MATERNAL WEIGHT, HEIGHT AND RISK OF POOR PREGNANCY OUTCOME IN AHMEDABAD, INDIA

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ABSTRACT

This paper explores the relationships between maternal weight, height and poor pregnancy outcome using a data set from a case-control study of low birth weight (LBW) and perinatal mortality in Ahmedabad, India. Maternal height and weights were compared between mothers of 611 perinatal deaths, 644 preterm-LBW, and 1465 normal birth weight controls as well as 617 small-for-gestational age (SGA) and 1851 appropriate-for-gestational-age (AGA) births. Weight and height were much lower in this population compared to western standards. Low weight and height were associated with increased risk of perinatal death, prematurity and SGA. After adjusting for confounders, maternal weight remained significantly associated with poor pregnancy outcomes, whereas height was only weakly associated. Attributable risk estimates show that low weight is a much more important contributor to poor outcome than low height. Improvement in maternal nutritional status could lead to substantial improvement in birth outcome in this population.

Key words: *Maternal weight, Maternal height, Pregnancy outcome, Perinatal mortality.*

Low birth weight (LBW; <2.5 kg) and perinatal mortality are important public health problems in developing countries(l,2), particularly in the Indian subcontinent, where LBW rates are 30-50%, which are among the highest in the world(3). Factors responsible for low birth weight differ substantially between developed and developing countries(4). Associated with such a high rate of low birth weight is a high rate of perinatal mortality—the official figure of 56 perinatal deaths per 1000 births for India(5) seems to be an underestimate(6).

Reports from developed and developing countries show that maternal anthropometric measurements are associated with birth outcome(4,7-9). We have reported that low maternal weight is an important risk factor for PNM and LBW(10,ll). In this paper we explore the association of maternal weight, height and two weight-height indices with pregnancy outcome, in order to determine which anthropometric measure is the best predictor of poor perinatal health.

Material and Methods

The study methods have been reported earlier(10,l 1) and only a brief description is provided here. The data used in this analysis was collected in a case-control study from three teaching hospitals in Ahmedabad, India during 1987-1988. The cases consisted of two groups—611 perinatal deaths (stillbirths >500 g and early neonatal deaths before discharge), and 1317 LBW-a 20%

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sample of all LBW babies. Controls were selected from births of normal weight (>2.5 kg) which occurred immediately following the selected cases, and survived the perinatal period (n=1465). Information on sociodemographics, obstetric history, use of antenatal care and details of delivery were obtained by maternal interview and abstraction of medical records after delivery and before discharge from the hospital. Mothers were weighed using spring scales to the closest kilogram and height was measured to the closest millimetre. Maternal weight was divided into categories of ≤40, 41-45, 46-50 and >50 kg and height was divided into <145, 145-149, 150-154 and 2:155 cm. The highest weight and height categories used as reference groups in analysis. We also calculated the weight-height ratio index (WHRI=weight in kg/[height in cm]^2) and weight-height product index (WHPI = [weight in kg x height in cm x 100]/ [45 x 150]).

The data was analyzed in three sets of case-control comparisons of maternal anthropometric measures. The first set consisted of comparison of 611 perinatal deaths and 1465 controls. For the second set LBW cases were divided into preterm (<37 weeks) and term (37 weeks and more) groups, and 644 preterm-LBW cases were compared with 1465 Controls. Length of gestation was assessed by date of the last menstrual period and by Cuppuro's method which is a simplification of the Dubowitz scoring system(12). For assessing risk factors for SGA we re-divided all the LBW cases (n=1317) and controls (n=1465) into small for gestational age (SGA <10th percentile), appropriate for gestational age (AGA = 10 to 90th percentile) and large for gestational age (LGA >90th percentile) using standards developed by Bhatia *et al.*(17) in India. The third set of case-control comparisons was made between 617 SGA and 1851 AGA infants after excluding 295 LGA infants and 19 infants with incomplete data.

Odds ratios and 95% confidence intervals were calculated for maternal weight, height and weight-height indices for perinatal death, preterm birth and SGA(14). Logistic regression(14) was used to adjust for potential confounding factors such as maternal age, parity, obstetric history, antenatal care, health problems during pregnancy and delivery which were found significantly associated with the outcomes in our previous analysis(10,ll). Adjusted odds ratios and 95% confidence intervals were calculated from the beta coefficients and standard errors(14). Odds ratios whose confidence intervals did not overlap one were taken as statistically significant.

To assess the overall effect of lower height and weight on these poor birth outcomes, we estimated attributable risks(16) for maternal weight, height and weight-height indices, using the prevalence of these factors among the controls and the adjusted odds ratios from the logistic regression.

Results

We compared maternal anthropometric risk factors for 611 perinatal deaths and 644 preterm-LBW cases with 1465 controls infants. We also compared the same risk factors for 617 SGA with 1851 AGA infants. The distribution of perinatal deaths, preterm-LBW, SGA, AGA and controls by maternal weight, height WHRI and WIIPI and unadjusted odds ratios are given in *Table I.* More than two third of the control mothers and about three fourths of the cases had weight less than 50 kg, which suggests most mothers in this population were underweight. The unadjusted odds ratios for low

TABLE I– *Maternal Weight, Height and Odds Ratios for Perinatal Death, Preterm and SGA Births in Ahmedabad*

n =	Controls 1465	PN deaths 611		Preterm-LBW 644		SGA 617	AGA 1851	
	%	%	OR	%	OR	%	%	OR
Weight (kg)								
≤40	11.6	22.6	3.3*	28.9	5.6*	27.1	18.9	2.6
41-45	27.3	29.0	1.8*	32.0	2.7*	31.0	29.6	1.9*
46-50	29.0	22.6	1.3	20.3	1.6*	24.1	26.7	1.6*
>50	29.5	17.5	1.0	31.0	1.0	12.2	21.9	1.0
Mean	48.1	45.4**		44.0**		44.2	46.4**	
SD	6.79	6.94		6.53		6.21	6.75	
Height (cm)								
<145	4.9	7.2	2.4*	8.2	2.8*	9.7	6.4	2.2*
145-149	20.8	27.8	2.2*	30.1	2.5*	28.5	25.1	1.6*
150-154	37.3	29.6	1.7*	39.4	1.7*	39.2	37.7	1.8*
<155	35.7	21.8	1.0	21.1	1.0	20.6	29.6	1.0
Mean	153.2**	151.7		151.5**		151.3	152.4**	
SD	5.07	4.69		5.10		5.26	5.14	
Weight-Height Ratio Index								
<0.18	14.7	24.4	2.7*	29.2	4.5*	27.6	21.2	1.9*
0.18-0.19	27.9	30.6	1.8*	33.9	2.7*	33.1	30.7	1.6*
0.20-0.21	17.1	13.4	1.3	14.3	1.9*	13.6	15.3	1.3
0.22+	37.4	23.1	1.0	16.6	1.0	19.9	29.7	1.0
Mean	0.2050	0.1968**		0.1917**		0.1931	0.1995**	
SD	0.0264	0.0275		0.0250		0.0243	0.0262	
Weight-Height Product Index								
<90	9.3	19.8	3.4*	25.5	5.8*	25.6	15.8	2.6*
90-99	20.5	22.4	1.7*	25.3	2.6*	24.8	22.7	1.7*
100-109	24.3	22.4	1.5*	22.7	2.0*	22.9	25.3	1.4*
110+	43.0	26.8	1.0	20.5	1.0	20.9	33.1	1.0
Mean	109.3	102.2**		99.0**		99.3	104.9**	
SD	17.24	17.28		16.54		15.78	17.12	

(Percentages in columns are not adding up to 100 because % for cases and controls with missing data are not shown here).

(* p value <0.05, ** p value <0.01, Con. = controls, Perinatal deaths and Preterm-LBW were compared with the same 1465 controls).

maternal weight are significant for all outcomes and increase with decreasing maternal weight. The association of maternal weight was much stronger for preterm-LBW birth than SGA and perinatal death. Mean weight was significantly lower (p value <0.01) in cases than controls for all three outcomes *(Table I).*

Maternal height showed similar but less strong associations with the three outcomes. Both the weight-height indices showed similar and significant increasing risks (odds ratios) with lower indices. The distribution of WHRI shows that most of the mothers have low weight as compared to height. The odds ratios for WIIPI are somewhat larger than that for WHRI. Mean height, WHRI and WIIPI were significantly lower in cases as compared to controls.

The results of multivariate analysis are presented in *Table II.* After adjusting for height and other important confounding variables the odds ratios for weight remained statistically significant and similar to the crude odds ratios for all three outcomes. However, the adjusted odds ratios (AOR) for height are substantially lower than the unadjusted odds ratios, and most are statistically either insignificant or only marginally significant. The AOR for the two weight-height indices were statistically significant and similar in magnitude to unadjusted odds ratios for all the three outcomes.

The attributable risks show that low maternal weight was associated with a substantial proportion of risk of perinatal death (37%), preterm-LBW (56%) and SGA (40%), while low height, independent of weight contributed only moderately to the risk *(Table II).*

Discussion

Our data show that mothers in this population are undernourished (as measured by anthropometry) as compared to western populations. In the Collaborative Perinatal Project in the USA 5% of mothers had pre-pregnancy weights less than 45.5 kg and 16% had weight less than 50 kg in (17), while more than 37% and 68% of the controls in our study had postpartum weights less than 46 kg and 51 kg respectively. In the 1958 British Perinatal Mortality Survey, 21% mothers were shorter than 155 cm(18), while 63% of controls in this study had heights below this level.

We could not obtain reliable information on pre-pregnancy weight or weight gain during pregnancy due to case-control nature of this study, hence we used postpartum weight as a measure of maternal nutritional status. Mollar *ex al.* have shown in African women with a total pregnancy weight gain of 6 kg, that maternal weight 24 hour postpartum was equal to weight at 14 weeks of gestation(19). As mean weight gain during pregnancy in India is only about 6 kg (Anderson MA. Relationship between maternal nutrition and child growth in rural India, Doctoral thesis Tufts University 1989, p 159. Unpublished), it is felt that postpartum weight closely reflects pre-pregnancy weight in our population. The association of maternal weight and height with poor perinatal outcome, found in our study, have been reported from developed and developing countries(4,9,20). In our analysis maternal weight remained a significant risk factor for perinatal mortality, preterm birth and SGA even after adjusting for height and other important confounding factors, indicating that weight has an independent effect on perinatal outcome, which agrees with Kramer's conclusion from a

TABLE II–*Adjusted Odds Ratios and Attributable Risks for Perinatal Death, Preterm and SGA Birth Associated with Maternal Weight, Height and Weight-Height Indices.*

	Perinatal death		Preterm-LBW		SGA	
	AOR (9% CI)	AR%	AOR (95% CI)	AR%	AOR (95% CI)	AR%
Weight (kg)						
≤40	2.9* (1.8-4.7)	13.9	4.9* (3.3-7.4)	28.6	2.4* (1.7-3.4)	16.0
41-45	1.7* (1.2-2.5)	12.1	2.5* (1.7-3.5)	18.1	1.7* (1.3-2.4)	12.5
46-50	1.6* (1.1-2.3)	11.1	1.7* (1.2-2.5)	8.9	1.7* (1.2-2.3)	11.3
>50	1.0		1.0		1.0	
Total AR%		37.1		55.6		39.8
Height (cm)						
<145	1.2 (0.6-2.1)	0.8	1.2 (0.7-2.0)	0.8	1.5* (1.0-2.2)	2.7
145-149	1.3 (0.9-1.9)	5.1	1.5* (1.1-2.1)	8.5	1.2 (0.9-1.6)	4.2
150-154	1.4* (1.0-1.9)	12.2	1.3* (1.0-1.7)	9.1	1.3* (1.0-1.7)	9.5
>155	1.0		1.0		1.0	
Total AR%		18.1		18.4		16.4
Weight-Height Ratio Index						
<0.18	3.0* (2.0-4.4)	17.5	4.9* (3.4-6.8)	25.2	1.9* (1.5-2.6)	13.4
0.18-0.19	2.0* (1.4-2.9)	16.6	2.9* (2.1-4.0)	23.3	1.6* (1.3-2.1)	13.0
0.20-0.21	1.6* (1.0-2.4)	6.1	2.0* (1.4-3.0)	7.5	1.3 (0.9-1.8)	3.2
0.22+	1.0		1.0		1.0	
Total AR%		40.2		56.0		29.6
Weight-Height Product Index						
<90	2.9* (1.9-4.4)	12.0	5.2* (3.7-7.3)	20.6	2.5* (1.9-3.4)	15.8
90-99	1.5* (1.1-2.2)	7.0	2.4* (1.8-3.3)	15.1	1.7* (1.3-2.2)	10.6
100-109	1.8* (1.2-2.5)	13.9	1.9* (1.4-4.6)	11.5	1.4* (1.1-1.8)	6.8
110+	1.0		1.0		1.0	
Total AR%		32.9		47.2		33.2

(AOR = Adjusted odds ratio, AR% = Attributable risk per cent, CI = confidence interval, * = Statistically significant AOR).

meta-analysis of published studies(4) and with a more recent report by Ferraz *et al.*(8).

Since, the association of height was much weakened, and the gradient in AOR disappeared after adjustment for weight and other important confounders, the effect low height (<155 cm) was probably mediated through low weight and other factors. The risk associated with moderate height (150-154 cm) remained statistically significant even after adjusting for confounders suggesting that moderate height may be somewhat independent risk factor. Ferraz *et al.* did find an association of low height (<150 cm) with increased risk of IUGR, but not with preterm birth(8). Peters *et al* reported that among British mothers, height was associated significantly with birth weight(21).

Some reports have shown that "thin" (low weight for height) women have a higher risk of IUGR and preterm birth than "average" women(4,22). While, Bhatia *et al.* have reported that the WIIPI was more closely associated with birth weight and preterm delivery than WHRI(23), our analysis shows that both indices were more or less equally associated with the three outcomes, after adjustment.

Odds ratios or relative risks measure the strength of an association, but attributable risk (AR) estimates are needed to assess the overall importance of any risk factor and the potential effect of its elimination in the community. Few studies in the past have tried to measure AR. In our study, AR estimates suggest that lower maternal weight (<50 kg) is a much more important risk factor than low height. The AR estimates of this study are higher than estimated by Kramer(4) because of the higher odds ratios and higher prevalence of low weights in our population. AR values for weight-height indices suggest that almost one third perinatal deaths and SGA births, and almost half the preterm births are attributable to low weight for height. However,, since maternal weight is routinely recorded and modifiable even in adults, and weight-height indices are difficult to calculate, we believe that maternal weight is the most practical and useful predictor of perinatal risk.

Our results clearly show that low maternal nutritional status plays an important role in poor pregnancy outcomes in this population. As our sample of mothers was similar to all mothers delivering in government institutions in Ahmedabad city which is similar to any large city in India, the results could be generalized to urban India as a whole. The policy implications are obvious; efforts to improve maternal nutrition should result in substantial improvement in birth outcomes. This could be achieved by improving coverage and utilization of the Integrated Child Development Services, a centrally supported program which covers about one third of India and has a component of supplemental feeding for pregnant and lactating women. Data from national studies (ICMR and NNMB) show that nutritional status of rural women is worse than urban women(24), and rural women have to do much more strenuous physical work. Hence, it can be speculated that poor nutrition would be equally if not more, important in rural mothers as a risk factor for poor pregnancy outcome.

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