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Maternal Anthropometry and Low Birth Weight: A Review

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Low birth weight is one of the major causes of neonatal disease and death. Low birth weight comprises of mounting serious health problems in adult life and is a cause of concern in many countries, India being one of them. Various factors influence and determine the risk of delivering an infant with a birth weight less than 2500g. Maternal anthropometry is one such factor which has an association with pregnancy outcome. More so, nutritional status assessment a prominent factor for assessment for risk of low birth weight depends heavily on maternal anthropometric factors, some reflect the maternal nutritional status or energy stores such as height, pre-pregnancy weight, pre-pregnancy BMI, while others reflect the changes during the course of pregnancy such as weight and weight gain patterns. Studies done globally and in India have reported various such indicators along with their cut offs for determining the risk of low birth weight, this review focuses on few such crucial maternal anthropometric parameters and their effect on neonatal birth weight.

Keywords: Maternal anthropometry, Low birth weight, Nutritional status.

Birthweight is an influential predictor of infant's growth and survival and is predominantly determined by mother's own health and nutritional status prior to conception as well as during pregnancy. Low birth weight (LBW) (<2500 g) results in impaired growth, a higher risk of mortality and morbidity[1], impaired brain development[2] and risk of chronic diseases in later life[3]. A Unicef-publication from 2014 states the worldwide situation of LBW in developing countries as more than twice the level in developed countries, 16.5 % versus 7 % , where South Asia has the highest incidence of low birth weight with 28 % having one in four new-borns who weigh less than 2,500 grams[4]. Especially Indian women have smaller babies attributed to their shortness and thinness and consume less calories before as well as during pregnancy, their ethnicity or racial differences can also be an indirect cause of LBW[5]. Similarly another study reports prevalence of low birth weight to be higher in Asia than elsewhere because of undernutrition of mother prior and during pregnancy[3]. Thus one may say that there are several factors which underline the cause of LBW and many of them are interdependent. One of the most important causes of all is mother's anthropometry which is a proximate indicator of mother's nutritional status. Maternal anthropometry includes an array of various maternal body measurements this review includes the effect of maternal anthropometry on birth weight through studies on pre-pregnancy and pregnancy weight, pre-pregnancy body mass index (kg/m^2), maternal weight gain patterns and height.

Pre-pregnancy weight and body mass index

Weight and body mass index before pregnancy are closely linked to the pregnancy outcome. The pre-pregnancy weight of the mother

is influenced by both genetic and environmental factors. The maternal body weight is genetically determined and, genes that control adiposity or lean body mass can also be expressed in the infant as well. However, even in the absence of such genetic expression, maternal weight prior to conception replicates the nutritional reserves that are available intrauterine for the growing fetus.[5] Shamsun Nahar, 2005[6] in one study suggested that the best predictor as a continuos variable for the birth weight was weight prior to conception. Further, he suggested that at registration with each 1 kg increase in maternal weight was associated with around 200 g increase in birth weight as well. In a review on association between maternal BMI, energy intake and pregnancy outcomes, Neggers and Goldenberg[7] found that weight prior to conception time and again predicted most infant measurements as against various other maternal factors. Several studies have also reported that mothers who have pre-pregnancy weight of <40 kg have a three times greater risk of having an LBW baby as compared to mothers with pre-pregnancy weight of >40 kg.[8-10.]

Pre-pregnancy body mass index on the other hand is the measure of pre-pregnancy weight in kilograms divided by the height in meters square. This index aids in determining the nutritional status of the mother prior to conception. The relationship between pre-pregnancy BMI and growth of the foetus intrauterine is biologically probable. However, the direct pathway by which it affects the infant birth weight is not known. A large body of data links the pre-pregnancy BMI to adverse pregnancy outcomes which includes fetal death, preeclampsia, gestational diabetes, low birth weight, and complicated deliveries[11.] Few studies indicate pre-pregnancy BMI to be the best indicator of birth weight of the child especially when measured d" 13 weeks[11-13.] Recent Indian studies on rural populations have also highlighted that low pre-pregnancy BMI is linked with high risk of low birth weight infants[14,15] whereas other studies indicate that women can minimize the risk of low birth weight babies by maintaining normal pre-pregnancy BMI[12, 16.] Thus inappropriate pre-pregnancy weight and body mass index can predispose adverse events in development and growth of the infant.

Maternal weight and weight gain patterns

Maternal weight and weight gain patterns are crucial and strongest predictors of placental weight and birth weight[17.] Maternal weight gain results from diverse factors which includes maternal dietary intake, pre pregnancy weight and height, gestational period, and fetal size. Many studies done globally and in India alone have highlighted that even in presence of other confounding factors such as socio-demographic factors maternal weight and weight gain patterns have an independent influence on birth weight of the infant. A meta-analysis on 25 studies related to maternal anthropometric indicators across 20 countries, reported that the weight attained during pregnancy had a strong relationship with infant birth weight and intrauterine growth[18.]

Quite a lot of cut-off points have been recommended by various studies done globally and in India. Kramer's meta-analysis[5], and studies from developing countries[19-25] have identified weight of the mother (<45kg), as a potential risk factor for babies born low birth weight. A variable range of average maternal weight is reported across India ranging from 41.7kg[26], 45kg[27], 51.2kg[3], Tripathi *et al*.,[8], and Karan Mathur[28] provided a cut off range between 40kg to 45 kg for predicting risk of low birth weight in Asian countries regardless of the gestational age . Whereas another study done by Sachin Mumbare 2012[29] and Sudha G[30] indicated weight d"55kg and d" 52kg as the risk factor for low birth weight. However a review of study conducted by Mija-tesse Ververs,2013[31] suggested that as there is no potential scientific evidence to determine which weight gain cut-off is most sensitive to low birth weight, and as weight gain changes every trimester and at least two measurements are needed, this indicator may not be suitable for screening purposes in case of any emergencies.

The relationship between a woman's dietary intake during pregnancy and the birth weight of an infant is a multifaceted process and is moderated through maternal weight gain patterns during pregnancy. In 2009, the Institute of Medicine (IOM) revised the guidelines for weight gain during gestation based on pre-pregnancy BMI, aimed at achieving positive pregnancy outcomes.[32]

Haugen, M, 2014[33] found that for normal and overweight women gestational weight gain greater than IOM standard increased the risk for unfavourable birth outcome. Fredrick *et al*, 2008[34]

Pre-pregnancy BMI	BMI kg/m2 (WHO)	Total weight gain range	Rates of weight gain- 2nd and 3rd trimester
Underweight	<18.5	12.5-16	0.5
Normal weight	185-24.9	11.5-15	0.4
Overweight	25-29.9	7-11.5	0.3
Obese (includes all categories)	≥30	5-9	0.2

reported that gestational weight gain within the limits set by guidelines of IOM was linked to a decreased risk of delivering infants who are low birth weight. Some recent studies from Asia have concluded that IOM guidelines are suitable for the Asian population, [35-36]. However, few Indian studies have been reported on comparison to the standards prescribed by IOM so far[37] which have suggested that excess as well as less weight gain during pregnancy could lead to adverse pregnancy outcomes.

Chihara, I., *et al*, 2015[38] found that women with inadequate weight gain in pregnancy were found to deliver low birth weight infants. An Indian observational cohort study on pregnant women carried out by Radhakanta Pal , 2017[39] reported that antenatal weight gain is significantly related to pre-pregnancy BMI with a significant increase in antenatal complications and caesarean section related to obesity. A study done by Manerkar *et al*, 2017[40] reported the average gestational weight gain to be higher for pregnant mothers who delivered normal weight babies as against those who delivered babies with low birth weight.

Maternal height

This indice of anthropometry indicates the nutritional status of the mother in the past and is considered as the proximate indicator of mother's nourishment in her childhood. Several studies done globally[13,41,42] and in India in recent past[25,43] and latest[44,45] on maternal factors associated with low birth weight highlight that the short stature of mother can contribute to low birth weight infants. Further there have been studies undertaken to identify the height cut offs for identifying the risk for low birth weight. According to studies reported in the west[46] maternal height less than 156cm increased the risk of low birth weight in women whereas a case control study with matched pairs done on rural pregnant mothers of Maharashtra reported that maternal height of d"145 cm results in infants delivered low birth weight[29]. Most studies[45, 47, 48] indicate a maternal height ranging from <146 cm to <150 cm with statistical significance for LBW. However, a review by Mija-tesse Ververs, 2013[31] suggested the paucity of appropriate cut offs for maternal heights.

Maternal sitting height

Sitting height is defined as the measurement from the vertex of the head to the base when seated[49], It allows the measurement of the stature in terms of head and trunk, mothers sitting height too depicts the past nutritional status in terms of her childhood and pubertal growth. This anthropometric measurement is less reported in the literature; however it is one of the simplest techniques to determine the risk of low birth weight. European studies have been done on identifying the nationwide references for sitting height and its ratio[50].

So far no Indian study has reported regarding the sitting height measurements and risk of low birth weight however a study conducted in Ranchi by Sudip datta banik, 2016[51] stated that the average sitting height of women is 74.3cm and further states that sitting height measurements would be an appropriate index over the currently used body mass index to identify the nutritional status. Similar approach in terms of pregnant women however is yet to be explored.

CONCLUSION

Low birth weight is a burning issue worldwide as well as in a developing country like India. It is of public health importance as well as the measure of quality of life and survival of the new generation. This review thus emphasizes the independent role of maternal anthropometric indicators and its interrelationship with low

birth weight especially because pre-pregnancy weight,BMI and weight gain happen to be the modifiable risk factors of adverse pregnancy outcomes.

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