Maternal Dietary Intake and Anthropometric Measurements of Newborn at Birth

Fareeha Shaikh[*,1], Fariha Zeeshan[2], Rubina Hakeem[2,3], Abdul Basit[2], Asher Fawwad[2] and Akhtar Hussain[1]

[1]*Faculty of Medicine, Institute of Health and Society, Department of International Community Health, University of Oslo, Norway*

[2]*Baqai Institute of Diabetology and Endocrinology, Baqai Medical University, Plot No. 1-2, II-B, Nazimabad No. 2, Karachi-74600, Pakistan*

[3]*Taibah University, Madinah Almuawwara, Saudi Arabia*

Abstract: *Objective*: To determine the association between maternal dietary intake and nutritional status during pregnancy with anthropometric measurements of the newborns at birth.

Methods: An observational study was conducted in Karachi, Pakistan from December 2009 to April 2010. Expectant mothers were recruited from selected antenatal clinics after obtaining informed consent. On the basis of the expected weight-for-height of adult women during pregnancy, mothers were categorized into under- and well-nourished groups. Dietary profile of 100 mothers (48 from 1st trimester and 52 from 3rd trimester) was recorded by using "Food Frequency Questionnaire and 24 hour dietary recall". Deliveries of 3rd trimester group of mothers were followed. Anthropometric measurements of newborns were recorded.

Results: Dietary profile of mothers showed that most of the mothers, regardless of trimester and nutritional status were consuming less than the recommended dietary intake. Fruit and vegetable intake was very low, pertaining to 96% and 93% of mothers respectively. Eighty percent mothers were consuming less than a serving of meat per day whereas 94% had low milk consumption per day. A significant negative association was noted between milk intake in well-nourished group and sub scapular skin fold thickness of the newborns at birth. Similarly, consumption of milk in undernourished mothers was also found associated negatively with mid upper arm circumference of the newborns ($p<0.05$).

Conclusion: Overall energy intake was low in undernourished compared to well-nourished mothers during early gestation. Moreover, maternal dietary intake and nutritional status during pregnancy have impact on fetal body composition.

Keywords: Anthropometric measurements, maternal diet, newborn, nutritional status, Pakistan.

INTRODUCTION

Nutritional future of a child is highly dependent on maternal nutritional status in pregnancy [1]. Mother's nutritional status is a major determinant of not only the health outcome but also chronic disease risk in a newborn during both childhood and adult life [2]. Unfortunately, in developing countries, pregnant females are nutritionally the most insecure group and a large number of expectant mothers do not receive optimum level of essential nutrients during their gestational period [3].

One of the major consequences of poor maternal health and dietary practices is low birth weight of babies [4]. It has been estimated that prevalence of neonates born with low birth weight in the world is 15.5% [5]. Moreover, their prevalence is two times higher in underdeveloped compared to developed countries and about half of these under weight babies born in South East Asian countries [6, 7]. Moreover, birth weight has been proven a strong predictor of immune response in later life of an individual [8].

A study from developed countries projected that low birth weight is associated with inadequate contribution of carbohydrate in dietary energy [9]. Similarly, a study showed that average diet of pregnant females was deficient in terms of most of the micronutrients [10].

Likewise, various studies have been conducted among Indo-Pak population to explore the relationship between maternal anthropometric and dietary parameters with birth size of neonates. A study from India reported significant association of maternal nutrient intake and anthropometric characteristic with birth weight of neonates [11]. Majority of the studies on the relation between maternal size and nutrition with neonatal size have used only weight of the newborn as a parameter of fetal growth. It is apparent that other measurement of fetal size such as length, mid upper

Address correspondence to this author at the Faculty of Medicine, Institute of Health and Society, Department of International Community Health, University of Oslo, P.O Box 1130 Blindern, N- 0317, Oslo, Norway;
Tel: 92 21 36688897, 92 21 36608565, 92 21 36707179; Fax: 92 21 36608568;
E-mail: research@bideonline.com

1876-5246/14

arm and head circumference may be important in predicting the outcome of fetal growth. Hence, a study was designed to highlight the relationship between maternal dietary intake and nutritional status during pregnancy with anthropometric measurements of the newborns at birth.

METHODOLOGY

An observational study was conducted in Karachi, Pakistan from December 2009 to April 2010. The study was approved by the Institutional Review Board of Baqai Institute of Diabetology and Endocrinology. One hundred expectant mothers (48 from1st trimester and 52 from 3rd trimester) were recruited from multiple antenatal clinics of privately practicing obstetricians after obtaining written consent.

Expectant mothers with singleton pregnancy in which conception occurred without treatment for infertility, no previous history of pregnancy induced hypertension, diabetes and/or congenital malformations were considered eligible to participate. Females having gestational diabetes and premature deliveries (gestation < 37 weeks) were excluded from the study. Mothers were interviewed on their first visit to the antenatal clinic. Demographic, obstetric and socioeconomic information was collected through structured questionnaire. Duration of gestation in study subjects was calculated from the first day of last menstrual cycle, supported by ultrasound measurements. Deliveries of 3rd trimester group of mothers were followed and anthropometric measurements of their newborns were recorded within 24 hrs of birth.

Maternal Nutritional Status

Height of mothers was measured in centimeters by fixing a measuring tape to the wall and weight was measured in kilograms by a portable analogue weighing scale. Biceps, triceps and suprailiac skin fold measurements were collected by using digital fat track II skin fold caliper. Mid upper arm (MUAC), waist and hip measurements were taken into account using non-stretchable measuring tape.

Neonatal Measurements

Weight at birth was taken by infant pan scale whereas length was collected by using an infant-o-meter. Abdominal, head and mid arm measurements were collected by using a non-stretchable measuring tape [12]. A digital body fat caliper was used to measure biceps, triceps and sub scapular skin fold.

Dietary Assessment

Dietary assessment was carried out in a face-to-face interview with pregnant women participating in the study, using a Food Frequency Questionnaire (FFQ) consisting of about 125 food items and 24 hour dietary recall (DR) in order to assess the frequency of consumption of specific food or category of food [13]. Fifty percent of early pregnancy assessments were made during 5-8 weeks of gestation and other 50% during 9-13 weeks of gestation. In the 3rd trimester group 88% of the dietary assessments were made during 34 to 40 weeks of gestation. FFQ and 24 hrs DR were designed in accordance with recommended dietary guidelines provided by the National Institutes of Health (NIH), United States Department of Agriculture (USDA) and Food and Agriculture Organization of the United Nations (FAO) [14]. Pakistani Food Composition Tables were used to generate estimates of daily intakes of total energy [15]. Bread, fruit, vegetables, milk and meat were used as different food groups. Food group consumption in the mothers was assessed by using Food Guide Pyramid [16]. A reference table of weight for height according to the week of pregnancy was used to categorize mothers as under nourished and well-nourished groups [17].

Statistical Analysis

SPSS version 13.0 was used to record and analyze study data. Dietary intake was evaluated as frequency of consumption of food groups and total energy intake as mean of nutrients in first and third trimester. Data presented as Mean ± SD. Pearson's correlation coefficient was used to investigate the relationship between maternal dietary composition during pregnancy and birth characteristics of the newborns. Results with P value less than 0.05 were considered statistically significant.

RESULTS

Dietary profile of 100 mothers (48 from 1st trimester and 52 from 3rd trimester) was recorded. Our results reported that most of the mothers regardless of trimester and nutritional status, were consuming less than the recommended amount of various foods. Bread and cereal intake of only 44% of mothers was according to the recommendation while 56% were consuming less than the recommended servings. Fruit and vegetable intake was incredibly low, pertaining to 96 and 93% of the study population respectively. Eighty percent of mothers were consuming less than a serving of meat per day whereas 94% had low milk consumption per day.

Table **1** shows baseline characteristics of pregnant women and newborns included in the study. Weight and Body Mass Index (BMI) of well-nourished mothers were significantly higher in both trimesters ($p<0.05$). Statistically significant difference was seen in skin fold measurement of undernourished and well-nourished mothers in first trimester ($p<0.05$) whereas in 3rd trimester group it was similar in both groups. Among the neonates, mean birth weight was 2.89±0.42 (kg).

Energy and food group intake of pregnant females in early and late pregnancy is presented in Table **2**. Mean calorie intake of both groups was less than the recommended dietary allowance for pregnant women per day. Among the food groups, only bread and cereal intake was fairly adequate in both trimesters while consumption of other groups was lower than the recommended amount of servings per day.

Pearson correlation coefficient was used to assess the association between maternal dietary intake during pregnancy and anthropometric measurements of the newborns at birth. A statistically significant negative association was noted between maternal milk intake in well-nourished group and sub scapular skin fold thickness of the newborn at birth. Similarly, consumption of milk in undernourished mothers was also found associated negatively with mid upper arm circumference of the newborns ($p<0.05$). Though not significant but a weak correlation was noted between daily fruit and meat intake in

Table 1. Characteristics of the pregnant women and newborns included in the study.

Mothers	1st Trimester			3rd Trimester		p-Value
Nutritional Status	Undernourished	Well-Nourished	p-Value	Undernourished	Well-Nourished	
N	21	27		22	30	
Age (years)	27.12±5.77	28.63±6.63	0.387	25.11±4.07	28.31±3.61	*0.003
Weight (kg)	47.64±5.27	65.37±11.75	*0.000	54.03±7.33	69.29±5.92	*0.000
Body Mass Index (kg/m²)	20.0±2.30	26.74±4.61	*0.000	22.67±2.88	28.37±2.17	*0.000
Biceps (mm)	12.27±6.49	20.10±7.33	*0.000	9.45±6.76	10.09±6.31	0.722
Triceps (mm)	16.62±6.43	26.30±6.94	*0.000	14.88±6.50	19.17±10.61	0.082
Suprailiac (mm)	11.75±5.62	17.16±5.74	*0.002	8.68±5.74	11.91±7.71	0.088
MUAC (cm)	23.16±4.85	28.88±4.07	*0.000	24.69±2.92	30.03±12.35	*0.036

Babies	Overall	Undernourished	Well-Nourished	p-Value
N	52	22	30	
Birth weight (kg)	2.89±0.42	2.81±0.35	2.97±0.46	0.18
Ponderal index (kg/m²)	33.44±12.75	35.68±13.5	31.20±11.7	0.20
Gestational age at birth (weeks)	39.27±1.53	39.48±1.55	39.06±1.53	0.32

Data presented as Mean ± SD.
MUAC- Mid upper arm circumference.
*P<0.05.

well-nourished mothers and sub scapular skin fold (r=0.40) and mid upper arm circumference (r=0.41) of the newborns respectively (Table **3**). Furthermore, an association was also observed between maternal weight and BMI and weight of neonates at birth (p< 0.008).

Table 2. Calorie and food group intake of mothers assessed by 24 hrs. Dietary recall (DR).

Intake	1st Trimester	3rd Trimester	Recommendation
Calories	1436.54±446.8	1406.7±316.0	*2510
Food groups			
Bread & cereals	6.86±2.61	7.56±2.83	†6-11
Milk	1.00±0.71	0.94±0.8	†2-3
Meat	1.61±0.98	1.87±1.27	†2-3
Vegetables	1.31±0.94	1.38±0.94	†3-5
Fruits	0.85±0.93	0.9±0.97	†3-4
Fats (gm.)	65.5±29.6	63.21±23.6	*65

DR=dietary recall.
*RDA= Recommended dietary allowance [14].
† Recommended servings [14].
Data presented as Mean ± SD.

Figs. (**1**, **2**) show comparison of energy intake in early and late pregnancy between undernourished and well-nourished mothers according to 24 hrs DR and FFQ. Energy intake of undernourished mothers in first trimester group assessed by FFQ as well as by 24 hrs DR was significantly low compared to well-nourished mothers (p<0.001) whereas it was similar in 3rd trimester group.

DISCUSSION

Our study showed that energy consumption of mothers in early as well as in late gestation was incredibly low with reference to the recommended dietary allowance for pregnant mothers in Pakistan [18]. Our results are in line with the findings of other studies conducted in Pakistan. Their results also indicated low calorie consumption in pregnant population compared to the recommended dietary allowance (RDA) during pregnancy [19]. Another study also found low energy intake in mothers compared to RDA, however mean intake in their population was higher compared to our study participants [20].

The trend of different food group intake in pregnant mothers was also assessed in the study. We observed that pregnant mothers regardless of trimester and nutritional status were consuming less than recommended servings of various food groups. Mean intake of only bread and cereal group was according to the recommended servings per day while consumption of other groups e.g. fruit, vegetables, milk and meat was found very low in both trimesters (1st and 3rd trimester). This trend of food group intake in our study participants has been reflecting the dietary habits of Pakistani population where women are not used to take milk and fruit in every day meal while carbohydrates and fats are the main components of the daily cooking [21].

Weight and crown heel length at birth are commonly used anthropometrics to evaluate the growth of the fetus during intrauterine life. However, other parameters such as head circumference, abdominal circumference and skin fold measurements are equally important in determining the intrauterine development of the fetus. Therefore, in addition to the weight and length other anthropometric measurements of newborns were also taken into account to look at the

Table 3. Correlation coefficients of neonatal anthropometrics with maternal dietary intake.

Undernourished						
Parameters	**Birth Weight**	**Crown Heel Length**	**Triceps Skin Fold**	**Sub Scapular Skin Fold**	**MUAC**	**Head Circumference**
Bread	-0.12 (0.56)	0.12 (0.56)	0.11 (0.58)	-0.09 (0.65)	-0.20 (0.33)	0.13 (0.51)
Vegetable	0.04 (0.82)	-0.18 (0.38)	0.05 (0.81)	0.03 (0.86)	-0.06 (0.76)	0.06 (0.76)
Fruit	-0.15 (0.47)	0.05 (0.79)	-0.36 (0.09)	-0.13 (0.53)	-0.32 (0.12)	-0.34 (0.09)
Meat	-0.04 (0.83)	0.07 (0.73)	-0.25 (0.25)	-0.31 (0.13)	-0.03 (0.87)	-0.16 (0.44)
Milk	-0.21 (0.32)	0.02 (0.90)	-0.13 (0.55)	0.26 (0.22)	-0.54 * (0.00)	0.06 (0.77)
Fats	0.09 (0.67)	0.077 (0.71)	0.11 (0.60)	0.10 (0.64)	0.10 (0.60)	0.08 (0.68)
Well-Nourished						
Bread	-0.03 (0.70)	-0.23 (0.27)	-0.07 (0.95)	0.14 (0.50)	-0.07 (0.80)	0.06 (0.76)
Vegetable	-0.15 (0.62)	-0.37 (0.13)	-0.04 (0.74)	-0.05 (0.92)	-0.06 (0.90)	0.19 (0.36)
Fruit	0.37 (0.08)	0.07 (0.73)	0.29 (0.18)	0.40 (0.06)	0.23 (0.29)	0.169 (0.41)
Meat	-0.10 (0.55)	-0.00 (0.98)	0.31 (0.15)	-0.22 (0.13)	0.41 (0.05)	0.372 (0.06)
Milk	-0.15 (0.24)	-0.30 (0.60)	-0.30 (0.16)	-0.46 * (0.02)	-0.26 (0.23)	0.02 (0.91)
Fats	0.09 (0.66)	-0.02 (0.89)	0.13 (0.52)	0.34 (0.09)	0.01 (0.94)	0.02 (0.89)

Data presented as Pearson's r (P value).
*P < 0.05.

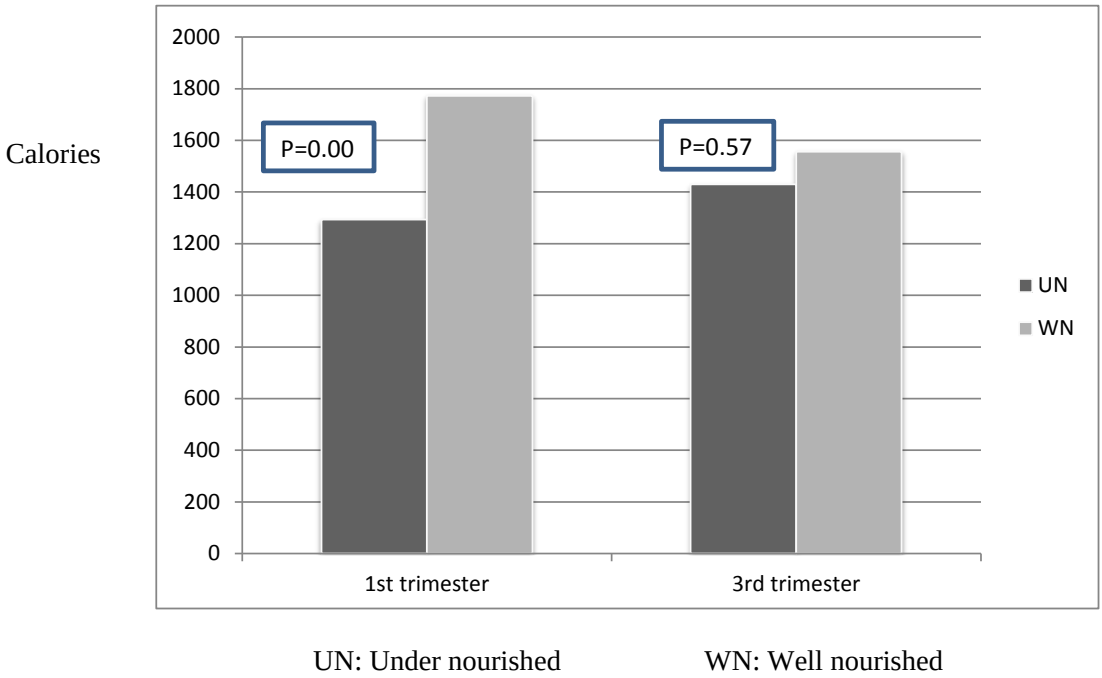

Fig. (1). Comparison of energy intake between maternal groups according to 24 hr Dietary Recall.

association between fetal growth and dietary intake in mothers during pregnancy. Our results reported an inverse relationship between sub scapular skin fold thickness of the newborns and maternal consumption of milk in well nourished group. Furthermore, intake of milk in undernourished mothers was also found associated significantly with mid upper arm circumference (MUAC) of the offspring at birth. Some European studies also observed an association between milk consumption in pregnant mothers and anthropometrics measurements of the newborns like weight, crown heel length and abdominal measurements at birth [22-24]. Moreover, their results were significant even after adjusting for confounders. However, we did not observe such type of association in our study population. Low milk consumption in our population might be one possible explanation of this difference. Moreover, small sample size of our study may be another reason for this difference.

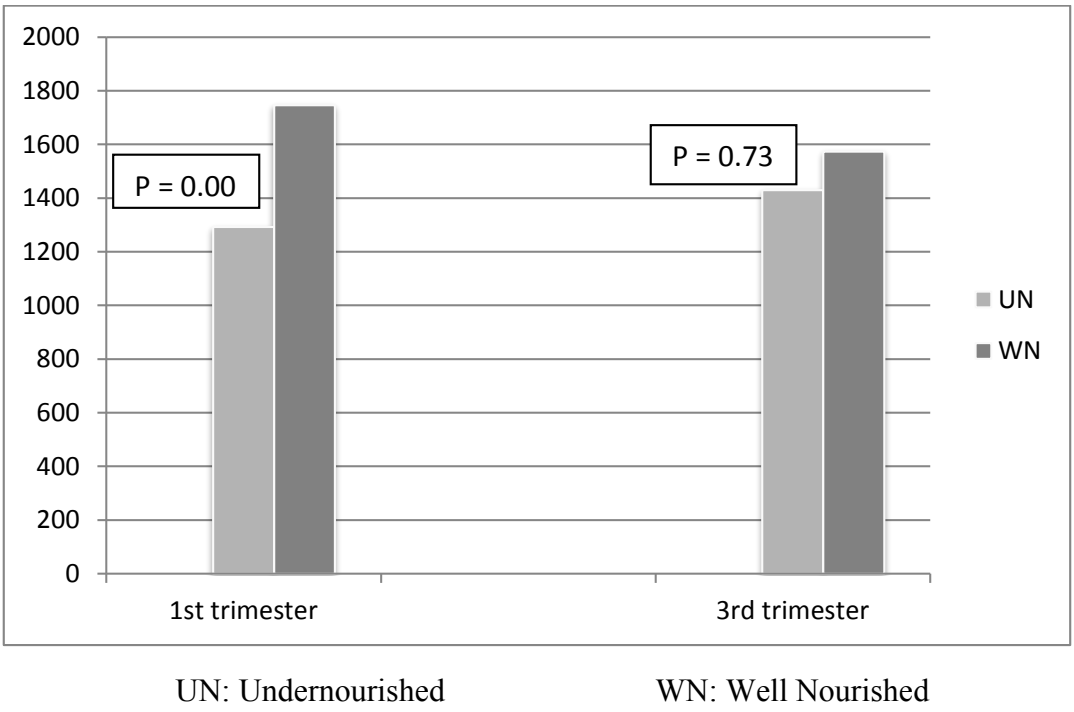

Fig. (2). Comparison of energy intake between maternal groups according to Food Frequency Questionnaire (FFQ).

Interestingly, we found that energy consumption in undernourished mothers was low compared to well-nourished mothers only in 1st trimester whereas in 3rd trimester group it was similar in both nutrition categories. This finding needs to be explored further in future studies with large sample size.

CONCLUSION

In this study, we observed that overall energy intake was low in undernourished compared to well-nourished mothers during early gestation. Moreover, maternal dietary intake and nutritional status during pregnancy have impact on fetal body composition.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

We acknowledge valuable support of research department of Baqai Institute of Diabetology and Endocrinology, especially Ms. Fariha Shaheen (Statistician) and Mr. Bilal Tahir (Research Coordinator) for their help in data entry and analysis. We sincerely thank all the participants who made this study possible.

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Received: January 21, 2014 Revised: May 6, 2014 Accepted: May 9, 2014