Research Article

Effects of Maternal food Insecurity on Birth Weight of Neonates: A Prospective Cohort

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Abstract | Pakistani population is seriously malnutritioned and is hunger redisposed. Based on the Global Hunger Index Pakistan is ranked at 107 of 118 countries .Food insecurity is among major causes of under-nutrition and has been associated with low birth weights. This study aimed to assess the effect of maternal food insecurity on birth weight of neonates in Lahore, Pakistan.Ina prospective cohort conducted at Shalamar Hospital Lahore; from April to August 2016, written informed consents were obtained from 103 eligible pregnant women. Data on demography was collected through a structured questionnaire and exposure was assessed through 6-items Version of U.S. Household Food Security Survey and cohort was followed until delivery, and birth weight was recorded. Follow up could be completed for 50 women only and response rate was 49%. Descriptive statistics were calculated, and relative risk and multinomial logistic Regression were applied using SPSS version 22. Mean maternal age was 28.100±4.824 years, mean education was 12.400±2.138 years, mean BMI was 29.420±5.075 and mean household income was PKR 25641±16251.543. With these characteristics, the mean birth weight of2.814±0.551 kg was recorded. Four percent (n=2) had very low food security and 34% (n=17) women had low food security. Importantly, food unsecured women had a 5.439 times increased risk of delivering a low birth weight neonate (RR=5.439, CI=1.710-17.296, p=0.002). Regression analysis indicated a significant association (AOR 16.076, CI=2.381-108.564, p=0.004).Based on these studies, it was concluded that food insecurity in pregnancy is associated with low birth weight in neonates. Antenatal screening of food insecurity and timely provision food supplements through social welfare can help reduce neonatal morbidity and mortality.

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Introduction

Low birth weight (LBW) is defined as a weight less than 2,500 gram at the time of birth [1]. Most of the infants are LBW are small for Gestational Age (SGA) due to intrauterine growth retardation (IUGR); or a shortened gestational period i.e. less than 37 weeks, classified as preterm [2]. In developed countries, 7% of newborns are LBW, 16.5% in developing countries with most in South Asia, where 19% newborns have been reported to be LBW [3]. Weight at birth influences infant development, and neonatal survival depends on the pre-conceptional health and dietary intake of mothers during pregnancy [4]. Later in life, fetal and neonatal health affects cognitive development and increases chances of development of chronic diseases [5].

Food security is a condition in which people have access of safe and nutritious food to fulfill their dietary needs and food preferences for an active and healthy life for physical, social and economic status [6]. Food insecurity is particularly important for pregnant women as they constitute the vulnerable group; and has implications for newborns. Maternal health is imperative for nutritional security as an under nourished mother is more possible to give birth to an under-nourished infant. In developing countries pregnant women more vulnerable to malnutrition and micronutrient deficiencies due to increased physiological needs[7] and suboptimal intake. LBW has been reported to be associated with food insecurityin low income populations [8].On the other hand in developed countries, food insecurity has been associated with increased BMI [9] and increases the risk of being over weight in women [10]. BMI more than 26.1 has been associated with macrosomic births (weight more than 4 kg) [11]. According to Laraia et al food insecurity is very important pregnant women because there is increase in nutritional requirements, they cannot put effort to prepare food and they have to leave jobs at the end of pregnancy which leads to socio-economic problems [12].

Pakistan is the world's sixth most populated country in the world, currently estimated that its population is over 188 million. According to the Planning Commission of Pakistan, the country's Vision 2030, half of the population suffers from moderate malnutrition. The most vulnerable groups of the population are children, women, and old people who had lowest income[13]. National Nutrition Survey 2011 also reported that 58.1% of households were food insecure at national level and 18% of women were under weight [14]. According to Global Hunger Index, 22% of population of Pakistan is under nourished and serious level of hunger is prevalent [15]. The presence food insecurity during pregnancy and its association with birth weight has not been examined in Pakistan; therefore, this study is aimed to assess effect of maternal food insecurity on birth weight of neonates in Lahore, Pakistan.

Material and Methods

Lahore, the second largest city of Pakistan and capital city of province Punjab, is the 14th most populous city in the World. A prospective cohort research study was conducted at a conveniently selected tertiary care hospital of Lahore (Shalamar Hospital) catering to all the socio-economic strata of the community. The duration of the study was almost 6months i.e. 29th April 2016 and end Oct 2016.

Pregnant women (19-45 years) in their 3rd trimester were consecutively approached and those fulfilling the inclusion and exclusion criteria were enrolled after taking written informed consent. Only registered patients were included in the study and women with past history of chronic disease and multiple births, still birth and congenital abnormalities were also excluded. Initially 103 pregnant women were recruited in the cohort but follow up could be completed only for 50 women. The response rate was approximately 49%.

In order to collect data on socio-demography and anthropometric measurements of women, a questionnaire was developed by the researcher. Information on maternal age, maternal and paternal education, occupation, household income (PKR), dependant family members, and parity was inquired from participants at the start of cohort. The language used in this questionnaire was easy and understandable for the participants. The questionnaire was pretested and adjusted accordingly.

Maternal weight was recorded at the start & end of cohort with minimal summer clothing. Maternal weight was recorded on an electronic weighing scale and rounded off to 0.1 kg. A standard stadiometer installed at the hospital was used to measure height without shoes and rounded off to 0.1 cm. Weight in kilograms was divided by height in m^2 to calculate BMI.

US Household Food Security Survey (six-item version) standardized by USDA in 2012 was used to measure food insecurity. Gulliford et al., (2004) have reported Cronbach's alpha reliability as 0.87 (16). This questionnaire consists of six structured questions and options were given as often true, sometimes true, never true, don't know/ refused. Scores were categorized as High Food Security (score 0-1), Low Food Security (2-4) and a score of 5-6 was considered Very Low Food Security [17].

Date on mode of delivery, gender, and length was obtained from patient's file at the end of cohort. Newborn's weight was measured within first hour of delivery, by placing the baby without clothing on an electronic weighing scale and rounded off to nearest

0.1 kilogram. Neonates who weighed less than 2500 grams were classified as LBW.

Two groups were formed after exposure was measured by administration of US Household Food Security Survey. Food secure women formed the control group and food insecure women formed the exposed or cohort group. Both groups were followed up till delivery. Questionnaires were administered face to face by the researcher. Birth weight was evaluated at follow up of patients.

Descriptive statistics such as mean, standard deviation range were calculated for all continuous variables. Correlation was calculated to observe relationship between socio-demographic variables and neonatal birth weight. Variables were categorized and Relative Risk was calculated. Multinomial Logistic Regression was applied keeping food insecurity as factor, birth weight as dependant variable and maternal age, BMI, income, education and parity as covariates. Package for Social Sciences Version 22 (SPSS vs. 22) was used to analyze data and a p-value < 0.05 was taken as significant.

Institutional Review Board of University of South Asia authorized the ethical approval of the study. The research was executed in conformity of the ethical principles laid by Helsinki Declaration. Participants were briefed about the nature of study, right to withdrawal was explained, anonymity, and confidentiality was ensured. All participants gave written consent.

Table 1: *Socio-demographic characteristics and anthropometric measurements of the mother.*

Maternal Variables	Mean	S. D
Age (years)	28.100	4.824
Education(Years)	12.400	2.138
Height (cm)	156.68	5.168
Weight in Kg. (Start of cohort)	72.960	12.961
BMI (Start of cohort)	29.420	5.075
Gestational Age in weeks(Start of cohort)	30.760	0.938
Gravidity	2.38	1.105

Results and Discussion

Descriptive statistics were calculated for all study variables. The mean weight of mothers was 73 kg at the start of cohort and 62% of mothers had 150-159 cm height (Table 1). The mean BMI at the start of cohort was 29.42. Mean education was intermediate. Majority of respondents were multipara and the mean of gravidity was 2.38.

Majority of the women belonged to the husband's income group of Rs.10000-25000 and 54% had 7-12 dependent family members and 40% of husbands received education above intermediate (Table 2).

Table 2: *Socio-demographic characteristics of the family.*

Variables	Mean	S. D
Fathers Education(Years)	12.000	2.213
Household Income(PKR)	25641.00	16251.543
Dependent Family Members	7.060	3.425

Table 3 shows that 52% of neonates had a normal birth weight and mean of birth weight was 2.8 kg. The mean length of new born was 47cm. 38% of babies had a length of 43-47 cms. 54% were male and 26% of new born were <2.5kg in weight.

Table 3: *Characteristics and anthropometric measurement of newborns.*

	Range	Frequency (n)	Percent (%)	Mean	S. D
Mode of delivery	C-section Normal	25 25	50 50	-	-
Gender	Female Male	23 27	46 54	-	-
Length (cm)	38-42 43-47 48-52	7 19 24	14 38 22	47.390	3.842
Head Circumference (cm)	25-30 31-35	7 43	14 86	32.46	1.477
Birth Weight (Kg.)	1.5-2.5 2.6-3.5 3.6-4.5	13 26 11	26 52 22	2.814	0.551

Figure 1 demonstrated that 62% (n=31) of mothers were highly food secure which means they have accessibility, availability of food during the phase of pregnancy, 34% (n=17) of mothers were facing low food security whereas 4% (n=2) pregnant women were very low food secure during gestational period.

Birth weight did not have a correlation with maternal age, education, height, weight at start of cohort, BMI, and dependent family members (p-value>0.05). Parity had a weak negative correlation with birth weight and paternal education had a weak positive correlation with birth weight, both were not statistically significant. A moderate positive correlation between

household income and birthweight was found which was statistically significant (r=0.287, p-value= 0.043) (Table 4).

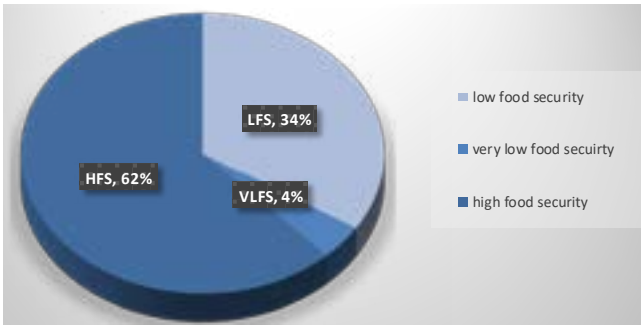

Figure 1: *Prevalence of food insecurity during pregnancy.*

Table 4: *Relationship of socio-demographic and anthropometry characteristics with birth weight of newborns.*

Characteristics	Birth Weight R	P-value
Mother's Age (year)	0.160	0.910
Mother's Education(Years)	0.180	0.211
Mother's Height (cm)	-0.026	0.856
Mother's Weight in Kg. (Start of cohort)	-0.208	0.147
BMI (start of cohort)	-0.174	0.227
Gravidity	-0.239	0.095
Father's Education(years)	0.246	0.085
Household Income	0.287	0.043*
Dependent Family Members	-0.115	0.427

Descriptive statistics of US household food security revealed that 62% had enough money to buy food when once finished whereas 38%women not enough budget to fulfill their nutritional needs and daily nutritional requirements that marked a great impact on birthweight of neonates, that was statistical significant (p-value=0.001). 76% pregnant women could afford balanced meals and about 24% women didn't afford balanced meals during pregnancy, and it was statistically associated with birth weight (p-value=0.001). The remaining statements were not associated with birth weight of neonates (Table 5).

When data was categorized as VLFS, LFS, and HFS it was found that all neonates (n=2) born to VLFS group were LBW. VLFS and LFS were further categorized as presence of food insecurity and HFS were categorized as absence of food insecurity. From 62% (n=31) of the food secure mothers only 10% (n=3) had LBW neonates whereas from food insecure group 52% (n=10) had low birth weight neonates (p=0.002). Table 6 shows that food insecure women had a 5.439 times increased risk of delivering a LBW neonate.

Table 5: *Descriptive statistics of us household food security questionnaire and association with birth weight.*

		Frequency	%age	P-value
The food that I bought just didn't last and we didn't have money to get more	Yes No	19 31	38 62	0.001*
We couldn't afford to eat balanced meals	Yes No	12 38	24 76	0.001*
In the 12 months, since last (current month), did you ever cut the size of your meals or skip meals because there wasn't enough money for food?	Yes No	5 45	10 90	0.103
If yes to question 3, How often did this happen?	Yes No	4 46	8 92	0.275
In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?	Yes No	5 45	10 90	0.275
In the last 12 months, were you ever hungry but didn't eat because there wasn't enough food?	Yes No	3 47	6 94	0.293

Table 6: *Relative risk of household food insecurity among mothers on birth weight of new born.*

Characteristics		Birth Weight <2.5 N (%)	Birth Weight >2.5 N (%)	RR	CI	P-value*
Food Insecurity	Yes	10 (52)	9 (48)	5.439	1.710-17.296	0.002*
	No	3 (10)	(90)			

**Fishers exact test*

Multinomial regression was applied to rule out effect of known confounders of birth weight. At the end only parity and food insecurity was found to be associated with birth weight. It is more likely that Food Insecure pregnant women rather than Food Secure pregnant women will give birth to a Low Birth Weight neonate (Table 7).

The current study was designed to assess the effect of food insecurity (which is based on accessibility, availability and affordability) during pregnancy on neonatal birthweight. Women belonging to low and middle socioeconomic status were selected. There are few

Table 7: *Multinomial logistic regression analysis.*

Variables		Adjusted Odds Ratio	P-value	Confidence Interval Lower	Upper
Maternal Education	< 10 years, > 11 years	0.254	0.171	0.036	1.807
Maternal Age	< 29 years, > 30 years	1.379	0.710	0.240	8.152
Income	< 25000 Rs., > 26000 Rs.	3.124	0.293	0.373	26.151
Gravidity	Multi Gravida, Prima Gravida	17.989	0.040	1.135	285.116
Food Insecurity	Yes, No	16.076	0.004*	2.381*	108.564*

researches that measure the effect of food insecurity during pregnancy in developed countries [8], [11]; but none had been conducted in Pakistan.

In 2015, it was estimated that 12.7% of US households (15.8 million) were food insecure out of which 5% were very low food secure [18]. But very high level of food insecurity has been reported in Pakistan a developing country in South Asia. National Nutrition Survey 2011 accounted that 58% of the population was food insecure and 18% of women were under weight [14]. Recently GHI (2016) also reported that 22% of population of Pakistan is under nourished [15]. The prevalence of food insecurity was 38% in this cohort of pregnant women which is alarming given the vulnerability and increased nutrient demands of pregnancy.

According to UNICEF (2013) incidence of LBW in Pakistan is 32% [19]. In the current study it was reported to be 26% which is still very high, a previous study however reported a lower incidence of 19% in 2013 [20]. In this study mean birth weight of neonate was 2.8 kg which was in line with the previous recent findings [20].

The findings of current research show that Food Insecure pregnant women rather than Food Secure pregnant women are more likely to give birth to a Low Birth Weight neonate. Previous studies in low-income populations have found similar results [8], yet others have reported delivery of macrosomic neonates among food insecure overweight women in developed countries [11]. Food insecure pregnant women had a 5.439 times increased risk of giving birth to a low birth weight neonate than food secure pregnant women. This association was highly significant and remained significant after adjustments were made by application of multinomial regression to control effect of known confounders.

Incidence of low birth weight is higher in developing countries and among resource constrained settings [21]. It has been reported that low socioeconomic level independently predicts LBW [22]. Khatun et al. have also concluded that incidence of LBW was higher among neonates born in families with yearly income less than national per capita income [23]. The current study concurs with the previous findings and it was found that the household income had a moderate yet statistically significant relationship with neonatal birth weight but no effect could be found after regression analysis. While moderate relationship was found between household income and LBW, multinomial analyses shows that it does not confound the association seen between Food insecurity and LBW in this cohort. In more disadvantaged populations, however, poverty and household income may play a greater role in determining LBW.

Many studies have reported that maternal age (less than 20 years and greater than 30 years) and maternal low education are risk factor in causation of LBW [23], [24] but no relationship was found between these variables and LBW in the current study. After adjustments were made using multinomial regression, food insecurity was stronger predictor of LBW.

In a systematic review and meta-analysis, it was concluded that birth of first child was linked with a significantly increased unadjusted risk of LBW/SGA birth, whereas having multiple or more than 5 previous children were not associated with increased risk of poor pregnancy outcomes [25]. Surprisingly, our study contradicted the previous findings and after regression analysis it was found that multiparous women had significantly increased odds of delivering a low birth weight neonate than prima gravida.

A major strength of this study is that an unexplored variable i.e. food insecurity was measured in an at-risk population i.e. pregnancy. The prospective nature of the study justifies the linear temporal relationship necessary for causation. Secondly a standardized questionnaire was used for assessment and a

trained nutritionist administered it to both cohorts and controls. Thirdly, an effort was made to control the confounders by excluding women with hypertension, diabetes mellitus, gestational diabetes mellitus, cardiovascular disease and anemia. Furthermore, multinomial logistic regression was applied to adjust for socio-demographic confounders.

A small sample size and low response rate was a limitation of the study. Firstly because there is low health seeking behavior in Pakistan [26] and women do not follow doctor's instructions on antenatal care. Secondly some of them do go to a tertiary care hospital to get a detailed check-up to identify any complication but do not plan on delivering there. They prefer to give birth at home or nearby facility due to economic constraints.

Resource limited settings, gender bias, lack of empowerment and decision making are some of the barriers which make it impossible for Pakistani women to follow nutrition and health advice, if any is available. The association between Food Insecurity and LBW reported may be higher for those food insecure women who do not seek antenatal care. Therefore, the risk may be conservative.

Conclusion

This study concludes and provides evidences that food insecurity during pregnancy along with socio economic statusesareassociated with low birth weight. The high prevalence of food insecurity during pregnancy and its significant effects on birth weight, in our sample makes it a major public health problem.

Screening for food insecurity should be made mandatory part of antenatal care. Nutritional counseling on how to have a balanced diet at a low cost will be beneficial and timely provision of support through nutrition interventions like food supplements (free or subsidized) may reduce incidence of low birth weight neonates and associated neonatal morbidity and mortality.

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Authors' contributions

Ayesha Saeed: Responsible for conception and design; analysis and interpretation of data; drafting and revising the manuscript.
Mobina Naqvi: Responsible for data collection; made substantial contribution to analysis, interpretation of data and drafting the manuscript.
Ahsan Javed: Substantial contribution to conception, design and revision for intellectual content.

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