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www.commprac.com
ISSN 1462 2815

MATERNAL NUTRITION AND POSTNATAL RISK FACTORS: IMPACT ON GROWTH AND DEVELOPMENT OF PAKISTANI INFANTS - FINDINGS FROM THE LAHORE BIRTH COHORT STUDY (LBCS)

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DOI: 10.5281/zenodo.12650851

Abstract

Background: In Pakistan, the prevalence of child malnutrition is higher than in other developing countries. This study analyzed the association between the health and growth of Pakistani infants with maternal nutritional status, depression, and dietary patterns after delivery. **Objective:** This study aimed to comprehensively investigate the growth & development of infants, exploring their relationship with a range of factors such as infant feeding practices, maternal nutritional status, psychological well-being, and socioeconomic factors. **Methodology:** The LBCS, a two-year prospective cohort study, recruited Pakistani infants at birth from the Punjab Medical Centre in Lahore. Information about the mothers after childbirth was obtained from hospital records and a predefined questionnaire was administered. Various data points were collected, including details about the mothers' backgrounds, anthropometric measurements of both the newborns and the mothers, maternal dietary intake during pregnancy, infant feeding practices after birth, and anthropometry measurements at 2.5 months, as well as breastfeeding and weaning practices when the infants reached 9 months old. **Results:** Findings indicate that maternal factors such as postpartum depression ($P<0.017$) and mother's occupation ($P<0.04$) have a great association with the infant's growth and development. It was also determined that breastfeeding ($P<0.018$), bread and cereals ($P<0.00$), dairy and dairy products ($P<0.015$), other milk ($P<0.00$), and meat and meat substitutes ($P<0.00$) also has a potentially significant association between the variables at 9 months. There was a significant correlation between breastfeeding and infant anthropometric measurements at 2.5 and 9 months of age, including length, weight for age, and head circumference percentile. **Conclusion:** In conclusion, the findings emphasize the persistent and intensifying impact of breastfeeding, guiding health care recommendations and underlining the need for infant health in the Pakistani context.

Keywords: LBCS, Postpartum Depression, Infant Growth, Nutritional Status, Feeding Practices.

INTRODUCTION

Malnutrition has an impact on general mother and child survival, health, and economic productivity of people, healthy development & growth of a child [1]. Growth is defined as a numerical increase in the size or mass of a body dimension, and child growth in all of its aspects is of primary importance to all and is regarded as one of the intrinsic qualities of childhood [2].

The postnatal development patterns of healthy children are well documented, leading to a number of clinical growth assessment parameters (linear growth, weight, growth velocity, growth patterns, body proportions, and head circumference) [3].

Adequate nutritional intake during the initial two years of life is critical for quick growth rate of every human being to reach his or her full potential [4]. Nutritional supplementation in the first 1000 days of life has been found to ameliorate birth and growth outcomes, as well as infant stunting also complementary feeding for 2 years give help to cope up nutrient deficiencies in infants [5].

Malnutrition occurs due to a lack of macronutrients specifically protein, and essential micronutrients called various vitamins & minerals; their deficiency results in serious health issues during pregnancy in the mother and stunting in a child after birth [1]. Maternal malnutrition (both over nutrition & undernutrition) can have substantial repercussions for fetal development and growth, as well as subsequent baby growth and development during and after breastfeeding.

Normal physical and cognitive development of a kid is crucial during the first three months of life to prevent physical and mental disabilities, certain behavioral difficulties, a lack of social skills, learning disabilities, a shorter attention span, and worse educational attainment [6].

The result from different previous but updated studies showed that early marriages, the big size of the family, extreme fertility rates and no birth spacing, low socioeconomic status, the lack of awareness about breastfeeding, and exclusive breastfeeding were the key component contributing to malnutrition [7].

The neonate's birth weight is a significant predictor of neonatal growth and survival, and it is strongly impacted by maternal health and nutrition during pregnancy. Nutrition education to population-level, fortification techniques and targeted supplements among at-risk populations, have the ability to address these hazards [8].

Maternal nutritional status (anthropometry, macro-, and micronutrients) prior to and/or during pregnancy may be a predictor of the child's cognitive performance. There is no conclusive evidence that maternal nutritional state during pregnancy has an effect on child's cognitive ability as determined by BMI, single micronutrient studies, or macronutrient intakes [9]. Nutrition has not been adequately integrated into Pakistan's national health system. Unfortunately there is no federal or provincial nutrition policy to address malnutrition in emergency and non-emergency conditions, and there is no high-level nutrition authority [10].

The present study was the first birth cohort study in Lahore, Pakistan. As healthy growth and development of an infant depend on maternal nutritional status and dietary pattern. Effective strategies should be adopted to protect the health of both the mother and neonate. The solicitation of such policies might help in improving the health of infants and mothers. The main emphasis of the study was to provide authentic recommendations to the government of Pakistan for the health of infants and their mothers.

METHODOLOGY

Study Design and Setting

The current Lahore Birth Cohort Study has been carried out in the district of Lahore, province of Punjab, Pakistan. A prospective study design was applied in this study.

The Lahore birth cohort study (LBCS) comprised two phases, which were based on infants and their mothers.

The sampling frame was Infants with their mothers from Pediatrics Department and Gynecology ward of Punjab Medical Centre Lahore, Pakistan. Infants were enrolled at birth and followed up at 2.5 months and 9 months of age. The study comprised two parallel cohorts: one examining maternal anthropometrics and dietary intake from prenatal to postpartum periods (one week to three months after delivery), and the other tracking infants' growth until 9 months of age. The selection of the data collection location was based on the availability of pediatric and neonatal facilities at the Punjab Medical Centre in Lahore, Pakistan.

Sampling Method and Subject Recruitment

The sampling technique for the data collection was purposive sampling. The mothers of infants were informed about the objectives and characteristics of the study and written informed consent were obtained. Among the 248 mothers who fulfilled the selection criteria, 49 were dropped out and total sample number was 199 throughout the study duration. The percentage of dropout rate was 5.5 % for both mother–infant at 2.5 monthly visits. The dropout rate was (2 %) lowest at the 9 months of infant's age.

Inclusion & Exclusion Criteria

The inclusion criteria for this study were limited to infants born at early term, defined as 37 weeks of gestation or later, and who were in good health. Exclusion criteria consisted of infants diagnosed with congenital diseases, those born post-term (gestational age exceeding 42 weeks), and multiple births such as twins or triplets.

Research Tools

A self-structured questionnaire was used to assess the data which includes demographics, health history, family strength, socioeconomic status, blood pressure, anthropometrics, biochemical, and the food frequency questionnaire of mothers and infants. Urdu Translated DASS 21 was used to assess the psychological status of women after birth. The DASS 21 is a clinical assessment instrument designed to examine an individual's three negative emotions (Depression, Anxiety, and Stress) [11].

Ethical Approval:

The study protocol was approved by the Human Research Ethics Committee USM (HREC) USM/JEPeM/20040225 and approval letter from the administration of the Punjab Medical Centre and Lady Willingdon Hospital Lahore Pakistan.

Data Analysis

The data analysis process for the study titled "A Lahore Birth Cohort Study (LBCS): Analysis of the growth and development of Pakistani infants in relation to the Nutritional Status of their mother and Associated Risk Factors after birth" was conducted using SPSS 26.0. Descriptive Statistics, Multiple Linear Regression Analysis, and Wilcoxon Test were used to study the association between maternal nutritional status and growth of infants, the different factors and maternal BMI categories, Mother's Weight and BMI, Friedman Test for Children's Weight and Length. All statistical tests were conducted with IC of 95% and P-value<0.05 considered as significant.

RESULTS

Demographic Characteristics of Participants

As shown in Table 1, 39.19 % (n = 78) mothers belonged to the age group of 19 – 25 years, 55.77 % (n = 111) mothers belonged to the age group of 26 – 32 years and 5.02 % (n = 10) mothers were among the age group of 33 – 38 years. It was discovered that about 62.3 % (n = 124) mothers were full-time homemakers, 17.6 % (n = 35) were homemakers with part-time jobs, 16.6 % (n = 33) were full-time working mothers and 3.5 % (n = 7) were students. Among the studied population, 1.0 % (n = 2) mothers had gestational weeks 37 and 99.0 % (n = 197) mothers had gestational weeks 38 – 42.

Table 1: Maternal characteristics at the time of enrollment (n=199)

Characteristics	n(%)	Mean (SD)
Age Group of Mother*		27 (4.2)
19 – 25 years	78 (39.1)	
26 – 32 years	111(55.7)	
33 – 38 years	10 (5)	
Mother Occupation		
Full-time homemaker	124 (62.3)	
Housewife with part time job	35 (17.6)	
Full-time Working	33 (16.6)	
Student	7 (3.5)	
Gestational Week		
37 weeks	2 (1)	
38 – 42 weeks	197 (99)	

Note: Descriptive Statistics was applied

*Measurements were taken at the time of enrollment

Growth and development of infants in relation to their mothers' nutritional status

Table 2 outlines the results of a multiple linear regression analysis investigating the influence of maternal dietary intake on infant length at 2.5 months in a sample of 199. The constant term is 53.27 and significantly impacts length ($p < 0.001$). The regression model as a whole is statistically significant ($p < 0.001$), suggesting that maternal dietary intake collectively impacts infant length at 2.5 months. This table (Table 2) also summarizes about effect of maternal dietary intake on infant weight at 2.5 months. The constant term significantly impacts weight ($p < 0.001$). While individual predictors like Carbohydrates, Protein, Fat, Kcals, and Iron do not reach significance, Calcium notably influences weight ($p < 0.001$). Table 2 investigates the influence of maternal nutrient intake on infant weight at 9 months that gave significantly results ($p < 0.001$). Among the predictors, Carbohydrates, Protein, Fat, Kcals, Iron, and Calcium show their respective coefficients, but only Calcium significantly contributes to infant weight ($p < 0.001$). . Among predictors like Carbohydrates, Protein, Fat, Kcals, Iron, and Calcium, only Kcals significantly contribute to length at 9 months($p = 0.027$).

This table also notify the results of maternal dietary intake effect on Birth Abdomen Circumference ($p < 0.001$). Statistical analysis revealed that impact of maternal dietary intake significantly influencing head circumference ($p < 0.001$) at birth. Table 2 presents the results maternal dietary intake on birth length ($p < 0.001$). The regression model as a whole demonstrates statistical significance ($p < 0.001$), indicating that maternal dietary intake has a significant impact on birth length. Table 2 displays that

none of the variables show a significant relationship with the set of dependent variables.

Table 2: Analysis of the growth and development of infants in relation to the nutritional status of their mother (at 2.5, 9 months and at birth)

	At 2.5 months		At 9 months		At Birth			
	Weight (kg) (p value)	Birth length (cm) (p value)	Weight (kg) (p value)	Birth length (cm) (p value)	Head circumference (cm) (P value)	Abdomen circumference (cm) (P value)	Weight (kg) (p value)	Birth length (cm) (p value)
Carbohydrates [a]	.223	.010*	.636	.095	.258	.067	.346	.043*
Protein [a]	.096	.114	.239	.368	.787	.932	.516	.457
Fat [a]	.866	.454	.836	.386	.584	.826	.613	.978
Kcals [b]	.070	.001*	.349	.027*	.365	.368	.518	.116
Iron [c]	.651	.916	.548	.977	.776	.834	.859	.872
Calcium [c]	.676	.910	.716	.876	.628	.907	.830	.471

*p-value (<0.05) indicate significance

a. Macronutrients are in grams/day

b. Kcals per day

c. Micronutrients are in milligrams/day

Factors affecting weight and length of infant at 9 months

Table 3 reveals noteworthy associations between various factors and infant length at 9 months. Mother's occupation, postpartum depression, breastfeeding, consumption of breads and cereals, dairy and dairy products, other milk, and meat and meat substitutes all exhibit significant p-values (0.045, 0.017, 0.018, 0.00, 0.015, 0.00, 0.00, respectively). These findings suggest potential links between household income and infant length. This table provides information about mother's occupation and household income which do not exhibit a significant correlation with infant length, as indicated by p-values exceeding 0.05 across all three time points. However, mother's depression ($p = 0.043$) and postpartum BMI ($p = 0.003$) show significant correlations with infant length at 9 months. Additionally, factors like bread & cereals, any other milk, meat & meat products, and weight also demonstrate a significant correlation with infant length at 9 months ($p < 0.05$). While the table highlights associations, further research is imperative to establish direct cause-and-effect relationships regarding how these factors influence infant weight.

Table 3: Multiple regression analysis of factors affecting weight and length of infant at 9 months (n=199)

	Weight (kg)			Length (cm)		
	Std. Error	Beta	Sig.	Std. Error	Beta	Sig.
Maternal Factors [a]						
Mother Occupation	0.032	-0.082	0.045*	0.083	0.091	0.057
Household Income	0.051	0.056	0.172	0.135	-0.002	0.966
Postpartum Weight	0.008	0.074	0.290	0.020	-0.092	0.263
Post-Partum BMI	0.020	-0.176	0.015*	0.053	0.250	0.003*
Depression Score	0.030	-0.179	0.017*	0.067	0.027	0.043*
Feeding Practices [a]						
Breastfeeding	0.098	0.168	0.018*	0.260	0.118	0.161
Formula feeding	0.090	0.082	0.211	0.235	0.121	0.114

Any other milk	0.095	-0.320	0.000*	0.240	0.418	0.000*
Weaning Practices at 9 months [a]						
Bread & Cereals	0.082	-0.216	0.000*	0.219	0.193	0.004*
Vegetables	0.074	0.040	0.434	0.192	-0.089	0.142
Fruits	0.069	0.082	0.101	0.181	0.053	0.374
Dairy Products	0.065	0.114	0.015*	0.171	-0.068	0.226
Meat and meat substitutes	0.067	0.333	0.000*	0.191	-0.188	0.003*
Junk Foods	0.061	-0.036	0.411	0.159	-0.029	0.577
Infant's Length [a]						
Length 9 month	0.020	0.590	0.000*	0.139	0.818	0.000*

Note: Multiple linear regression test was applied, Dependent Variable: Length and weight at 9 months

*p-value (<0.05) indicate significance

a. Maternal factors, feeding practices, Weaning Practices at 9 months and infants' weight are associated with infant's length at 9 moths

Association of postpartum depression at anthropometric measurements

Table 4 displays that there is a positive association between postpartum depression on infant birth weight for age Z score, birth weight (percentile), birth height for age z score and birth head circumference (percentile). Table 4 provides evidence that there is a positive association between postpartum depression on 2.5 months old infant weight for age Z score, 2.5-month weight (percentile), birth height for age z score and birth head circumference (percentile).this table also illustrates that there is negative correlation between postpartum depression on 9 months old infant weight for age Z score, 9-month weight (percentile) and birth height for age z score.

Table 4: Association of postpartum depression at 2.5 months, 9 months and birth anthropometric measurements (n=199)

Variables	At 2.5 months	At 9 months	At Birth
	Sig. (p value)	Sig. (p value)	Sig. (p value)
Birth WAZ [a]	0.426	0.258	0.585
Birth weight (Percentile)	0.584	0.471	0.885
Birth HAZ [b]	0.324	0.928	0.051
Birth Head Circumference (Percentile)	0.324	0.31	0.046

Note: Correlational Statistics was applied

Independent Variable: Postpartum depression; Dependent Variables: 2.5 months, 9 months and Birth Anthropometry

[a] WAZ weight for age Z score

[b] HAZ Height for age Z score

Association of mother's socioeconomic status on anthropometry of infants

Table 5 specifies displays that there is a negative association between socioeconomic status on infant birth weight for the age Z score, birth weight (percentile), birth height for age z score, and birth head circumference (percentile). Table 5 identifies that there is a negative association between socioeconomic status in 2.5-month-old infant weight for age Z score, weight (percentile), height for age z score, and head circumference (percentile). As shown in Table 5, provides evidence that there is a positive association between socioeconomic status on 9 months old infant weight for the age Z score, weight (percentile), and birth height for the age z score.

Table 5: Association of mother's socioeconomic status on 2.5 months, 9 months and at birth anthropometry of infants

Variables	At 2.5 months	At 9 months	At birth
	Sig.(p value)	Sig.(p value)	Sig.(p value)
WAZ [a]	0.932	0.088	0.57
Weight (Percentile)	0.986	0.925	0.259
HAZ [b]	0.255	0.137	0.007
Head Circumference (Percentile)	0.704	0.431	0.058

Note: Correlational Statistics was applied

Independent Variable: mother's Socioeconomic status; Dependent Variables: 2.5 months, 9 months and birth Anthropometry

[a] WAZ weight for age Z score

[b] HAZ Height for age Z score

DISCUSSION

The presented results from the Lahore Birth Cohort Study (LBCS) reveal several key associations between infant feeding practices, maternal factors, and the growth parameters of Pakistani infants. The current study demonstrates a significant correlation between breastfeeding and infant anthropometric measurements at 2.5 and 9 months of age, including length, weight for age, and head circumference percentile. Results of this study aligns with the previous studies that emphasize the influence of early feeding choices on infant growth. Another parallel study suggested that the source and content of breastfeeding might play a role as well [12]. Meanwhile, a same to current study, conducted by two scientist on relationship between infant eating behaviors and infant size and they discovered that general hunger and satiety responsiveness are related to weight and length, respectively. In the postnatal phase, breastfeeding emerges as a key factor influencing infant health [13]. Similar study found that a majority of mothers in Pakistan were aware of the importance of exclusive breastfeeding and practiced it [14].

Current study proposes a distinct results about growth trajectory for formula-fed infants that aligns with the study, which compared anthropometric indices among infants based on the type of feeding [15]. Current study is in contrast to the studies which indicate non significant link between breastfeeding practices and better growth outcomes in infants, with breastfed infants having superior nutritional status compared to non-breastfed infants [16,17]. Results of current study about the length and weight for age (Z score and percentile) were accordance with the findings of a study in which author found no significant differences in anthropometric measures, including BMI up to the age of seven years [18]. A study conducted to investigated the relationship between juice introduction age and child anthropometry. They discovered that early juice introduction (6 months) was related to higher weight-for-age and BMI-for-age z scores, as well as an increased risk of overweight/obesity [19]. These findings collectively underscore the importance of optimal feeding practices, including breastfeeding and the appropriate introduction of complementary foods, in shaping an infant's growth and development [13]. In this study, the majority of mothers (63.3%) were from the lower socioeconomic class. This finding aligns with previous research that links head circumference to maternal SES [20]. Furthermore, head circumference measurements in early childhood can serve as a cost-effective screening tool to

identify vulnerable children in low- and middle-income settings [21,22]. Findings of current study are echoed in the research, which concluded that inadequate consumption of food and poor dietary diversity among pregnant women, especially those residing in slum areas, result will be insufficient intake of macro-nutrients and micro nutrients [8]. This deficiency was found to be significantly correlated with the nutritional status of infants at birth, with a high prevalence of low birth weight observed [23,24]. Another study that is contraindicate with current study on balanced energy/protein supplementation could increase birth weight in undernourished women [25], while another study links the adequacy of maternal caloric and protein intake to the birth weight of infants, demonstrating that nutritional deficiencies during pregnancy are positively related to low birth weight [8].

Similar study explored that feeding practices play a crucial role, as seen in the current study, various other factors such as maternal health, infant health conditions, and early progressive eternal feeding also significantly impact infant growth [26]. In contrast, a study carried out longitudinal research on development patterns and body composition in infants with congenital heart disease (CHD) who underwent neonatal surgical surgery [27]. A study conducted on postpartum depression that denied how postpartum depression is not conducive to infant growth and development [28]. Another study investigated the effect of maternal postpartum depression on infant growth revealing no direct associations between the two factors [29]. In contrast, This study shows that postpartum depression initially has a positive association with infant anthropometry however we see this effect reverse at 9 months of age where postpartum depression has a negative association with infant anthropometry [29]. In conclusion, the current body of literature underscores the critical importance of adequate and balanced maternal nutrition, breastfeeding, and appropriate weaning practices for optimal infant growth. However, it also highlights gaps in our understanding, especially regarding the balance of macronutrient intake during pregnancy and the transition from breastfeeding to a mixed diet. Addressing these gaps could significantly enhance maternal and infant health outcomes.

CONCLUSION

In conclusion, this research contributes valuable insights into the intricate dynamics shaping infant growth and development. It highlights the crucial roles of breastfeeding, the timely introduction of complementary foods, and the significance of maternal nutritional well-being for ensuring optimal infant growth. By focusing on improving maternal well-being, we can ensure that infants receive the necessary nutrients and support for optimal growth.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgement: We want to thank all the participants in this study for their valuable contributions.

Funding: Not applicable

Conflict of interest: Authors declare that there is no conflict of interest.

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