Original Article

Correlation of Maternal and Paternal Height and Weight with Selected Fetal Parameters during the 3rd Trimester of Pregnancy: A Hospital Based Study in Bangladesh

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Key Words: Maternal anthropometry; Paternal anthropometry; Fetal biometry; Third-trimester pregnancy.

ABSTRACT:

Introduction: *Fetal growth is influenced by parental height and weight. Maternal intrauterine environment contributes an important role in determining baby's birth weight. However, a significant relationship also exists between the father's BMI and the baby's birth weight. But due to a lack of information about the effects of paternal body proportions on fetal growth, the paternal function is less evident. Ultrasound scans are mostly used to estimate the fetal growth parameters throughout the pregnancy. Among them, biparietal diameter (BPD), femur length (FL), abdominal circumference (AC) and estimated fetal weight (EFW) are the parameters that are most routinely taken in the 2nd and 3rd trimester of pregnancy. So, the findings of this study will contribute to enhance the knowledge of factors affecting the third trimester development and for better understanding of the physiological variations, probably produced by feto-maternal and feto-paternal interactions.*

Methods: *The study was cross-sectional analytical in nature. It included a total of 80 mother-father-fetus triad who attended for antenatal check up at the 3rd trimester of pregnancy between December 2023 and May 2024. The height and weight of the parents were measured and the mothers underwent ultrasonography from which the selected fetal parameters (BPD, FL, AC and EFW) were collected and recorded.*

Results: *All the fetal parameters (BPD, FL, AC and EFW) were found to have statistically significant positive correlations with maternal weight and maternal BMI, but only FL and EFW had statistically significant positive correlations with paternal BMI during the 3rd trimester of pregnancy. None of the fetal parameters were found to have any statistically significant correlation with maternal and paternal height and paternal weight.*

Conclusions: *Maternal weight and parental BMI can be used as important indicators to assess fetal growth during the 3rd trimester of pregnancy. This outcome will also be helpful in providing special attention to nutritional education and appropriate timely nutritional intervention of the couples at the pre-pregnancy stage and very early stage of pregnancy.*

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Introduction

Parental height and weight are known to be two important factors associated with offspring's birth weight (Takagi et al. 2019). Maternal body mass index (BMI) is positively associated with infant birth weight as the maternal intrauterine environment plays a considerable role in determining birth weight (Mamidi et al. 2022; Takagi et al. 2019; Pomeroy et al. 2015). There have been inconsistent findings on assessing the relationship between the father's BMI and the birth weight of the child. Some researches (Lin et al. 2022; Campbell and McPherson 2019) found a significant relationship between the father's BMI and the baby's birth weight. However, one research revealed no significant association with paternal BMI, indicating that the influence of paternal height on fetal development is stronger than paternal BMI (Deshpande et al. 2023).

Maternal height, pre-pregnancy weight and weight gain throughout pregnancy have been found to be important predictors of fetal intrauterine growth patterns and subsequently newborn size (Mamidi et al. 2022; Hanieh et al. 2014). Maternal height reflects the mother's early environmental circumstances (Wills et al. 2010). Yet, maternal pre-pregnancy weight and pregnancy weight gain are important markers of the actual environmental conditions. Several studies have shown an association between maternal height, maternal pre-pregnancy weight and pregnancy weight gain with newborn size. It is well established that newborn size is positively correlated with maternal pre-pregnancy weight status as well as pregnancy weight gain (Mamidi et al. 2022; Catalano et al. 2014). Newborn size, however, is the result of intrauterine growth patterns. Consequently, an association between maternal somatic factors and fetal growth patterns can be assumed (Pölzlberger et al. 2017) .

Ultrasound scans are frequently practiced to determine the gestational age and to estimate fetal growth pattern (Pölzlberger et al. 2017; Butt et al. 2014). Crown-rump length, biparietal diameter, head circumference, femur length and abdominal circumference are the ultrasonographic fetal parameters that are mostly taken throughout the pregnancy (Sadler 2022; Gray 2021). Among them, crown rump length is thought to be the most precise measurement to determine the gestational age specifically in the 1st trimester of pregnancy (Gray 2021; Rahman et al. 2018; Butt et al. 2014). But Sarris et al. (2010) reported that there was no remarkable relationship between the maternal weight and fetal crown-rump length for the 1st trimester of pregnancy. However, in general, it is evidenced that fetal size in the 2nd and 3rd trimesters is correlated with maternal traits (Leung et al. 2008; Salpou et al. 2008).

It is well established that maternal body composition has an impact on the fetal development (Skåren et al. 2020). Due to a lack of information about the effects of paternal body proportions on fetal growth, the paternal function is less evident. According to Lin et al. (2022), the birthweight of the child is influenced by paternal body proportions. This result showed that although maternal weight had a greater effect on birthweight than paternal weight, father's genetic traits still affect birthweight irrespective of maternal factors. Others have reported that paternal height had a strong impact on the fetal parameters during the 3rd trimester of pregnancy as well as the offspring's birthweight rather than the paternal BMI (Deshpande et al. 2023; Takagi et al. 2019). Another study stated that the height and weight of the mother and father both have an equal impact on postnatal weight increase (Skåren et al. 2020).

In an effort to understand determinants of offspring linear growth, one study examined the association between parental height and change in femur length in the prenatal period. In that study, neither maternal nor paternal height was linked to growth from 17 to 29 weeks, while maternal height tended to be more strongly connected with the change in the fetal femur length from 29 weeks until birth than paternal height (Gross 2017). Another study reveals that parent's heights have an impact on their children's growth (Wu et al. 2021).

Methods

Study design and samples

This was a cross-sectional analytical study done under the Department of Anatomy, Bangladesh Medical University (BMU). The pregnant mothers of 3rd trimester or the couples who attended in the Mohammadpur Fertility and Service Training Centre (MFSTC) and Maternal and Child Health Training Institute, Dhaka (MCHTI) for antenatal check-up from December, 2023 to May, 2024 were included in this study.

Each mother-father-fetus triad unit was included only once. Mothers with diagnosed case of gestational diabetes mellitus (GDM), gestational hypertension (GHTN), pre-eclamptic toxemia (PET), oligohydramnios/polyhydramnios, uterine abnormalities (congenital- bicornuated uterus or acquired- fibroid) and fetuses with major malformations detected by USG scan (congenital anomalies, chromosomal abnormalities, skeletal dysplasia). Gross structural abnormalities of mother/father affecting the limb or spine (congenital anomaly, accident, illness) were also excluded from the study. A total of 80 mother-father-fetus triad unit were included in the study by the exclusion criteria.

Data collection

Data were collected from the selected participants by filling out the data collection sheet. At the time of data collection, each participant was made anonymous with a code (sample ID number). All information obtained from them were kept confidential to ensure the safeguards. The data collection sheet was filled out to evaluate the personal and family histories, medical and obstetric histories, lifestyle, occupation, housing conditions and socio-demographic status of the participants. After that, ultrasonographic examination of the selected mothers was performed by the sonologists according to the standard guidelines and observed by the researcher herself. Then the reports were collected from the participants from which the selected fetal parameters were taken. All the anthropometric measurements were assorted in a data entry sheet.

Procedure of measurement of height

Height was measured by using stadiometer. The participant was requested to be barefooted and to remove any hair ornaments, jewelry, buns or braids from the top of the head. Then, the participant was asked to stand on the baseplate of the stadiometer with his/her heel together, toes apart and back as straight as possible. So that, his/her heels, buttocks, shoulders and the head were in contact with the vertical plane of the stadiometer. The participant's head was positioned in the Frankfort horizontal plane and the arms were hung freely by the sides with the palm facing towards the thighs (Fig 1). Then, the headplate of the stadiometer was placed against the participant's head to determine the maximum height of the individual. The stature was then measured from the baseplate to the headplate of the stadiometer at which level the headplate was stuck on the participant's head and the height was recorded in centimeters.

Fig 1 Procedure of measuring height.

Fig 2 Procedure of measuring weight.

Procedure of measurement of weight

Weight was measured by using digital weighing scale. The scale was placed on a flat surface. The participant was requested to be barefooted and then asked to step onto it with minimum clothing. The participant's head was positioned in the Frankfort horizontal plane and the arms were hung freely by the sides with the palm facing towards the thighs (Fig 2). Then, simply read the numbers to find out how much he/she weighs and the weight was recorded in kilograms.

Procedure of observing ultrasonography & taking the measurements of selected fetal parameters

During an ultrasound, mother was asked to lie down in supine position on the examination table or bed. Sometimes, she might be asked to move or hold her breath while capturing images on the screen. After ensuring proper positioning with the presence of researcher herself, transabdominal ultrasonography was performed by a limited number of trained sonologists who agreed on standardized procedures before the study. According to Hadlock's criteria (Hadlock et al. 1982 a, b, c), the following sonographic measurements were measured: fetal biparietal diameter (BPD), abdominal circumference (AC) and femur length (FL). BPD is measured between the outer edge of the fetal skull closest to the transducer and the inner edge of the fetal skull farthest from the transducer at the level of the paired thalami and cavum septi pellucidi (Rumack et al. 2023). FL is measurement of the ossified diaphysis of the femur ensured by showing that both the greater trochanter and the lateral condyle of femur are simultaneously in the plane of section (Rumack et al. 2023). AC is the dimension of outer perimeter of the fetal abdomen, measured at the level of the liver, stomach and intrahepatic portion of the umbilical vein (Rumack et al. 2023). EFW was calculated using Hadlock's formula, Log10 weight = 1.335 - 0.0034 AC x FL + 0.0316 BPD + 0.0457 AC + 0.1623 FL (Hadlock et al. 1984). BPD, AC and FL were measured in millimeters (mm) and EFW was measured in grams (gm). The whole procedure of ultrasonography of each participant was carefully observed and monitored by the researcher herself. After that, the ultrasonographic reports of them were collected and the measurements of selected fetal parameters were taken from their reports. In this study, same model of Samsung Medison Sonoace X8 OB/GYN Ultrasound machine was used in both hospitals.

Quality control and quality assurance

The stadiometer, weighing scale and ultrasound machine were properly checked and field tested before finalization by measuring other pregnant women who were not included in the study. Participants were provided clear instructions and proper demonstrations before taking measurements. Anthropometric measurements were taken by ensuring proper positioning, exposure and calibration of equipment.

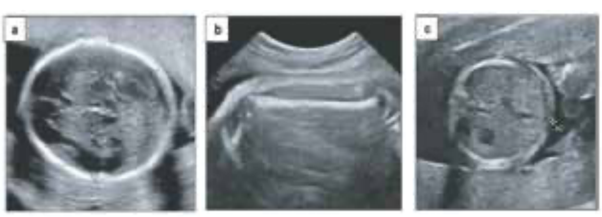

Fig 3: Ultrasonographic measurement of (a) BPD, (b) FL and (c) AC

The landmarks were accurately identified and each of the measurements were taken twice and calculate the average to avoid intra-observer error. Quality control of images for BPD, AC and FL measurement were performed using the specific landmarks and planes according to the standard guidelines and by proper caliper placement. All the reports and images were carefully recorded and reliably archived with documentations.

Data analysis

All statistical analyses were performed using IBM SPSS software for windows, version 27.

Results

Almost half of the mothers (45%) were in the age group of 21 to 25 years and the median (range) of maternal age was about 24 (18-34) years. More than half of the fathers (51.25%) in this research were in the age group of 30 to 39 years of age and the median (range) of paternal age was about 30.50 (20-47) years. All the socio-demographic and family characteristics and personal history of the parents are presented in Tables 1 to 3.

More than half of the mothers (58.75%) were within the range of 36 to 40 weeks of gestational age and the mean ± SD gestational age as per LMP was 36.14 ± 2.54 weeks (Table 4).

The mean ± SD of maternal height, weight and BMI was 151.87 ± 6.19 cm, 63.19 ± 10.76 kg and 27.5 ± 4.38 kg/m² respectively. The median (range) paternal height was 165.04 (137.16-190.50) cm and the mean ± SD of paternal weight and BMI was 64.46 ± 10.42 kg and 23.80 ± 3.38 kg/m² respectively. Ultrasonographic measurements of selected fetal parameters reported that majority of the fetal BPD (43.75%), FL (42.50%), AC (60%) were in the range of 85 to 89.99 mm, 70 to 74.99 mm and 300 to 344.30 mm respectively. The mean ± SD of estimated fetal weight was 2600.94 ± 468.69 gm.

All the fetal parameters (BPD, FL, AC and EFW) were found to have statistically significant positive correlations with maternal weight and maternal BMI, but only FL and EFW had statistically significant positive correlations with paternal BMI during the 3rd trimester of pregnancy. None of the fetal parameters were found to have any statistically significant correlation with maternal and paternal height and paternal weight (Table 5-7).

Table 1 Socio-demographic characteristics of the parents (n = 80)

Socio-demographic characteristic	Maternal n (%)	*P*-value	Paternal n (%)	*P*-value
Age (years)				
≤20	20 (25)		1 (1.25)	
21-25	36 (45)		11 (13.75)	
26-30	21 (26.25)		28 (35)	
31-35	3 (3.75)		26 (32.5)	
36-40			10 (12.5)	
≥40			4 (5)	
Median (Range)	24 (18-34)	0.018	30.50 (20-47)	0.035
Educational qualification				
Tertiary	14 (17.50)		14 (17.50)	
Secondary	45 (56.25)		51 (63.75)	
Primary	16 (20)		11 (13.75)	
No formal education	5 (6.25)		4 (5)	
Occupational status				
Housewife	76 (95)			
Service holder	4 (5)		32 (40)	
Businessman			20 (25)	
Driver			10 (12.50)	
Others			18 (22.50)	

Table 2 Family characteristics of the parents (n = 80)

Family characteristic	n (%)	*P*-value
Monthly family income (BDT)		
<12,900	18 (22.5)	
12,900 – 21,500	36 (45)	
>21,500	26 (32.5)	
Median (Range)	17,500 (7000-100000)	<0.001
Dwelling place		
Pucca house	40 (50)	
Semi-pucca house	29 (36.25)	
Tin house	11 (13.75)	

Table 3 Personal history of the parents (n = 80)

	Maternal n (%)	Paternal n (%)
Smoking history		
Yes	0 (0)	25 (31.25)
No	80 (100)	55 (68.75)
Tobacco and betel nut chewing history		
Yes	2 (2.50)	2 (2.50)
No	78 (97.50)	78 (97.50)

Table 4 Gestation related characteristics (n = 80)

Gestation related characteristic	n (%)	*P*-value
Gestational age (weeks)		
28-30	2 (2.5)	
31-35	31 (38.75)	
36-40	47 (58.75)	
Mean ± SD	36.14 ± 2.54	<0.157
Birth order		
1st	29 (36.25)	
2nd	32 (40)	
3rd	14 (17.50)	
4th	5(6.25)	

Table 5 Correlation of maternal and paternal height with selected fetal parameters during the 3rd trimester of pregnancy

	Maternal height			Paternal height		
Selected fetal parameter	Correlation coefficient (r)	*P*-value	Coefficient of determination (r^2)	Correlation coefficient (r)	*P*-value	Coefficient of determinatio n (r^2)
BPD	+0.127	0.260	0.016	-0.091	0.423	0.008
FL	+0.117	0.303	0.014	+0.007	0.950	0.000
AC	+0.178	0.115	0.032	+0.010	0.928	0.000
EFW	+0.146	0.195	0.021	+0.019	0.868	0.000

Table 6 Correlation of maternal and paternal weight with selected fetal parameters during the 3rd trimester of pregnancy

	Maternal weight			Paternal weight		
Selected fetal parameter	Correlation coefficient (r)	*P*-value	Coefficient of determination (r^2)	Correlation coefficient (r)	*P*-value	Coefficient of determinatio n (r^2)
BPD	+0.402	<0.001	0.162	+0.119	0.295	0.014
FL	+0.317	<0.001	0.101	+0.197	0.080	0.039
AC	+0.291	<0.001	0.085	+0.162	0.151	0.026
EFW	+0.375	<0.001	0.141	+0.217	0.054	0.047

Table 7 Correlation of maternal and paternal BMI with selected fetal parameters during the 3rd trimester of pregnancy

	Maternal BMI			Paternal BMI		
Selected fetal parameter	Correlation coefficient (r)	*P*-value	Coefficient of determination (r^2)	Correlation coefficient (r)	*P*-value	Coefficient of determinatio n (r^2)
BPD	+0.374	<0.001	0.140	+0.205	0.068	0.042
FL	+0.283	0.011	0.080	+0.221	0.049	0.049
AC	+0.226	0.044	0.051	+0.189	0.094	0.036
EFW	+0.336	0.002	0.021	+0.242	0.031	0.058

Discussion

This cross-sectional analytical study investigated the correlation between maternal and paternal anthropometric measurements and selected fetal parameters during the third trimester of pregnancy in a Bangladeshi population. The findings highlight that maternal anthropometric indicators, particularly weight and body mass index (BMI), exerted a more significant influence on fetal growth than paternal characteristics, indicating the dominant maternal contribution to intrauterine development.

The mean maternal age (23.9 ± 3.7 years) and paternal age (31.1 ± 5.5 years) observed in this study are similar to findings from previous Bangladeshi and South Asian research (Akter et al. 2012; Ferdous et al. 2018). These averages are notably lower than those reported in Western populations, where maternal age tends to range between 31 and 33 years (Ambrosio et al. 2020; Skåren et al. 2020; Gross 2017). This discrepancy likely reflects socio-cultural norms regarding marriage and childbearing that differ between developing and developed countries. The paternal age range was also consistent with regional data (Takagi et al. 2019), suggesting similar reproductive timing among men in South Asia.

Maternal anthropometric characteristics in this research showed that the mean height (151.9 ± 6.2 cm) and weight (63.2 ± 10.8 kg) were consistent with studies conducted among Bangladeshi andIndian women (Akter et al. 2012; Yajnik et al. 2012; Mamidi et al. 2022) but lower than values reported in developed countries (Ambrosio et al. 2020; Gross 2017). Similarly, paternal height (165.0 cm) and weight (64.5 ± 10.4 kg) were comparable to regional averages (Khadem and Islam 2014; Wu et al. 2021) yet remain lower than those in Western populations (Skåren et al. 2020). These anthropometric differences reflect ethnic, nutritional, and socioeconomic variations, highlighting the influence of genetics and lifestyle on stature and body composition.

The fetal parameters observed in this study, including biparietal diameter (89.3 mm), femur length (69.7 mm), abdominal circumference (303.8 mm), and estimated fetal weight (2600.9 g), were consistent with previous data from Bangladesh and other Asian countries (Mazhar et al. 2011; Ferdous et al. 2018; Poojari et al. 2023). However, they were slightly lower than WHO and INTERGROWTH-21st reference standards (Kiserud et al. 2017; Papageorghiou et al. 2014).

This variation may be attributed to population-specific genetic and environmental factors such as maternal nutrition, socioeconomic status, and lifestyle differences that influence fetal growth across regions.

A key finding of the study was the significant positive correlation between maternal weight and BMI with all selected fetal parameters—biparietal diameter, femur length, abdominal circumference, and estimated fetal weight—during the third trimester. These results are in agreement with earlier research emphasizing the strong impact of maternal nutritional status on fetal growth (Mamidi et al. 2022; Kiserud et al. 2017; Takagi et al. 2019). Studies have shown that adequate maternal nutrition and optimal BMI are essential for proper placental development and nutrient transport to the fetus, both of which determine fetal size and weight (L'Abée et al. 2011). This supports the hypothesis that maternal physiology and energy reserves directly affect intrauterine growth outcomes.

In contrast, paternal anthropometric characteristics showed weaker associations with fetal growth parameters. No significant correlations were observed between paternal height and weight with fetal parameters. However, paternal BMI showed a positive correlation with fetal femur length andestimated fetal weight. These findings partially agree with studies suggesting that paternal BMI influences fetal growth through epigenetic mechanisms and sperm quality, although the maternal influence generally remains more pronounced (Pomeroy et al. 2015; Campbell and McPherson, 2019; Lin et al. 2022). The limited paternal influence observed here reinforces the understanding that fetal growth during gestation is predominantly determined by maternal metabolic and physiological conditions rather than paternal anthropometry.

The stronger correlation between maternal anthropometry and fetal parameters can be explained physiologically. Maternal body composition directly affects placental growth, uterine blood flow, and nutrient delivery, which are vital for fetal tissue development. Paternal factors, while contributing genetically, do not directly impact the intrauterine environment. Several previous studies have also confirmed that maternal height and BMI have significant intrauterine influences, whereas paternal contributions manifest mainly in postnatal growth and stature (Zhang et al. 2015).

These findings have important public health implications. In low- and middle-income settings such as Bangladesh, maternal undernutrition and low BMI remain common, contributing to intrauterine growth restriction and low birth weight (WHO, 2023). Hence, strengthening maternal nutrition through dietary counselling, iron and folic acid supplementation, and BMI-based monitoring during antenatal visits is crucial. Interventions should ideally begin in the preconception phase to optimize maternal energy stores and improve fetal growth potential (Akter et al. 2012; Mamidi et al. 2022). Educating couples about the significance of maternal health and nutrition could further enhance pregnancy outcomes and reduce neonatal complications.

Despite the strengths of this study, including its analytical design and emphasis on both maternal and paternal influences, several limitations should be noted. The sample was limited to two hospitals in Dhaka and selected through convenience sampling, restricting the generalizability of the findings. Data were collected only during the third trimester, preventing the assessment of longitudinal changes in fetal growth. In addition, potential inter-observer variation in ultrasound measurements could not be completely eliminated, though standard protocols were maintained. Moreover, certain variables such as pre-pregnancy weight, maternal diet, and physical activity were not included, which may have influenced the results.

Future research should build on these findings by incorporating a larger and more diverse sample across multiple regions of Bangladesh, tracking fetal growth throughout all trimesters, and analyzing additional maternal factors such as nutritional intake, weight gain patterns, and micronutrient levels. Further studies should also consider fetal sex differences and the combined effects of genetic and environmental factors on intrauterine growth. Developing population-specific fetal growth charts based on local anthropometric data would help clinicians better assess fetal well-being and detect deviations from normal growth trajectories.

Conclusions

In conclusion, this study demonstrates that maternal anthropometric characteristics, particularly weight and BMI, are strongly associated with fetal growth parameters during the third trimester of pregnancy, while paternal influences appear less pronounced. These findings underscore the critical role of maternal nutrition and body composition in determining fetal development. Public health initiatives emphasizing early nutritional intervention, weight monitoring, and antenatal care can significantly improve pregnancy and neonatal outcomes in the Bangladeshi population.

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