate linear regression analysis was used to investigate the effect of the independent variables on neonatal birth weight, crown heel length and head circumference and p-values <0.05 were considered statistically significant.

Results

Socio-demographic Profile

The mean age + S.D of the study subjects was 23.48±3.61years. Majority of the study subjects were educated till high school (58.0%) and were home-makers (95.0%). Majority were from rural area (77.0%).

Anthropometric Characteristics of Study Subjects

The anthropometric characteristics of the study population are shown in Table 1.

Table 1.Anthropometric characteristics of study subjects

Anthropometric characteristics	Mean	Standard deviation
Mother		
Pre-pregnancy weight (Kg)	49.63	10.54
Maternal height (cm)	159.52	8.26
Quetelet's index (Kg/m ²)	18.52	5.39
Mid-upper arm circumference (cm)	23.41	2.89
Gestational weight gain (Kg)	9.00	3.92
New-born		
Birth-weight (Kg)	2.88	0.35
Crown heel length (cm)	45.65	2.87
Head circumference (cm)	33.21	1.79
Gestational age (Weeks)	37.25	3.14

Details regarding the Delivery

82% of study subjects had caesarean section and 18% had normal delivery. Among the study subjects, 87% had new-borns who were of normal weight (2.5-3.5 kg), 9% were low birth weight babies (<2.5 kg) and 4% were weighing >3.5 kgs.

Correlation between Mothers' and New-borns' Anthropometric Measurements

Bivariate regression analysis was done to assess the correlation between maternal and new-borns' anthropometric measurements. Maternal height showed the highest correlation ($r=0.301$) followed by gestational weight gain ($r=0.233$) and mid-upper arm circumference ($r=0.222$). Pre-pregnant Quetelet's index showed the weakest correlation ($r=0.062$). Maternal height, mid-upper

arm circumference and gestational weight gain had a p-value <0.05.

Correlation between New-borns' Crown-heel Length and Maternal Anthropometric Measurements

Maternal Mid-upper arm circumference showed the highest correlation ($r=0.209$) and it was statistically significant ($p<0.05$). Weakest correlation was found for Quetelet's index ($r=0.074$).

Correlation between New-borns' Head Circumference and Maternal Anthropometric Measurements

Maternal mid-upper arm circumference showed the highest correlation ($r=0.475$) followed by gestational weight gain (0.263) and both showed a statistically significant correlation ($p<0.05$). Age of the mother showed the weakest correlation ($r=0.059$).

Table 2.Correlation coefficients between mothers' and new-borns' anthropometric measurements

Mothers' variables	New-born variables					
	Birth-weight		Crown-heel length		Head circumference	
	r	p	r	p	r	p
Age	0.089	0.377	0.094	0.354	0.059	0.559
Pre-pregnancy weight	0.187	0.063	0.114	0.259	0.161	0.110
Maternal height	0.301	0.002*	0.107	0.288	0.131	0.194
Quetelet's index	0.062	0.543	0.074	0.463	0.103	0.310
Mid-upper arm circumference (MUAC)	0.222	0.026*	0.209	0.037*	0.475	0.001*
Gestational weight gain	0.233	0.020*	0.136	0.179	0.263	0.008*
Gestational age	0.078	0.441	0.038	0.710	0.070	0.486

*Statistically significant.

Multiple Linear Regression Analysis: Relative Importance of the Independent Variables

The results of the multivariate linear regression models are shown in Tables 3. In the birth-weight model, pre-pregnancy weight (β -2.96 $p<0.05$), maternal height (β 1.771 $p<0.05$) and Quetelet's index (β 2.606 $p<0.05$) continued to be predictors of birth weight. R square was 0.237 which meant this model explained 23.7% of birth weight variance. In Head circumference model, MUAC (β 0.573 $p<0.05$) turned out to have the statistically significant effect on head circumference. Since R square was 0.218, this model could explain 21.8% of head circumference variance.

Linear regression equation: Birth weight = β_0 + β_1 (age) + β_2 (pre-pregnancy weight) + β_3 (Height) + β_4 (Quetelet's index) + β_5 (MUAC) + β_6 (gestational weight gain) + β_6 (gestational age).

Table 3. Linear regression of variables associated with new-born's anthropometry

Variables	Birth weight			Crown heel length			Head circumference		
	β^U	β^S	p	β^U	β^S	p	β^U	β^S	p
	$R^2 = 0.237, p=0.01^*$			$R^2 = 0.084, p=0.304$			$R^2 = 0.218, p<0.05^*$		
Age	-0.012	-0.129	0.208	-0.121	-0.152	0.174	-0.015	-0.030	0.760
Pre-pregnancy weight	-0.098	-2.960	0.013*	-0.224	-0.824	0.520	-0.110	-0.647	0.570
Maternal height	0.075	1.771	0.003*	0.172	0.494	0.445	0.068	0.312	0.588
Quetelet's index	0.261	2.606	0.010*	0.592	0.721	0.510	0.195	0.378	0.698
MUAC	0.022	0.181	0.159	0.221	0.223	0.113	0.356	0.573	<0.05*
Gestational weight gain	0.017	0.188	0.063	0.062	0.085	0.440	0.050	0.108	0.269
Gestational age	0.000	0.002	0.983	0.014	0.016	0.881	0.006	0.010	0.915

β^U Unstandardized coefficient; β^S Standardised coefficient; *statistically significant.

Table 4. Linear regression of variables associated with new-born's anthropometry excluding maternal weight, Quetelet's index and gestational weight gain

Variables	Birth weight			Crown heel length			Head circumference		
	β^U	β^S	p	β^U	β^S	p	β^U	β^S	p
	$R^2 = 0.153, p=0.03^*$			$R^2 = 0.074, p=0.117$			$R^2 = 0.232, p<0.05^*$		
Age	-0.019	-0.195	0.055	-0.137	-0.173	0.103	-0.035	-0.071	0.459
Maternal height	0.012	0.291	0.004*	0.029	0.085	0.412	0.006	0.027	0.771
MUAC	0.024	0.202	0.048*	0.232	0.234	0.028*	0.301	0.485	<0.05*
Gestational age	-0.004	-0.040	0.681	0.000	0.000	0.996	-0.019	-0.032	0.723

β^U Unstandardized coefficient; β^S Standardised coefficient; *statistically significant.

In the second model, pre-pregnancy weight, Quetelet's index and gestational weight gain was excluded to simulate late reporting in pregnancy. Results are shown in Table 4. MUAC continued to be the predictor of birth weight (β 0.202 $p<0.05$), crown heel length (β 0.234 $p<0.05$) and head circumference (β 0.485 $p<0.05$) and was statistically significant. Maternal height also had a significant effect on birth weight (β 0.291 $p<0.05$). R square indicated that 15.3% of birth weight 7.4% of crown heel length & 23.2% of head circumference variance was explained by the 3 models (Table 4).

Discussion

Nutritional status of mothers has long been known to influence birth weight of children. Here anthropometric measurements were used as proxies for nutritional status. MUAC is easier to record and it can be used effectively in community situation even by paramedical workers.¹⁰

UNICEF supplies the MUAC tapes with both numbers and colours. It classifies mother as Severe Acute Malnutrition (<18.5 cm), Moderate acute malnutrition (18.5-21 cm), and

at-risk mothers (21-23 cm). Management of malnutrition is based on the category: SAM: refer for intense nutritional support, MAM: refer for nutritional support, at risk: pregnant & lactating mothers need nutritional support.⁹

In the present study, age of study subjects was 23.4 ± 3.6 years, pre-pregnancy weight of 49.62 ± 10.5 kg, height of 159.5 ± 8.2 cm, gestational weight gain of 9 ± 3.9 kg, gestational age of 37.24 ± 3.14 weeks, MUAC of 23.4 ± 2.89 cms. In a study on maternal anthropometry as a predictor of birth weight, age of study subjects was 23.6 ± 5.1 years, height of 152 ± 5.6 cm, MUAC of 24.2 ± 0.2 cms.¹¹ Another study on mid-upper arm circumference in pregnant women and its relation to birth weight showed maternal age of 27 ± 6.59 years, pre-pregnancy weight of 55.8 ± 9.8 kg, height of 156.7 ± 5.9 cm, gestational weight gain of 8.8 ± 4 kg, gestational age of 38.08 ± 1.32 weeks and MUAC of 27 ± 3.4 cms.⁸

In the present study, birth weight was 2.87 ± 0.34 kg, crown heel length was 45.6 ± 2.8 cm and head circumference were 33.2 ± 1.8 cms. Another study on MUAC & birth weight showed birth weight of 3.1 ± 0.48 kg, crown heel length of 48.7 ± 2.08 cm and head circumference of 34.4 ± 1.4 cm.⁸

In the present study, low birth weight (LBW) of neonates was found to be 9%. In contrast, a study in Raipur on correlation between MUAC and neonatal anthropometry, LBW was seen in 52.2% of neonates.¹²

In the present study, Maternal height ($r=0.301$), gestational weight gain ($r=0.233$) and mid-upper arm circumference ($r=0.222$) showed statistically significant correlation for birth weight. Mid-upper arm circumference showed the statistically significant correlation ($r=0.209$). Maternal Mid-upper arm circumference ($r=0.475$) and gestational weight gain ($r=0.263$) showed a statistically significant correlation ($p<0.05$). Another study on MUAC and birth weight, gestational age ($r=0.425$), MUAC ($r=0.399$), pre-pregnancy weight ($r=0.378$), Quetelet's index ($r=0.364$) showed statistically significant correlation for birth weight. Quetelet's index ($r=0.329$), gestational age ($r=0.309$), age ($r=0.282$), MUAC ($r=0.306$) and pre-pregnancy weight ($r=0.094$) correlated for crown heel length.⁸ Another study on MUAC and birth anthropometry showed correlation of 0.65 for birth weight and 0.47 for neonatal length.¹²

In multivariate regression, pre-pregnancy weight ($\beta -2.96$, $p<0.05$), maternal height ($\beta 1.771$, $p<0.05$) and Quetelet's index ($\beta 2.606$, $p<0.05$) continued to be predictors of birth weight. MUAC ($\beta 0.573$, $p<0.05$) showed of having effect on head circumference. In a study on MUAC, multivariate regression showed that MUAC ($\beta 45.52$, $p<0.05$) and gestational age ($\beta 135.48$, $p<0.05$) showed to have significant effect on birth weight.⁶ Another study on maternal anthropometry showed that maternal height ($\beta 0.273$, $p<0.05$) and pregnant BMI ($\beta 0.398$, $p<0.05$) had significant contribution to birth weight.¹¹

On simulating late reporting of pregnancy without pre-pregnancy anthropometric indicators, MUAC was a significant predictor of birth weight, crown heel length and head circumference. One advantage of using MUAC to assess women at nutritional risk of giving birth to low birth weight babies is that arm circumference measurements can be taken whenever a woman visits a health worker or health centre. Recent studies have demonstrated that MUAC is closely related to maternal weight.

Conclusion

In the present study, mid upper arm circumference showed significant correlation with birth weight, crown heel length and head circumference. Additionally, maternal height & gestational weight gain showed significant correlation with birth weight and head circumference. Multivariate linear regression showed that pre-pregnancy weight, height & Quetelet's index were significant predictors of birth weight. On simulating late reporting of pregnancy without pre-pregnancy anthropometric indicators, MUAC was a significant predictor of birth weight, crown heel length and head circumference.

Recommendations

MUAC could be considered as a potential indicator of maternal nutritional status, and may be used instead of pre-pregnancy weight, as an alternative indicator to assess women at risk of poor pregnancy outcome in communities when presentation for prenatal care is late.

Conflict of Interest: None

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