Nutritional Status in Pregnancy and Prediction of Low Birth Weight: Evaluation of a Table of Reference

Rasaki A. Sanusi and Victoria A. Oredipe
Department of Human Nutrition, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria

Abstract

Context: Maternal nutrition, before and during pregnancy is an important determinant of birth weight and the high rate of low birth weight (LBW) in developing countries has been attributed to poor maternal nutrition. Maternal nutrition is difficult to assess during pregnancy because of the physiological alterations, yet there is the need to identify women whose weight profile suggest the delivery of LBW babies.
Objective: A reference standard of weight for height by week of pregnancy has been developed specifically for pregnant women in Ibadan. The validity of this table in predicting LBW is being evaluated.
Study Design, Setting and Subjects: The data of 255 pregnant women who attended the University College Hospital, Ibadan for antenatal and delivery care between 1996 and 1999 were used to test the validity of a reference table in predicting LBW. The maternal weight at 26wks, 34wks and 39/40wks was compared with the predicted weight for specific height in the reference table. The maternal weights at those points in gestation were correlated with delivery of LBW infants.
Results: The accuracy of this table of reference in predicting LBW is described by a sensitivity of 50% at 26 weeks and 33% at 39/40weeks; a specificity of 93% at 26weeks and 100% at 39/40weeks and an overall accuracy of 92% at 26wks and 96% at 39/40wks.
Conclusion: The table of reference of weight for height by week of gestation, despite its limitations, comes useful in antenatal care settings in identifying women at risk of delivering LBW infants.

Key Words: Nutrition, Pregnancy, Maternal Weight, Birthweight [Trop J Obstet Gynaecol, 2002, 19: 63-67]

Introduction

Maternal nutritional status has been identified as an important determinant of pregnancy outcome [1], since the birth weight of infants is, to a large extent, dependent on maternal nutritional status both before and during pregnancy [2, 3]. Therefore birth weight is an indirect mechanism of assessing maternal nutrition [4] and it is also crucial to survival of the infants. Pregnant women, lactating mothers and young children represent the group most vulnerable to nutritional deprivations since their nutrient requirements are proportionally higher and the effects of malnutrition in them may be severe and long-lasting [5,6,7]. Although demand for energy and other nutrients is increased during pregnancy [8], maternal metabolic adaptation has been reported [9]. Furthermore, some women in developing countries deliberately lowered their dietary intake in order to have smaller babies [10, 11]. Emerging evidence that small-for-date infants at birth have increased health risks later in life [12,13] also makes low birth weight (LBW), a cause for concern.

This study was undertaken in response to the clearly defined need to provide guidance to national health services on practical ways of assessing women's nutritional status particularly during pregnancy [14]. The main objective of this study was to evaluate the accuracy and validity of a reference table of 'weight for height by week of pregnancy' and its value in predicting low birth weight.

Materials and Methods

This table of reference is a modification of the one developed by Gueri *et al* [15]. The modification is the use of weight for height reference data, which is specific to our location. The table of reference was designed based on the assumptions that:
(a) the pre-pregnant weight (PPW) of the women is that predicted by their heights. For this purpose a study of weight and height of young adults (18-24 years old) in Ibadan was undertaken.
(b) the average increase in weight throughout pregnancy should be 20% of the PPW in women who deliver babies with normal birth weight.
(c) a reference woman's weight increased by 1.7% of PPW in the first trimester and the remaining 18.3% gain over the PPW was achieved uniformly during the second and third trimesters.

In the present study, the table of reference was evaluated with retrospective data from the University College Hospital, Ibadan. Data harvested

Correspondence: *Dr R.A. Sanusi, Department of Human Nutrition,Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria.*

Table 1

Reference Standard: Weight for Height per Week of Pregnancy

HT	PP WT	GESTATION (WEEKS)																									
(m)	(Kg)	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
1.40	42.60	43.3	43.6	43.8	44.1	44.4	44.7	45.0	45.3	45.6	45.9	46.2	46.4	46.7	47.0	47.3	47.6	47.9	48.2	48.4	48.7	49.0	49.3	49.6	49.9	50.2	50.5
1.41	43.23	43.9	44.1	44.4	44.7	45.0	45.3	45.6	45.9	46.2	46.5	46.8	47.1	47.4	47.7	48.0	48.3	48.5	48.8	49.1	49.4	49.7	50.0	50.3	50.6	50.9	51.2
1.42	43.84	44.6	44.8	45.1	45.4	45.7	46.0	46.3	46.6	46.9	47.2	47.5	47.8	48.1	48.4	48.7	49.0	49.3	49.6	49.9	50.2	50.5	50.8	51.1	51.4	51.7	52.0
1.43	44.46	45.2	45.5	45.8	46.1	46.4	46.7	47.0	47.3	47.6	47.9	48.2	48.5	48.8	49.1	49.4	49.7	50.0	50.3	50.6	50.9	51.2	51.5	51.8	52.1	52.4	52.7
1.44	45.08	45.8	46.1	46.4	46.7	47.0	47.3	47.6	47.9	48.2	48.5	48.8	49.1	49.4	49.7	50.0	50.3	50.6	50.9	51.3	51.6	51.9	52.2	52.5	52.8	53.1	53.4
1.45	45.69	46.4	46.7	47.0	47.3	47.6	47.9	48.2	48.5	48.8	49.2	49.5	49.8	50.1	50.4	50.7	51.0	51.3	51.6	51.9	52.2	52.5	52.9	53.2	53.5	53.8	54.1
1.46	46.31	47.0	47.3	47.6	47.9	48.2	48.5	48.8	49.1	49.5	49.8	50.1	50.4	50.7	51.0	51.3	51.6	52.0	52.3	52.6	52.9	53.2	53.5	53.9	54.2	54.5	54.8
1.47	46.93	47.7	48.0	48.3	48.6	48.9	49.2	49.6	49.9	50.2	50.5	50.8	51.1	51.5	51.8	52.1	52.4	52.7	53.0	53.4	53.7	54.0	54.3	54.6	55.0	55.3	55.6
1.48	47.54	48.3	48.6	48.9	49.2	49.6	49.9	50.2	50.5	50.9	51.2	51.5	51.8	52.1	52.4	52.8	53.1	53.4	53.8	54.1	54.4	54.7	55.0	55.3	55.7	56.0	56.3
1.49	48.16	48.9	49.2	49.5	49.8	50.1	50.5	50.9	51.2	51.5	51.9	52.2	52.5	52.8	53.1	53.4	53.7	54.0	54.4	54.7	55.1	55.4	55.7	56.0	56.4	56.7	57.0
1.50	48.78	49.6	49.9	50.2	50.6	50.9	51.2	51.6	51.9	52.2	52.5	52.9	53.2	53.5	53.8	54.2	54.5	54.9	55.2	55.5	55.9	56.2	56.5	56.8	57.2	57.5	57.8
1.51	49.39	50.2	50.5	50.8	51.2	51.5	51.8	52.2	52.5	52.8	53.2	53.5	53.8	54.2	54.5	54.8	55.2	55.5	55.8	56.2	56.5	56.8	57.2	57.5	57.9	58.2	58.5
1.52	50.01	50.8	51.1	51.4	51.8	52.1	52.4	52.8	53.1	53.5	53.8	54.2	54.5	54.8	55.2	55.5	55.8	56.2	56.5	56.9	57.2	57.5	57.9	58.2	58.5	58.9	59.2
1.53	50.63	51.5	51.8	52.1	52.5	52.8	53.2	53.5	53.9	54.2	54.5	54.9	55.2	55.6	55.9	56.3	56.6	56.9	57.3	57.6	58.0	58.3	58.7	59.0	59.3	59.7	60.0
1.54	51.25	52.1	52.4	52.7	53.1	53.4	53.8	54.1	54.5	54.8	55.2	55.5	55.9	56.2	56.6	56.9	57.3	57.6	58.0	58.3	58.7	59.0	59.3	59.7	60.0	60.4	60.7
1.55	51.86	52.7	53.0	53.4	53.7	54.1	54.4	54.8	55.1	55.5	55.8	56.2	56.5	56.9	57.2	57.6	57.9	58.3	58.6	59.0	59.3	59.7	60.0	60.4	60.7	61.1	61.4
1.56	52.48	53.3	53.6	54.0	54.3	54.7	55.0	55.4	55.7	56.1	56.5	56.8	57.2	57.5	57.9	58.2	58.6	58.9	59.3	59.7	60.0	60.4	60.7	61.1	61.4	61.8	62.1
1.57	53.09	53.9	54.2	54.6	54.9	55.3	55.6	56.0	56.4	56.7	57.1	57.4	57.8	58.2	58.5	58.9	59.2	59.6	60.0	60.3	60.7	61.0	61.4	61.8	62.1	62.5	62.8
1.58	53.71	54.6	54.9	55.3	55.6	56.0	56.4	56.7	57.1	57.5	57.8	58.2	58.6	58.9	59.3	59.6	60.0	60.4	60.7	61.1	61.5	61.8	62.2	62.6	62.9	63.3	63.7
1.59	54.33	55.2	55.5	55.9	56.3	56.6	57.0	57.4	57.7	58.1	58.5	58.8	59.2	59.6	59.9	60.3	60.7	61.0	61.4	61.8	62.1	62.5	62.9	63.3	63.6	64.0	64.4
1.60	54.95	55.9	56.2	56.6	57.0	57.3	57.7	58.1	58.5	58.9	59.2	59.6	59.9	60.3	60.7	61.0	61.4	61.8	62.2	62.5	62.9	63.3	63.6	64.0	64.4	64.8	65.2
1.61	55.56	56.5	56.8	57.2	57.6	58.0	58.3	58.7	59.0	59.5	59.8	60.2	60.6	61.0	61.3	61.7	62.1	62.5	62.9	63.2	63.6	64.0	64.4	64.7	65.1	65.5	65.9
1.62	56.18	57.1	57.4	57.8	58.2	58.6	59.0	59.3	59.7	60.1	60.5	60.9	61.2	61.6	62.0	62.4	62.8	63.1	63.5	63.9	64.3	64.7	65.0	65.4	65.8	66.2	66.6
1.63	56.79	57.7	58.0	58.4	58.8	59.2	59.6	59.9	60.3	60.7	61.1	61.5	61.9	62.2	62.6	63.0	63.4	63.8	64.2	64.6	64.9	65.3	65.7	66.1	66.5	66.9	67.3
1.64	57.42	58.4	58.7	59.1	59.5	59.9	60.3	60.7	61.1	61.5	61.9	62.2	62.6	63.0	63.4	63.8	64.2	64.6	65.0	65.4	65.7	66.1	66.5	66.9	67.3	67.7	68.1

PPWT: Pre-Pregnancy Weight **HT**: Height

from ante-natal care records and birth registers included: maternal age, height, parity, number of ante-natal clinic visits, weight at each attendance, mode of delivery, gestation length, birth weight and gender of neonates. The women whose data were excluded were those with multiple pregnancy, instrumental delivery, diabetes mellitus, and gross oedema.

Analysis of data was done using Microsoft-Excel 5.0; 1995 and Statistical package for the Social Sciences (SPSS) for Windows version 10. Accuracy of the table of reference in predicting LBW was assessed based on and limited to the parameters of 'sensitivity,' 'specificity,' 'positive predictive value' and 'negative predictive value'.

Results

The table of reference is presented as Table 1. Only two hundred and fifty-five subjects met the inclusion criteria. The main characteristics of the population used for evaluation are presented in Table 2.

A detailed look at the age distribution showed that 4 (1.5%) were less than 20yrs old while 5 (1.9%) were older than 40yrs. Over 80% of these women attended the antenatal clinic five or more times before delivery. Duration of pregnancy was 37-40 weeks in 175 (68.6%), 41-44 weeks in 66 (25.8%) and 33-36 weeks in 14 (5.4%) of the subjects. The birth weight of the babies showed that 174 (68%) weighed between 2.5kg and 3.5kg, 47 (18.4%) weighed between 3.6kg and 4.0kg while 24 (9.4%) weighed less than 2.5kg . The maternal weights at 26 weeks, 34weeks and 39/40weeks of gestation were between 80% and 120% of the predicted weights in 75% of the women.

In over 90% of babies with birth weight over 2.5kg, the maternal weights at 26, 34 and 39/40 weeks were greater that 80% of the predicted weights [x^2: 5.3, 24.8, 36.0. respectively; $p<0.05$] (Table 3).

The specificity of this table of reference was 93% at 26 weeks, 99% at 34 weeks and 100% at 39/40 weeks. The sensitivity was 50%, 16.6% and 33% at 26, 34 and 39/40 weeks respectively. The positive predictive values, the negative predictive values and the overall accuracy is shown and explained in Tables 4 and 5.

Table 2

Summary Description of Study Subjects

	Range	*Mean*	*SD*
Age (yrs)	17-40	30.72	4.31
Height (m)	1.45-1.78	1.62	0.06
Parity	0-7	1.68	1.39
Weight at 26wks(kg)	40-94.1	67.67	10.71
Weight at 34wks(kg)	45-114	71.22	11.85
Weight at Term(kg)	44-115	73.59	12.73
No. of Clinic Visits	3-12	7.0	1.9
Gestation Duration(wks)	33-43	39.5	1.69
Birth Weight (Kg)	1.8-4.5	3.15	0.49
% of standard at 26wks	73-164	110.29	16.39
% of standard at 34wks	75-185	109.54	17.16
% of standard at Term	75-181	109.42	17.15

Discussion

The low birth weight rate in Nigeria is high, a problem of public health dimensions [10,16]. Although increased morbidity and mortality has been associated with LBW [4,17] emerging evidences also suggest chronic non-communicable diseases in adult life[18,19,20]. Since LBW of infants in the developing countries are due to intra-uterine growth retardation[21] the major determinants are poor maternal nutritional status at conception, low gestational weight gain due to dietary inadequacy and short maternal stature[22]. It is therefore logical and desirable to identify pregnant women who are at risk of LBW delivery early enough during pregnancy to provide appropriate interventions.

The main objective of this study was to provide a simple tool that can be used at the most peripheral parts of the health service system to prevent LBW and also address the issue of maternal malnutrition. A meta-analysis on maternal anthropometry and pregnancy outcomes by WHO [14] suggested that specificity for anthropometric indicators rarely

Table 3

Maternal Weight, as a Percentage of the Standard, Correlated With Occurrence of Low Birth Weight

	At 26wks		At 34wks		At 39/40wks	
	BW (kg)		BW (kg)		BW (kg)	
	< 2.5	> 2.5	< 2.5	> 2.5	< 2.5	> 2.5
Maternal Weight						
< 80% Standard	1	7	3	1	2	0
> 80% Standard	1	99	15	206	4	106
Total	***2***	***106***	***18***	***207***	***6***	***106***

Table 4

Measurement of Accuracy

		True Status		
		Low Birth Weight (LBW)	**Normal Birth Weight (NBW)**	**Total**
Predicted Status	**LBW**	Correctly Predicted LBW (a)	Incorrectly Predicted LBW (b)	***All Predicted LBW (a+b)***
	NBW	Incorrectly Predicted NBW (c)	Correctly predicted NBW (d)	***All Predicted NBW (c+d)***
	Total	***All True LBW (a+c)***	***All True NBW (b+d)***	***Grand Total***

Sensitivity (Se) = Correctly Predicted LBW (a) / All True LBW (a+c)

Specificity (Sp) = Correctly Predicted NBW (d) / All True NBW (b+d)

Positive Predictive Value (PPV) = Correctly Predicted LBW (a) / All Predicted LBW (a+b)

Negative Predictive Value (NPV) = Correctly Predicted NBW (d) / All Predicted NBW (c+d)

Accuracy = (True Positive + True Negative) 100 / Grand Total

= (a+d) / (a+b+c+d) * 100

exceed 90% and it is typically found in the range of 65% to 80%. Sensitivity, also ranges between 25% and 45%. The high specificity of over 90% and negative predictive value of 99% using this table of reference, even at 26 and 34 weeks of gestation, clearly suggest that this tool is quite accurate. The sensitivity and specificity of this tool remain the same even when the pregnancy outcome variable was adjusted to 3.0 kg. Furthermore when the birth weight of those whose mothers achieved 80% predicted weight were compared with those that achieved less than 80%, the difference was significant ($p< 0.05$).

Table 5

Accuracy of Table of Reference in Predicting LBW

	@ 26wks	@ 34wks	@ 39/40wks
Sensitivity	50%	16.6%	33%
Specificity	93%	99%	100%
PPV	12.5%	75%	100%
NPV	99%	93%	96%
Accuracy	92.5%	92.8%	96%

PPV: Positive Predictive Value
NPV: Negative Predictive Value

Identifying these categories of at-risk pregnant women has been the focus of previous efforts [15,23,24]. Gueri *et al* [15] designed a similar table based on similar assumptions. However, the weight and height profiles used were those of young adults in the United States of America. These weights and heights were too high for Nigerians of similar age groups, hence a new chart of weights and heights derived from young Nigerian adults resident in Ibadan was used in this study. That over 95% of the women delivered at term is consistent with previous findings [21].

The high rate of LBW in Nigeria, the paucity of expertise at the peripheral health facilities, and the clearly defined need for the assessment of the nutritional status during pregnancy [14] underscore the relevance of this study and therefore the tool hereby provided. The need for this table of reference to be evaluated with data from other parts of Nigeria is recognised. It is also necessary to assess the utility of this tool prospectively in antenatal care settings.

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