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Effect of Maternal Third Trimester Energy and Protein Intake on Pregnancy Weight Gain and Newborn Birth Weight

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ABSTRACT. *During pregnancy maternal, body needs enough energy and nutrients to meet the requirement for growth of the fetus and increased body demands of the mother. Malnutrition during pregnancy causes intra-uterine growth retardation and low birth weight deliveries. The present study was conducted to investigate the effect of maternal energy and protein intake on the pregnancy outcome. One hundred and forty obstetrically normal mothers between 20 - 40 yrs, who delivered babies at the maternity wards of the Teaching Hospital Kandy were selected as subjects. Mothers having pre-pregnancy weight <45.5 kg, height <145 cm and gestational duration <37 weeks and other obstetric complications were excluded from the study. Birth weight data were collected from nurses' records in the labor room in the obstetric wards. Maternal dietary data were collected from a food frequency questionnaire and two dietary recalls done in the third trimester. Pre-pregnancy maternal data were obtained from prenatal records. Results indicated that energy and protein intakes have positive correlations with pregnancy weight gain. Multiple regression and partial correlation analyses showed that the maternal energy intake contributed to 50% of the pregnancy weight gain and the association was very strong (p=0.0001) whereas the contribution from the protein intake to the pregnancy weight gain was only 10% and was not significant. When the energy and protein intakes were compared using the recommended cut-off levels, the correlation coefficients of maternal energy intake (>2200 kcal/day) and protein intake (>55 g/day) on the total pregnancy weight gain were 0.670 (p=0.000) and 0.60 (p=0.000), respectively. With the birth weight of the new born, maternal height did not have any significant correlation (r=0.028, p=0.745) but the total weight gain during pregnancy had a significant positive correlation (r=0.447, P=0.000). The correlation between the maternal pre-pregnancy weight and the birth weight of the new born was weak (r =0.165, p=0.051). It is evident that for a successful pregnancy outcome, it is important to have adequate energy and protein in the maternal diet and achieve a desirable weight gain during pregnancy.*

INTRODUCTION

Nutrition of the mother has a profound influence on the course and outcome of her pregnancy. If the nourishment needed for developing fetal tissue and organs are inadequate, the fetus may not grow and develop normally. The fetus that fails to achieve their inherent

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growth potential (growth restricted fetus) is at risk for increased morbidity and mortality (Bennett and Brown, 1998; Chamberlain, 1995).

Calorie intake is a particular concern during pregnancy because of its relationship to maternal weight gain. Among Sri Lankan, the daily calorie requirement is increased by 200 - 300 kcal, during pregnancy in addition to the normal requirement of 1900 kcal. The overall requirement is 2200 kcal and this is to supplement the overall increase in Basal Metabolic Rate (BMR) due to the increase in hormonal activity (Wickramanayake and Gunarathne, 2000). Recommended maternal weight gain during pregnancy ranges from 7 - 18 kg depending on whether the woman is obese, overweight, normal weight or malnourished and the highest weight gain recommended being for malnourished mothers (Bonnie and Sue Rodwell, 2000).

In Sri Lanka, the prevalence of low birth weight was 17.1% in the year 2002 which has shown a decline during the past decade. The infant morality rate (IMR) has also dropped during the past decade (Annual Health Bulletin, 2002, 2000, 1994). The highest recorded low birth weight in 2002 was in the Nuwara Eliya district while IMR was highest in the estate sector. Anuradhapura district recorded the highest neonatal mortality rate (NNMR) of 23.6 and the districts of Kandy and Matara have also recorded high NNMR of 22.1 and 20.6, respectively. Perinatal mortality rate showed a sustained decline and was very high in Nuwara Eliya, Matara and Kandy districts.

Studies done in developing countries suggested that the lack of knowledge about food and food fallacies are the major causes of poor maternal nutrition rather than the availability of foods. Food restrictions, avoidance of nutritional food and taboos also lead to malnutrition (Bonnie and Sue Rodwell, 2000).

The purpose of the present study was to determine the dietary intake of pregnant mothers and to examine the effect of maternal diet on the pregnancy weight gain and the birth weight of the new born.

MATERIALS AND METHODS

Subjects and selection criteria

The study included 140 subjects between 20 - 40 years of age, who delivered babies at the maternity wards of the Teaching Hospital, Kandy from the beginning of January 2005 to the end of August 2005. Mothers having pre-pregnancy weight <45.5 kg, height <145 cm and those with pre-existing obstetrically complicated diseases such as, viral infections, pregnancy induced hypertension, urinary tract infections, heart disease, diabetes, oedema, anemia and polyhydramniosis were excluded at the beginning of the study. Multiple fetuses, alcoholic and smoking mothers and mothers with heavy work load were also excluded at the beginning. Mothers who delivered babies <37 weeks were excluded at the end of the study. All mothers received vitamin and mineral supplements (vitamin C, folate, calcium lactate, fersolate) and the worm treatment from the antenatal clinic.

Personal data collection

Name, address, age, education, occupation, work load, expected date of delivery (EDD), last regular menstrual period (LRMP), parity data, sanitary habits, employment

status and other relevant data were collected by interviewing the mothers at the time of taking their first food recall. Information on public health midwifery (PHM) division and Medical Officer of Health (MOH) division were collected using antenatal records. Maternal health status, medication data and disease prevalence data were collected from medical records maintained by a medical officer during each clinic visit and from the bed head ticket.

Pre-pregnancy weight data

Weight of the mother in the booking visit was considered as her pre-pregnancy weight, which was taken during the 4 - 6 weeks of gestation. Although the exact pre-pregnancy weight is unknown, since the total weight gain in the first trimester is about 0.7 kg, any error of the calculated weight may be of not much significance. Moreover it is generally agreed that the fetal weight gain during this period is negligible (Wikramanayake, 1998).

Maternal and newborn measurements

Maternal weight and height data were collected from prenatal records. In their prenatal period, subjects were attending the same clinic and the measurements were taken by trained persons using scales which are routinely checked for accuracy. Weights of the newborn were taken in the labor room by a senior registered nursing officer using an electronic scale. The accuracy of the scales was routinely checked by the investigator himself.

Dietary Intake

Dietary intake was calculated from two 24 hrs food recalls and a 7 day food frequency questionnaire administered during the third trimester. The recalls were done during the 28 - 33 weeks and 30 - 35 weeks and the frequency questionnaire was administered around the 37^{th} week when they were admitted to the hospital for delivery. Using serving portions, food exchange lists and food composition tables, energy and protein intakes were manually calculated by the investigator.

Data analysis

Descriptive analysis was carried out on maternal and newborn data. Pearson product moment correlation coefficients were calculated to estimate correlations among maternal dietary data, pregnancy weight gain and newborn birth weight. Multiple regression analysis was performed on SAS to find the strength of the associations.

RESULTS AND DISCUSSION

Sample characteristics

The study sample consisted of one hundred and forty young mothers from the Central Province who attended prenatal clinics in Teaching Hospital, Kandy. The majority of the sample was housewives (77%) and the rest were working mothers with sedentary work (7%) or moderate work (16%). The majority of subjects have studied up to G.C.E. Ordinary Level (56%) and others have studied up to G.C.E. Advanced Level (36%) or entered the universities (8%). Anthropometric data revealed that the mean maternal height

was 155 cm and the pre-pregnancy weight was 54.4 kg. The mean total weight gain during pregnancy was 9.4 kg (Table 1). All the mothers had adequate minimum height and pre-pregnancy weight for child birth. According to Wikramanayake and Gunarathna (2000) the appropriate maternal height and pre-pregnancy weight for non-complicated pregnancy and labor are >145 cm and > 45.5 kg, respectively. The mean total weight gain during pregnancy was lower than the internationally recommended weight gain of 12.5 kg, but it was greater than the total weight gain recommended (8.0 kg) for Sri Lankan women.

Table 1. Characteristics of the study subjects.

Characteristic	Mean	SD
Maternal age (years)	28.3	4.8
Maternal height (cm)	155.0	4.5
Pre-pregnancy weight (kg)	54.4	3.3
Gestational duration (weeks)	39.2	0.7
Weight at delivery (kg)	63.7	3.7
Total pregnancy weight gain (kg)	9.4	1.4

Note: n = 140

Birth weights of the newborn

Of the study subjects, 83% had babies within the normal range of birth weight and 17% were low birth weight deliveries. Prevalence of low birth weight among both sexes were different with boys having a higher percentage of low birth weight (24%) than girls (11%) (Figure1).

Figure 1. Prevalence of birth weight categories.

According to the Annual health bulletin (2002), prevalence of low birth weight in Sri Lanka was 17.1% and that of the Kandy district was 19.1%. The prevalence of low birth

weight of the study sample was more close to the national figure than that of the Kandy district.

Adequacy of nutrient intake among subjects

The energy and protein intake of the subjects measured through food recall and food frequency questionnaire is given in Table 2. The mean energy intake was 2404 kcal/day. A fairly high proportion (83%) of the mothers in this study sample met the recommended energy requirement of 2200 kcal/day (Wikramanayake and Gunarathna, 2000) while only 17% had lower intake. The mean protein intake of the sample was 55.7 g/day which is equal to the Recommended Daily Intake (RDI) of protein during pregnancy. The protein intake was adequate for most of the subjects (77%). Even among the low intake category the mean protein intake was 50 g, which was the lower cut-off listed in Wikramanayake and Gunarathna (2000).

Table 2. Nutrient intake of subjects based on the requirement.

Nutrient intake /day	Number (%)	Mean	SD
Energy (kcal)			
Adequate ≥ 2200	118 (83)	2471.3	173.7
Inadequate < 2200	22 (17)	2094.5	49.7
Protein (g)			
Adequate ≥ 55	108 (77)	57.6	1.3
Low < 55	32 (23)	50.0	3.6

Effect of maternal diet on the pregnancy weight gain

The effect of maternal energy and protein intakes on the pregancy weight gain is shown in Figure 2. The majority of subjects (83%) had adequate enrgy intake (>2200 kcal/d) and their mean pregnancy weight gain was high (10.1 kg). The correlation between energy intake and weight gain was significant (r= 0.67, p= 0.000). In 17% of subjects, the energy intake was below the adequacy level and their mean pregnancy weight gain (8.0 kg) was lower than the value observed for Sri Lankan women, which is 9.5 kg (Wikramanayake, 1998). There was no significant correlation between low energy intake (< 2200 kcal) and total weight gain (r= 0.094, p=0.432). Protein intake also affected the total weight gain. Among the subjects (67%) who consumed adequate (>55 g/day) amounts of protein, the weight gain was more (10.2 kg) than the Sri Lankan cut-off and the correlation between protein intake and weight gain was moderate and significant (r= 0.60, p=0.000). Subjects who had taken inadequate amount of protein (23%) had their mean weight gain low (8.1 kg). This figure is below the national cut-off weight gain and there was no corelation (r= 0.270, p=0.135).

This result shows that when a mother consumes adequate energy and protein during her pregnancy period, in the third trimester, it postively contributes to her pregnancy weight gain.

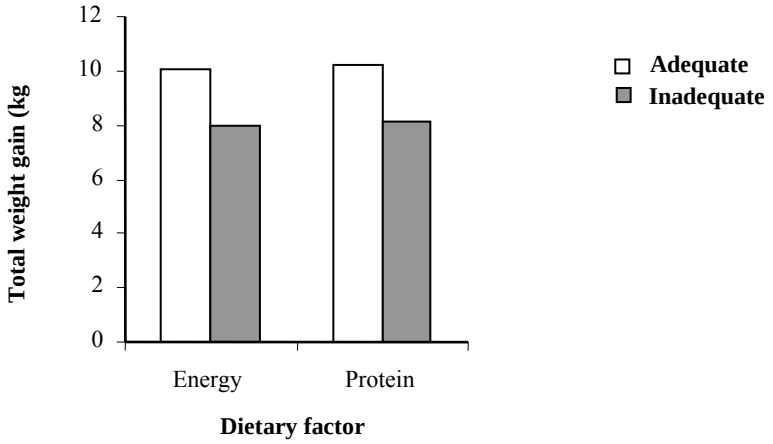

Figure 2. The effect of maternal energy and protein intake on Pregnancy weight gain.

To study the independent effect of the two variables energy and protein, on the maternal total weight gain, partial correlation coefficients were analysed. The results indicated that energy is the more important dietary factor than protein on the maternal total weight gain (Table 3).

Table 3. Pearson correlation coefficients (r) of dietary factors on maternal total weight gain.

Dietary factor	Controlled factor	r value	p value
Energy intake	Protein	0.4970	0.001
Protein intake	Energy	0.0976	0.260

Relationship of maternal exposure variables with the birth weight

There was a significant positive correlation ($r=0.789$, $p<0.001$) between total pregnacy weight gain and the newborn birth weight. Maternal pre-pregnancy weight and the maternal height did not show significant correlation with the newborn birthweight (Table 4). It should be noted that exclusion of mothers with very low heights (<45 cm) and pre-preganacy weights (<45 kg) in the study may have affected the results to some extent. The gestational duration and teenage pregnancies are two facotrs that can affect newborn

birth weight but their effects could not be established here since all the subjects recruited for the study had gestational duration over 37 weeks and the teenage pregnancies were excluded in the study. Suniti (1990) has reported a positive correlation between the maternal height and newborn birth weight but no such correlation was reported by Thilakarathna (2004).

Table 4. Effect of maternal variables on the birth weight of newborn.

Variable	Pearson's correlation (r-value)	p value
Maternal height	0.028	0.745
Pre-pregnancy weight	0.165	0.051
Pregnancy weight gain	0.789	0.000

Effect of maternal dietary factors on birth weight of newborn

Maternal energy intake significantly affected the babies birth weight when the energy intake was above the daily requirement of 2200 kcal (r=0.365, p=0.000). Majority of subjects (84%) had consumed more than the daily requirement of energy and the mean birth weight (2893.6 g) of their babies were higher than others. Maternal protein intake also significantly affected (r=0.689, p=0.000) their babies birth weight, when it exceeded the daily requirement of 55 g. Majority of subjects (77%) had consumed more than 55 g of protein/day and their babies were heavier (mean = 2930 g) than others (Figure 3).

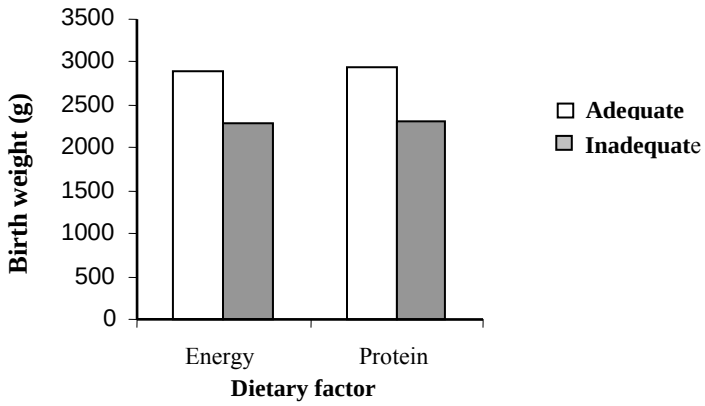

Figure 3. The effect of energy and protein intake on birth weight of the newborn.

However, partial correlation analysis indicated that there was no independent effect of each dietary factor on the newborn birth weight (Table 5.).

Table 5. Pearson correlation coefficients (r) of dietary factors and maternal total weight gain on newborn birth weight.

Influencing factor	Controlled factors	r value	p value
Energy intake	Protein/total weight gain	0.0573	0.511
Protein intake	Energy/total weight gain	0.0372	0.670
Total weight gain	Energy/Protein	0.1742	0.045

Effect of maternal dietary factors on birth weight based on sex

When the maternal energy and protein intakes of normal and low birth weight deliveries were compaired, it was found that there were no sex differences within either category indicating that the sex of the newborn has no association with mothers' energy and/or protein intake (Figure 4).

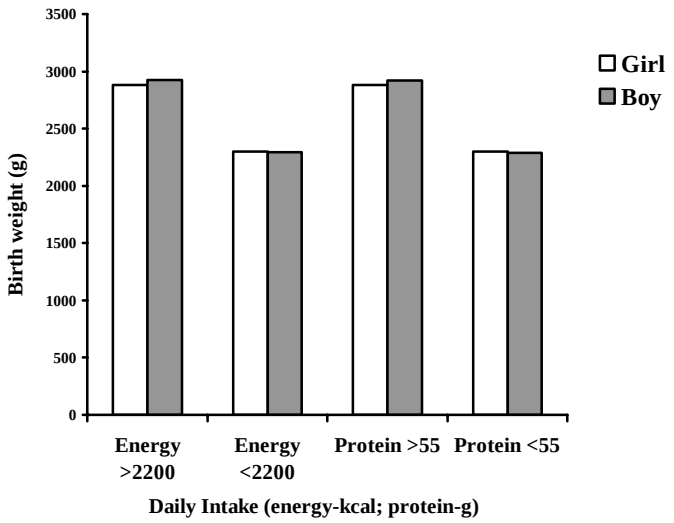

Figure 4. Effect of maternal energy and protein intake on birth weight based on sex.

CONCLUSIONS

The study revealed that maternal energy intake over 2200 kcal/day and protein intake over 55 g/day were associated with higher pregnancy weight gain and higher newborn birth weights. Among the dietary factors energy intake contributed more than protein to the pregnancy weight gain. It can be concluded that for a successful pregnancy outcome it is

important to provide adequate energy and protein in the maternal diet and achieve a desirable weight gain during pregnancy.

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