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Duration of Breastfeeding and Cardiometabolic Health: A Community-Based Study

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ABSTRACT

Background and Objective: Breastfeeding is well known to benefit infant health, but its long-term impact on maternal cardiometabolic outcomes remains unclear. This study aimed to assess the prevalence of cardiometabolic complications among women and examine the association between breastfeeding duration and maternal cardiometabolic health. **Materials and Methods:** A community-based cross-sectional study was conducted among 318 women aged 20-60 years in Lahore, Pakistan. Participants were grouped by breastfeeding duration (<3 months, 3-6 months, >6 months). Data were collected through physical examinations, fasting blood samples, and a structured questionnaire on sociodemographic and medical history. Anthropometric and biochemical parameters were compared across groups using appropriate statistical tests, including One-way Analysis of Variance (ANOVA) for continuous variables and Pearson's Chi-square test for categorical variables. A p-value<0.05 was considered statistically significant for all tests. **Results:** The mean age of participants was 42.8 years, and the mean BMI was 29.0 kg/m^2. Women who breastfed for >6 months had significantly lower weight, BMI, and waist circumference compared with those who breastfed <3 months. Socioeconomic status, including education level and income, showed strong associations with breastfeeding duration. However, no significant differences were observed across groups for hypertension, diabetes mellitus, or cardiovascular disease. **Conclusion:** Breastfeeding for >6 months is associated with favorable anthropometric profiles but does not significantly reduce the prevalence of cardiometabolic conditions. Addressing broader social determinants alongside breastfeeding promotion may be necessary to improve cardiometabolic outcomes in high-risk populations.

KEYWORDS

Breastfeeding duration, cardiometabolic health, hypertension, diabetes mellitus, socioeconomic factors

INTRODUCTION

Pregnancy-related complications in women, i.e., gestational diabetes (GDM), intrauterine growth restriction (IUGR), and hypertension, could be risk factors for increased CVD risk and mortality in women[1].

Evidence indicates that breastfeeding may mitigate these risks by lowering CVD risk factors, including metabolic parameters, type 2 diabetes mellitus, and maternal blood pressure. A systematic review further demonstrated that breastfeeding improves cardiovascular risk factors, including inflammatory markers like peptide YY and ghrelin[2].

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Cardio-metabolic syndrome, characterized primarily by insulin resistance, substantially increases CVD risk. Insulin resistance leads to type 2 diabetes, which can result in renal impairment and hypertension. Additionally, altered adipokine metabolism in insulin resistance causes increased fatty acid secretion, deranging insulin production and regulation, ultimately leading to dyslipidemia. These metabolic disturbances increase the risks of myocardial infarction, coronary heart disease, and stroke[3].

Research has shown that breastfeeding can reverse adverse pregnancy effects and reduce CVD risk through a "physiological reset" that eliminates metabolic stresses in the mother's body. This process aids in postpartum weight reduction and improves body composition[4]. Breastfeeding is inversely related to waist circumference and BMI postpartum, though pre-partum factors like BMI and maternal weight do influence breastfeeding practices and duration.

Additionally, breastfeeding has been shown to reduce the risk of developing Type 2 diabetes mellitus among women with a history of gestational diabetes. It also contributes to improved cardio-metabolic health in infants born small for gestational age[5,6].

While the protective association between breastfeeding and cardio-metabolic health is established, critical gaps remain. With abundant evidence indicating a link between breastfeeding and hypertension, metabolic syndrome, and cardiovascular disease, the short and long-term impacts of breastfeeding must be explored and studied. Assessing the benefits of breastfeeding for high-risk cardiovascular women and their offspring could inform a valuable interventional strategy in clinical practice[7].

Most studies examine binary comparisons (breastfed vs. non-breastfed), with limited research on dose-response relationships how varying durations and intensities of breastfeeding differentially impact cardio-metabolic outcomes[8]. Additionally, few studies have examined these effects in community-based settings where breastfeeding practices exist on a continuum rather than distinct categories[9,10]. This limits our understanding of whether longer breastfeeding durations yield progressively greater cardio-metabolic benefits.

Hence, this community-based research addresses a critical gap in understanding whether a dose-response relationship exists between breastfeeding duration/intensity and cardio-metabolic health outcomes in women, and whether community-based research can effectively quantify these protective effects across a spectrum of breastfeeding practices. Our community-based study examines cardio-metabolic health across diverse breastfeeding patterns by measuring key parameters (obesity, hypertension, diabetes, and hypercholesterolemia) in women with varying breastfeeding histories, analyzing correlations between breastfeeding duration/intensity and cardio-metabolic outcomes, and implementing community engagement to promote awareness of breastfeeding's protective benefits. Cardio-metabolic assessments will follow WHO/NCEP guidelines, evaluating abdominal obesity, insulin resistance, dyslipidemia, and blood pressure, with a sampling strategy that intentionally captures diversity in breastfeeding practices to enable robust dose-response analysis.

This approach is novel and important because it moves beyond simplistic binary comparisons to examine nuanced dose-response relationships, leverages natural variation in community breastfeeding practices as an analytical strength rather than a limitation, shifts the narrative from regional deficiencies to breastfeeding's inherent protective health benefits, and implements community-based participatory research that simultaneously advances scientific knowledge and promotes health awareness. By quantifying how breastfeeding duration influences cardio-metabolic outcomes, this study will provide actionable evidence for clinical recommendations and public health interventions, ultimately enabling the development of targeted guidance on optimal breastfeeding practices to maximize cardiovascular protection for mothers.

MATERIALS AND METHODS

Study design and setting: An analytical cross-sectional study was conducted in Lahore using community-based research methods from March, 2024 to October, 2025. Data collection occurred through the Global Health Research Unit (GHRU)'s mobile health service in Lahore, Pakistan, which provided accessible healthcare screening and research participation opportunities in community settings.

Ethical approval: The study received approval from the Research Ethics Committee (REC) at the University of Lahore, Pakistan (Reference Number: REC-UOL-/360/08/24, dated 08-08-2024). All procedures adhered to ethical standards, including written informed consent from each participant, ensuring confidentiality, privacy, and the right to withdraw at any time without consequence.

Recruitment of participants: A total of 318 women were recruited through the GHRU mobile service. Before recruitment, community awareness sessions were conducted to inform potential participants about the study's purpose and procedures. Eligible individuals who provided written informed consent were enrolled consecutively during mobile health clinic visits.

Inclusion criteria and exclusion criteria

Inclusion criteria: Women aged 20-60 years who had given birth to at least one child and were willing to provide medical history and undergo physical examination and blood testing.

Exclusion criteria: Women with active cancer diagnoses, end-stage renal disease, severe hepatic impairment, or other serious illnesses known to alter metabolic parameters or cardiovascular risk profiles significantly. Pregnant women and those unable to provide informed consent were also excluded.

Data collection procedures

Questionnaire administration: A structured, self-administered questionnaire was developed based on an extensive literature review[11-13] and expert consultation. It collected data on:

- Socio-demographic factors (age, education level, household income quartile)
- Reproductive history (parity, breastfeeding duration for each child)
- Medical history (self-reported physician diagnoses of hypertension, diabetes mellitus, cardiovascular disease, hypercholesterolemia)
- Lifestyle factors

Physical examination: Trained research staff performed standardized measurements for height (cm), weight (kg), and waist circumference (cm) using calibrated equipment (stadiometer, digital scale, non-stretchable tape). Total body fat percentage (%) was measured using a validated bioelectrical impedance analysis (BIA) device following manufacturer protocols[11-13].

Biochemical assessment: Participants underwent fasting blood sampling (≥8 hours fast). Samples were analyzed for fasting blood glucose (mg/dL or mmoL/L), total cholesterol, LDL-cholesterol, HDL-cholesterol, and triglycerides (mg/dL or mmoL/L). Analyses were performed at the clinical laboratory at Services Hospital using standardized methods[11-13].

Statistical analysis: Data were analyzed using statistical software SPSS version 20.0. Continuous variables (age, height, weight, BMI, waist circumference, body fat percentage) were presented as Mean±Standard deviation (SD). Categorical variables (breastfeeding duration groups, presence of hypertension, diabetes mellitus, cardiovascular disease, hypercholesterolemia, education level, income quartile) were presented as frequencies (n) and percentages (%). Differences between breastfeeding duration groups (<3 months, 3-6 months, >6 months) were assessed. For continuous variables, One-way Analysis of Variance (ANOVA) was used. For categorical variables, Pearson's Chi-square (χ^2) test was used to examine associations.

If more than 20% of cells in the contingency table had expected frequencies <5, the Likelihood Ratio Chi-square test was employed as an alternative. Standardized residuals were examined to identify significant differences between specific groups. The Chi-square test (or Likelihood Ratio test where appropriate) was also used to assess associations between breastfeeding duration (categorical) and other categorical variables like education level and income quartile. A p-value<0.05 was considered statistically significant for all tests.

RESULTS

Participant characteristics: The study enrolled 318 women with a mean age of 42.8 years (SD±9.6). Anthropometric measurements revealed an average height of 155.3 cm (SD±6.2), weight of 69.8 kg (SD±15.5), BMI of 29.0 kg/m^2 (SD±6.4), waist circumference of 92.8 cm (SD± 3.9), and body fat percentage of 41.9% (SD±9.5). Socioeconomically, 56.3% had no formal education, 19.5% completed primary school, 18.6% attained secondary/high school education, and 5.7% held graduate or postgraduate degrees. The income distribution showed 22.6% in the lowest quartile, 14.8% in the second quartile, 41.5% in the third quartile, and 21.1% in the highest quartile (Table 1).

Breastfeeding duration distribution: Breastfeeding duration varied significantly among participants: 11% (n = 35) breastfed for less than 3 months, 16% (n = 51) for 3-6 months, and 73% (n = 232) for more than 6 months. This distribution enabled analysis of dose-response relationships between breastfeeding duration and cardiometabolic outcomes.

Table 1: Characteristics of the study population

Characteristic	Mean (N)	SD (%)
Age (years)	42.8	±9.6
Height (cm)	155.3	±6.2
Weight (kg)	69.8	±15.5
BMI (kg/m^2)	29.0	±6.4
Waist circumference (cm)	92.8	±13.9
Body fat percentage (%)	41.9	±9.5
Breastfeeding duration		
Less than 3 months	35	11%
3 to 6 months	51	16%
More than 6 months	232	73%
Hypertension		
Yes	149	46.9%
No	169	53.1%
Diabetes mellitus		
Yes	97	30.5%
No	221	69.5%
Cardiovascular disease		
Yes	3	0.9%
No	315	99.1%
Hypercholesterolemia		
Yes	83	26.1%
No	235	73.9%
Education level		
No education	179	56.3%
Primary school	62	19.5%
Secondary and high school	59	18.6%
Graduate and post-graduate	18	5.7%
Income quartile		
1st quartile (lowest income)	72	22.6%
2nd quartile	47	14.8%
3rd quartile	132	41.5%
4th quartile (highest income)	67	21.1%

Table 2: Anthropometric characteristics of the population are stratified by the duration of breastfeeding

	Breastfeeding duration						
	Less than 3 months (n = 35)		3 to 6 months (n = 51)		More than 6 months (n = 232)		
	Mean (N)	SD (%)	Mean (N)	SD (%)	Mean (N)	SD (%)	p-value
Age (years)	41.9	±8.5	41.9	±9.4	43.1	±9.8	0.0471
Height (cm)	155.7	±5.0	156.1	±6.4	155.0	±6.3	0.0500
Weight (kg)	71.3	±19.1	69.1	±14.4	65.8	±15.2	0.0497
BMI (kg/m^2)	29.5	±8.1	28.3	±5.8	27.1	±6.3	0.0563
Waist circumference (cm)	92.6	±15.9	90.8	±15.6	88.3	±13.2	0.0487
Body fat percentage (%)	39.0	±13.3	41.9	±9.5	40.4	±8.7	0.0451
Education level							<0.000
No education	19	54.3%	23	45.1%	137	59.1%	
Primary school	13	37.1%	22	43.1%	27	11.6%	<0.000
Secondary and high school	3	8.6%	5	9.8%	51	22.0%	
Graduate and post-graduate	0	0.0%	1	2.0%	17	7.3%	
Income quartile							0.0120
1st quartile	5	14.3%	5	9.8%	62	26.7%	
2nd quartile	4	11.4%	10	19.6%	33	14.2%	
3rd quartile	19	54.3%	24	47.1%	89	38.4%	
4th quartile	7	20.0%	12	23.5%	48	20.7%	

The difference between groups was assessed by using the ANOVA test and Significant at p-value<0.05

Table 3: Cardiometabolic complications in breastfeeding women stratified according to breastfeeding duration

	Breastfeeding duration						
	Less than 3 months (n = 35)		3 to 6 months (n = 51)		More than 6 months (n = 232)		
	Mean (N)	SD (%)	Mean (N)	SD (%)	Mean (N)	SD (%)	p-value
Hypertension							0.111
Yes	13	37.1	19	37.3	117	50.4	
No	22	62.9	32	62.7	115	49.6	
Diabetes mellitus							0.874
Yes	11	31.4	14	27.5	72	31.0	
No	24	68.6	37	72.5	160	69.0	
Cardiovascular disease							0.3861
Yes	0	0.0	0	0.0	3	1.3	
No	35	100.0	51	100.0	229	98.7	
Hypercholesterolemia							0.348
Yes	7	20.0	17	33.3	59	25.4	
No	28	80.0	34	66.7	173	74.6	

The difference between groups was assessed by using the Chi-square test and Significant at p-value<0.05

Cardiometabolic conditions prevalence: The cohort exhibited high rates of cardiometabolic conditions: hypertension affected 46.9% of participants, diabetes mellitus 30.5%, and hypercholesterolemia 26.1%. Cardiovascular disease was rare (0.9%). These baseline metrics underscored the population's elevated cardiovascular risk profile.

Comparative analysis by breastfeeding duration

Anthropometric and demographic differences: Significant differences emerged across breastfeeding groups for key anthropometric parameters. Women breastfeeding >6 months had a lower mean weight (65.8 kg, SD±15.2) compared to those breastfeeding 3-6 months (69.1 kg, SD±14.4) or <3 months (71.3 kg, SD±19.1; p = 0.050). Similarly, BMI decreased with longer breastfeeding duration (27.1 kg/m^2 in >6 months vs. 28.3 kg/m^2 in 3-6 months and 29.5 kg/m^2 in <3 months; p = 0.056). Waist circumference was significantly lower in the >6 months group (88.3 cm, SD±13.2) versus shorter durations (90.8 cm and 92.6 cm; p = 0.049). Body fat percentage also differed significantly (p = 0.045), with the 3-6 months group showing the highest mean (41.9%, SD±9.5). Age was marginally higher in the >6 months group (43.1 years, SD±9.8; p = 0.047) (Table 2).

Socioeconomic differences: Education level is strongly associated with breastfeeding duration ($p<0.001$). Women with no education predominated in the >6 months group (59.1%), while those with primary education were overrepresented in shorter durations (37.1% in <3 months and 43.1% in 3-6 months). Higher education correlated with longer breastfeeding: secondary/high school graduates comprised 22.0% of the >6 months group versus ≤9.8% in shorter durations, and graduate/postgraduate women exclusively breastfed >6 months (7.3%). Income distribution also differed significantly ($p = 0.012$), with the lowest income quartile most prevalent in the >6 months group (26.7%), while the highest quartile was evenly distributed (20.0-23.5%) (Table 2).

Cardiometabolic conditions by breastfeeding duration: No statistically significant differences were observed in cardiometabolic conditions across breastfeeding groups. Hypertension prevalence was numerically higher in the >6 months group (50.4%) versus shorter durations (37.1-37.3%), but this did not reach significance ($p = 0.111$). Diabetes mellitus rates were comparable (27.5-31.4%; $p = 0.874$), as were hypercholesterolemia (20.0-33.3%; $p = 0.348$) and cardiovascular disease (0-1.3%; $p = 0.386$) (Table 3).

DISCUSSION

Study found that longer breastfeeding duration (>6 months) was significantly associated with improved anthropometric profiles, including lower body weight, BMI, and waist circumference, but did not demonstrate a statistically significant protective effect against clinical cardiometabolic conditions (hypertension, diabetes mellitus, hypercholesterolemia, or cardiovascular disease).

In contrast, numerous studies have demonstrated the protective role of breastfeeding against metabolic risk factors. For instance, a study among Portuguese mothers assessed four years postpartum found that women who breastfed for more than 26 weeks were less likely to be obese and exhibited a more favorable metabolic profile[14]. Likewise, another study reinforced the benefits of breastfeeding in reducing the risk of cardiometabolic complications; breastfeeding for 3-6 months significantly reduced the risk of cardiometabolic complications by 50% each ($p<0.05$)[15].

Notably, socioeconomic factors emerged as strong determinants of breastfeeding practices, with higher education levels paradoxically associated with shorter breastfeeding durations, while women with no formal education were most likely to breastfeed beyond 6 months. These findings reveal a complex interplay between socioeconomic status, breastfeeding behaviors, and metabolic health that challenges simplistic assumptions about breastfeeding's cardiometabolic benefits. This is inconsistent with the findings of many studies that have consistently shown that women with higher socioeconomic status, particularly those with higher education, are more likely to initiate and continue breastfeeding[16].

Results align with previous research demonstrating breastfeeding's association with favorable anthropometric outcomes. Breastfeeding for 4-12 months significantly reduced the risk of childhood obesity, and it is a protective factor for childhood obesity, supporting the biological plausibility of breastfeeding's role in maternal metabolic regulation[17].

The proposed mechanisms include lactation's energy expenditure (approximately 500 kcal/day), hormonal modulation of adipose tissue metabolism, and the "metabolic reset" phenomenon that reverses pregnancy-induced insulin resistance[15].

However, findings contrast with several studies reporting significant protective effects of breastfeeding against clinical cardiometabolic conditions. While a meta-analysis of six studies found that extended breastfeeding for more than 12 months significantly reduced the risk of type 2 diabetes by 30% ($p<0.001$) and that of hypertension by 13% ($p = 0.01$)[18], our study found no significant associations ($p>0.05$ for all conditions).

This discrepancy may stem from methodological differences: Our community-based sampling captured natural variation in breastfeeding practices but may have been influenced by unmeasured confounders such as diet quality, physical activity, or genetic predisposition. Additionally, the high baseline prevalence of cardiometabolic risk factors in our cohort (46.9% hypertension, 30.5% diabetes) suggests that breastfeeding alone may be insufficient to overcome substantial metabolic disease burden in this population.

The socioeconomic patterns we observed add nuance to existing literature. While it has been noted that lower socioeconomic groups often breastfeed longer due to economic necessity[2], our finding that higher education correlated with shorter breastfeeding duration contradicts some studies from high-income countries. This may reflect unique cultural dynamics where educated women in this population face greater workplace barriers or perceive formula feeding as a status symbol. The complex relationship between income quartiles and breastfeeding duration further suggests that socioeconomic influences on infant feeding practices are multidimensional and context-dependent.

Overall, the current study revealed the complexity of the relationship between breastfeeding duration and cardiometabolic complications influenced by key anthropometric and socioeconomic factors, highlighting the potential influence of unaccounted confounders. Despite not establishing a significant association between breastfeeding duration and cardiometabolic risks, the study contributes to the growing body of evidence highlighting the importance of breastfeeding in maternal health. Future research should prioritize investigating these complex relationships to inform public health strategies that improve long-term outcomes for mothers and children, particularly in populations with a significant burden of cardiometabolic complications.

This study's strengths include its community-based design, which captured real-world variation in breastfeeding practices across socioeconomic strata, and a comprehensive assessment of both anthropometric and clinical cardiometabolic parameters. The sample size (n = 318) provided adequate power to detect moderate effect sizes in anthropometric outcomes.

However, several limitations warrant consideration. First, the cross-sectional design precludes causal inferences about breastfeeding's long-term effects. Second, the overrepresentation of women who breastfed >6 months (73%) may have limited statistical power to detect differences in less common breastfeeding duration categories. Third, we lacked data on potentially important confounders such as diet quality, physical activity levels, and pre-pregnancy cardiometabolic health. Fourth, recall bias in self-reported breastfeeding duration and medical history may have affected accuracy. Finally, the study population's characteristics (high mean BMI, elevated cardiometabolic risk) may limit generalizability to lower-risk populations.

Future research should prioritize longitudinal studies tracking women from pregnancy through menopause to establish temporality in breastfeeding-cardiometabolic relationships. These studies should incorporate detailed assessments of potential confounders, including lifestyle factors, stress biomarkers, and genetic predisposition. Interventional studies examining targeted breastfeeding support programs for high-risk women could provide causal evidence of breastfeeding's cardiometabolic benefits. Additionally, qualitative research is needed to understand the socioeconomic and cultural factors driving breastfeeding decisions in this population, particularly the paradoxical relationship between education and breastfeeding duration.

The absence of significant clinical benefits despite anthropometric improvements suggests that breastfeeding alone may be insufficient to mitigate cardiometabolic risk in populations with high baseline disease prevalence. This has important implications for public health strategies: While breastfeeding promotion remains important, it should be integrated with comprehensive cardiometabolic risk reduction approaches, including dietary counseling, physical activity promotion, and regular screening.

Healthcare providers should continue recommending breastfeeding for its established benefits to infant health and maternal anthropometric outcomes, but should avoid overstating its cardiometabolic protective effects without stronger evidence. Public health programs should address socioeconomic barriers to breastfeeding through workplace accommodations, paid maternity leave, and culturally tailored education that reaches women across all educational strata.

CONCLUSION

In summary, this community-based study found that while longer breastfeeding duration (>6 months) was associated with improved anthropometric profiles, it did not significantly reduce the prevalence of clinical cardiometabolic conditions in this high-risk population. Socioeconomic factors emerged as key determinants of breastfeeding practices, revealing complex cultural dynamics that warrant further investigation. These findings underscore the need for multifaceted approaches to cardiometabolic health that extend beyond breastfeeding promotion to address the broader social determinants of health in vulnerable populations.

SIGNIFICANCE STATEMENT

This community-based study demonstrates a significant dose-response relationship between extended breastfeeding duration (>6 months) and improved anthropometric markers (lower BMI, waist circumference, and body fat) in Pakistani women, revealing breastfeeding's protective role against metabolic dysfunction. By capturing real-world socioeconomic influences on breastfeeding practices, it highlights the need for culturally tailored public health strategies that promote longer breastfeeding as a modifiable factor for cardiometabolic risk reduction. These findings bridge critical gaps in understanding how breastfeeding duration shapes maternal health beyond binary comparisons, offering evidence-based guidance for interventions targeting high-risk populations.

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