Biosocial Determinants and Infant Feeding Practices Influencing Growth among Tribal Infants in Manipur Valley

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Abstract
Birth weight and early infancy growth are critical indicators of child health, shaped by a complex interplay of maternal biosocial, nutritional, and environmental factors. This longitudinal study investigates the influence of maternal characteristics and feeding practices on infant growth among tribal populations in the valley districts of Manipur. A sample of 457 mother–infant pairs was followed over twelve months, with infant weight as the primary outcome variable. Using multiple and stepwise regression analyses, the study evaluates seventeen maternal and environmental predictors, including maternal age, weight, parity, education, antenatal care, and infant feeding practices. The findings reveal that infant age ($p < 0.01$) and maternal weight ($p < 0.01$) are the most significant positive predictors of growth, while maternal age ($p < 0.05$) and parity ($p < 0.01$) show significant negative associations. Exclusive breastfeeding ($p < 0.01$) and colostrum feeding ($p < 0.01$) emerge as strong contributors to improved infant weight. Antenatal care utilization ($p < 0.01$) and access to safe drinking water ($p < 0.01$) also positively influence growth outcomes. The study underscores the multifactorial nature of infant growth and emphasizes the need for targeted maternal and child health interventions in underserved tribal communities, supporting context-specific health strategies.

Keywords: Birth Weight, Infant Growth, Maternal Biosocial Factors, Breastfeeding, Tribal Health

Introduction

Birth weight is widely recognized as a fundamental indicator of neonatal health and a key determinant of an infant's subsequent growth and survival trajectory. According to the World Health Organization (WHO), low birth weight (LBW) is defined as less than 2.5 kg and is strongly associated with increased risks of morbidity, mortality, and impaired development. Normal birth weight ranges between 2.5 and 4.0 kg, while weights exceeding 4.0 kg are categorized as macrosomic. Previous research finding highlights that birth weight is influenced by a complex interaction of maternal, socio-economic, cultural, and nutritional factors. For instance, Kramer (1987) identified maternal nutrition and socio-economic conditions as major determinants of fetal growth. Similarly, Abu-Saad and Fraser (2010) emphasized the critical role of maternal nutritional status during pregnancy in shaping birth outcomes. Studies by Jejeebhoy (1995) and Fotso et al. (2008) further demonstrated that maternal education and access to healthcare services significantly affect both birth weight and early child health. In addition, Elshibly and Schmalisch (2008) established a positive relationship between maternal height and infant birth weight, while Ramakrishnan et al. (1999) highlighted the importance of antenatal care and micronutrient intake in preventing LBW. These earlier studies collectively underscore the multifactorial nature of birth weight and the importance of maternal biosocial characteristics.

Infancy, particularly the first year of life, represents a critical period of rapid growth and heightened vulnerability to environmental influences, especially nutrition. Feeding practices play a central role in shaping infant health and developmental outcomes. Breastfeeding, recognized as the optimal feeding practice, provides essential nutrients, enhances immunity, and protects against infections. Victora et al. (2016) demonstrated the profound protective effects of breastfeeding on infant survival and long-term health. Earlier work by Cabigon (1997) also emphasized its importance in reducing infant mortality, particularly in developing countries. Moreover, studies by Martorell and Zongrone (2012) highlighted the long-term consequences of early nutritional deficiencies on growth and development. The intergenerational effects of LBW have also been documented, with research indicating that women born with low birth weight are more likely to give birth to LBW infants (Conley and Bennett, 2000). Despite global recommendations advocating exclusive breastfeeding for the first six months, inappropriate feeding practices remain prevalent, particularly in low-resource settings. Research by Bhutta et al. (2008) pointed to the role of socio-cultural practices, poverty, and limited healthcare access in influencing infant feeding behaviours. These factors continue to adversely affect infant growth, underscoring the need for focused research on maternal biosocial determinants, particularly among tribal populations such as those in the Manipur Valley.

Literature Review

Early research has consistently established birth weight as a crucial determinant of infant survival and long-term health outcomes. The World Health Organization (1992) provided foundational classifications of birth weight, emphasizing the risks associated with low birth weight. Cabigon (1997) highlighted the vital role of breastfeeding in improving infant survival, particularly in resource-limited settings. Ramakrishnan et al. (1999) identified maternal nutrition, infections, and antenatal care as key contributors to variations in birth weight. Similarly, Sarkar and Saikia (2000) observed differences in birth weight across ethnic groups, noting relatively better outcomes among tribal populations compared to caste groups. Critchley and Unal (2003) examined the adverse effects of tobacco use during pregnancy, linking it to reduced gestational age and increased incidence of LBW. Subsequent studies expanded the scope of inquiry to include maternal biological and socio-demographic factors. Elshibly and Schmalisch (2008) demonstrated a strong positive correlation between maternal height and infant birth weight, suggesting that maternal physical characteristics significantly influence fetal growth. The WHO and UNICEF (2004) reported that India contributes a disproportionately high share of LBW infants among developing countries, underscoring the need for targeted maternal health interventions. Research during this period also emphasized the importance of parity, maternal age, and birth order in shaping neonatal outcomes. Studies conducted across different regions consistently found that higher parity and improved maternal nutritional status were associated with better birth weights, while younger maternal age and poor nutrition increased risks of LBW.

Further investigations focused on the role of feeding practices and socio-cultural influences on infant growth. Several researchers highlighted that exclusive breastfeeding significantly reduces infant morbidity and mortality, while early introduction of complementary foods often leads to adverse health outcomes. Studies also pointed to the persistence of traditional beliefs and practices that influence maternal diet, hygiene, and childcare behaviours, particularly in rural and tribal communities. Additionally, maternal education and access to healthcare services were identified as critical determinants of both feeding practices and infant growth. Research across developing countries revealed that inadequate utilization of antenatal and postnatal care services contributes to poor birth outcomes and suboptimal infant nutrition.

Objectives

The present study is designed to explore the influence of maternal biosocial characteristics on infant growth within tribal-dominated populations of the valley districts of Manipur. Recognizing that infant growth is shaped by a combination of biological, social, and environmental factors, the study seeks to provide a comprehensive understanding of these interrelationships. The primary objective is to examine how various maternal biosocial factors such as age, nutritional status, parity, education, and socio-economic conditions affect infant growth outcomes. In addition, the study aims to analyse the association between infant feeding practices and growth patterns, acknowledging the critical role of early nutrition during infancy. A further objective is to evaluate the relative contribution of different biosocial determinants in influencing infant growth, thereby identifying the most significant predictors. By addressing these objectives, the study intends to generate insights that can contribute to improving maternal and child health strategies, particularly in underserved tribal communities.

Materials and Methods

This study adopts a longitudinal research design to assess infant growth, measured primarily through body weight, among a sample of 457 eligible mothers from four valley districts of Manipur. The data were collected over a period of twelve months, with monthly follow-ups conducted for infants born during February - March 2019. The sampling frame consisted of infants registered in hospitals and maternal health clinics within the selected regions, and participants were selected using Simple Random Sampling Without Replacement (SRSWOR). Information was gathered through pre-tested semi-structured schedules administered via personal interviews, ensuring both reliability and consistency in data collection. Additionally, age-specific data on infant feeding practices were recorded to examine their influence on growth trajectories. The analytical framework employs multiple regression models to evaluate the relationship between infant weight (as the dependent variable) and a set of seventeen predictor variables. These predictors include infant age (in months) as a temporal factor, along with several maternal biosocial characteristics such as maternal age, body weight, parity, and family income. Educational status is categorized into different levels, ranging from illiterate to higher education, allowing for a detailed assessment of its impact on infant growth. Categorical variables are transformed into binary dummy variables to facilitate statistical analysis. Data processing and analysis are conducted using SPSS, enabling a systematic examination of the complex interactions between maternal factors, feeding practices, and infant growth outcomes.

Variable Specifications

In this study, the dependent variable (Y) is infant growth, operationalized as the infant's body weight measured in kilograms (kg). A total of seventeen predictor variables (Xi) are taken into examine their influence on growth outcomes. These include both continuous and categorical maternal biosocial factors. The continuous variables comprise infant's age (in months), maternal age (in years), maternal weight (in kg), parity (number of births), and family income (expressed in thousands of rupees). Maternal education is treated as a categorical variable with multiple levels: illiterate, literate but below matriculation, matriculate but below higher secondary (10+2), higher secondary but below undergraduate, and graduate and above. This classification enables a more detailed assessment of how varying levels of education influence infant growth. Several qualitative variables are incorporated into the analysis through binary dummy coding to facilitate statistical modeling. These include mode of delivery (normal = 1, caesarean section = 0), place of delivery (hospital = 1, home = 0), nature of menstrual cycle (regular = 1, irregular = 0), colostrum feeding (yes = 1, no = 0), and exclusive breastfeeding up to 6 months (yes = 1, no = 0). Other variables include antenatal care visits (yes = 1, no = 0), alcohol consumption (used = 1, never used = 0), tobacco use in any form (yes = 1, no = 0), source of drinking water (piped = 1, other sources such as stream or well = 0), type of housing (pucca, i.e., brick wall and RCC = 1, others = 0), and house ownership status (own = 1, rented or free = 0). These dummy variables are specifically constructed for the present analysis to capture the diverse socio-environmental and behavioural influences on infant growth, thereby enabling a comprehensive and nuanced evaluation of maternal biosocial determinants.

Analysis and Results

Statistical results are observed on the factors influencing infant growth, with particular emphasis on maternal biosocial characteristics. Using both multiple regression and stepwise regression approaches, the analysis aims to identify key determinants of infant weight and assess their relative contributions. Table 1 presents the multiple regression analysis examining the influence of maternal biosocial factors on infant weight. The overall model is highly significant ($F = 552.10$, $p < 0.001$) with a high coefficient of determination ($R^2 = 0.819$), indicating that approximately 81.9% of the variation in infant weight is explained by the included predictors. Among all variables, infant's age in months emerges as the strongest predictor ($b = 0.479$, $p < 0.01$), suggesting that infant weight increases significantly with age, as expected in normal growth patterns. Maternal weight also shows a positive and highly significant effect ($b = 0.034$, $p < 0.01$), indicating that better-nourished mothers tend to have heavier infants. In contrast, maternal age ($b = -0.012$, $p < 0.05$) and parity ($b = -0.097$, $p < 0.01$) exhibit negative associations, implying that older mothers and those with higher birth order tend to have infants with relatively lower weights. Similarly, maternal educational level shows a significant negative coefficient ($b = -0.089$, $p < 0.01$), which may reflect underlying socio-cultural or behavioural factors affecting childcare practices.

Feeding-related variables demonstrate strong positive associations with infant weight. Exclusive breastfeeding ($b = 0.342$, $p < 0.01$) and colostrum feeding ($b = 0.359$, $p < 0.01$) significantly enhance infant growth, highlighting the importance of appropriate early feeding practices. Antenatal care visits also positively influence infant weight ($b = 0.245$, $p < 0.01$), indicating the role of maternal healthcare utilization. Conversely, irregular menstrual patterns show a significant negative effect ($b = -0.287$, $p < 0.01$), suggesting possible reproductive health influences on birth outcomes. Environmental factors such as source of drinking water ($b = 0.136$, $p < 0.01$) and housing conditions (mode of living house: $b = -0.171$, $p < 0.01$) are also significant, reflecting the importance of living conditions. However, variables such as family income, mode and place of delivery, alcohol consumption, and house type are statistically insignificant ($p > 0.05$), indicating their limited independent contribution in this model.

In the stepwise regression analysis, it identifies the most influential predictors of infant weight by progressively adding variables across twelve models shown in Table 2. In Model 1, infant age alone explains a substantial portion of the variation ($b \approx 0.479$, $p < 0.01$). As additional variables are introduced, the explanatory power of the model improves, revealing the relative importance of different biosocial factors. Maternal weight consistently remains a significant positive predictor across all models ($b \approx 0.031$–0.034, $p < 0.01$), reinforcing its critical role in determining infant growth. Maternal age also consistently shows a negative effect, although its magnitude decreases slightly in later models, suggesting interaction with other variables. With the inclusion of feeding practices in Model 4 and beyond, type of feeding emerges as a strong positive determinant ($b \approx 0.33$–0.36, $p < 0.01$). Similarly, the nature of menstrual period consistently shows a negative and significant effect across models ($b \approx -0.28$ to -0.38, $p < 0.01$). As the models progress, additional significant variables include source of water, antenatal visits, and mode of living house, all of which reflect environmental and healthcare-related influences. Parity and maternal education enter in later models (Model 9 and 10), both showing negative associations with infant weight, consistent with findings from Table 1. Colostrum feeding (Model 11 and 12) and tobacco use (Model 12) are also significant, with colostrum feeding positively influencing weight and tobacco use showing a modest positive association, which may require cautious interpretation due to possible confounding effects.

Discussion

The findings of the present study reinforce the multifactorial nature of infant growth, highlighting the significant influence of maternal biosocial characteristics, feeding practices, and environmental conditions. The strong positive association between infant age and weight observed in both regression models is consistent with normal growth trajectories and aligns with earlier findings by Martorell and Zongrone (2012), who emphasized rapid growth during infancy. Maternal nutritional status, reflected through maternal weight, emerged as a consistent and significant predictor, supporting the observations of Kramer (1987) and Abu-Saad and Fraser (2010), who identified maternal nutrition as a key determinant of fetal and postnatal growth. The negative association of maternal age and parity with infant weight suggests that higher maternal age and increased birth order may adversely affect infant growth, which corroborates earlier studies indicating that reproductive burden and maternal depletion can influence birth outcomes (Ramakrishnan et al., 1999). Interestingly, the negative effect of maternal education contrasts with conventional expectations and findings by Jejeebhoy (1995) and Fotso et al. (2008), suggesting that in tribal contexts, education may not directly translate into improved childcare practices due to persistent socio-cultural influences.

Feeding practices emerge as critical determinants of infant growth in this study. The positive effects of exclusive breastfeeding and colostrum feeding strongly support the findings of Victora et al. (2016) and Cabigon (1997), who highlighted the protective and growth-promoting benefits of breastfeeding. The significance of antenatal care further aligns with Ramakrishnan et al. (1999), emphasizing the importance of maternal healthcare utilization in improving birth outcomes and infant health. The negative impact of irregular menstrual patterns indicates underlying reproductive health issues, which may affect fetal development, while environmental factors such as safe drinking water and housing conditions underscore the role of living standards in shaping infant growth. These findings are consistent with Bhutta et al. (2008), who noted that socio-environmental constraints significantly affect child health in developing regions. The stepwise regression analysis further refines these relationships by demonstrating the cumulative and persistent influence of key variables such as maternal weight, feeding practices, antenatal care, and environmental conditions. The inclusion of variables like parity, maternal education, and colostrum feeding in later models confirms their additional explanatory power. However, the unexpected positive association of tobacco use with infant weight warrants cautious interpretation, as it may reflect confounding or indirect effects, contrasting with findings by Critchley and Unal (2003).

Conclusion

The present research provides comprehensive evidence that infant growth, as measured by body weight, is strongly influenced by a combination of maternal biosocial, nutritional, and environmental factors. The findings clearly demonstrate that infant age and maternal nutritional status are the most consistent and significant predictors of infant growth, underscoring the importance of maternal health during and after pregnancy. Additionally, factors such as parity, maternal age, and reproductive health conditions exhibit notable effects, indicating that both biological and reproductive characteristics of mothers play a crucial role in shaping infant outcomes. The high explanatory power of the regression model further confirms that these variables collectively account for a substantial proportion of variation in infant weight, highlighting the multifaceted nature of growth determinants. Equally important are the roles of feeding practices and healthcare utilization. The positive impact of exclusive breastfeeding, colostrum feeding, and antenatal care emphasizes the need for promoting optimal maternal and child health practices, particularly in resource-constrained and tribal settings. Environmental conditions, including access to safe drinking water and housing quality, also emerge as significant contributors, reflecting the broader socio-economic context in which infant growth occurs. However, the persistence of certain unexpected findings, such as the negative association of maternal education and the marginal role of income, suggests the influence of deep-rooted socio-cultural practices that may limit the translation of knowledge into improved health behaviours. The present findings highlight the need for integrated and context-specific interventions focusing on maternal nutrition, reproductive health, awareness of appropriate feeding practices, and improved living conditions. Such targeted efforts are essential for enhancing infant growth and reducing health disparities among tribal populations in regions like the Manipur Valley.

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Table - 1: Regression analysis of infant weight with mother's biosocial factors

Variable	Regression Coefficient (b)	95% CI for b	P-value
Constant	2.145	1.610, 2.680	<0.01
Infant's age in month	0.479	0.469, 0.489	<0.01
Age of mother	-0.012	-0.022, -0.003	<0.05
Weight (in kg)	0.034	0.028, 0.039	<0.01
Parity	-0.097	-0.141, -0.054	<0.01
Educational level	-0.089	-0.126, -0.051	<0.01
Family income (in '000Rs.)	0.002	-0.001, 0.005	>0.05
Mode of delivery	0.078	-0.030, 0.186	>0.05
Place of delivery	-0.010	-0.039, 0.019	>0.05
Exclusive breastfeeding	0.342	0.201, 0.483	<0.01
Colostrum feeding	0.359	0.128, 0.590	<0.01
Antenatal visit	0.245	0.101, 0.389	<0.01
Nature of menstrual period	-0.287	-0.445, -0.129	<0.01
Use of alcohol	-0.142	-0.298, 0.014	>0.05
Use of tobacco	0.198	0.052, 0.344	<0.01
Source of water	0.136	0.067, 0.205	<0.01
House type	0.072	-0.042, 0.186	>0.05
Mode of living house	-0.171	-0.258, -0.084	<0.01

Model diagnostics: Model F = 552.10, $P < 0.001$; $R^2 = 0.819$

Table 2: Stepwise analysis of infant weight (in kg) with mother's biosocial factors

Model	Variable	Regression Coefficient (b)	95% CI for b	P-value for t-test
1	(Constant)	4.35	4.27, 4.43	<0.01
	Infant age in month	0.479	0.468, 0.490	<0.01
2	(Constant)	2.81	2.50, 3.12	<0.01
	Infant age in month	0.480	0.469, 0.491	<0.01
	Mother weight (kg)	0.031	0.024, 0.036	<0.01
3	(Constant)	3.30	2.95, 3.65	<0.01
	Infant age in month	0.480	0.469, 0.491	<0.01
	Mother weight (kg)	0.032	0.025, 0.037	<0.01
	Age of mother	-0.021	-0.031, -0.015	<0.01
4	(Constant)	2.94	2.56, 3.32	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.033	0.026, 0.041	<0.01
	Age of mother	-0.022	-0.032, -0.016	<0.01
	Type of feeding	0.365	0.215, 0.515	<0.01
5	(Constant)	3.29	2.88, 3.70	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.029	-0.039, -0.021	<0.01
	Type of feeding	0.348	0.205, 0.492	<0.01
	Nature of menstrual period	-0.321	-0.470, -0.168	<0.01
6	(Constant)	3.02	(2.60, 3.46)	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.033	0.027, 0.041	<0.01

	Age of mother	-0.029	-0.039, -0.021	<0.01
	Type of feeding	0.349	0.205, 0.492	<0.01
	Nature of menstrual period	-0.309	-0.458, -0.156	<0.01
	Source of water	0.142	0.072, 0.212	<0.01
7	(Constant)	2.86	2.42, 3.30	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.029	-0.039, -0.021	<0.01
	Type of feeding	0.349	0.205, 0.492	<0.01
	Nature of menstrual period	-0.382	-0.530, -0.230	<0.01
	Source of water	0.142	0.072, 0.212	<0.01
	Antenatal visit	0.268	0.128, 0.408	<0.01
8	(Constant)	2.88	2.44, 3.32	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.029	-0.039, -0.021	<0.01
	Type of feeding	0.332	0.188, 0.478	<0.01
	Nature of menstrual period	-0.361	-0.520, -0.205	<0.01
	Source of water	0.128	0.062, 0.196	<0.01
	Antenatal visit	0.268	0.128, 0.408	<0.01
	Mode of living house	-0.132	-0.212, -0.052	<0.01
9	(Constant)	2.76	2.32, 3.20	<0.01
	Infant age in month	0.481	0.470, 0.49	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.021	-0.031, -0.012	<0.01
	Type of feeding	0.349	0.205, 0.492	<0.01
	Nature of menstrual period	-0.341	-0.502, -0.185	<0.01
	Source of water	0.128	0.062, 0.196	<0.01
	Antenatal visit	0.268	0.128, 0.408	<0.01
	Mode of living house	-0.132	-0.212, -0.052	<0.01
	Parity	-0.072	-0.112, -0.032	<0.01
10	(Constant)	2.59	2.15, 3.04	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.012	-0.021, -0.002	<0.05
	Type of feeding	0.331	0.182, 0.472	<0.01
	Nature of menstrual period	-0.282	-0.442, -0.126	<0.01
	Source of water	0.142	0.072, 0.212	<0.01
	Antenatal visit	0.292	0.152, 0.432	<0.01
	Mode of living house	-0.138	-0.218, -0.058	<0.01
	Parity	-0.089	-0.129, -0.049	<0.01
	Mother's educational level	-0.079	-0.115, -0.043	<0.01
11	(Constant)	2.30	1.82, 2.78	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.012	-0.021, -0.002	<0.05
	Type of feeding	0.338	0.198, 0.478	<0.01
	Nature of menstrual period	-0.289	-0.448, -0.138	<0.01
	Source of water	0.148	0.078, 0.218	<0.01
	Antenatal visit	0.252	0.112, 0.392	<0.01
	Mode of living house	-0.148	-0.228, -0.068	<0.01
	Parity	-0.098	-0.138, -0.058	<0.01
	Mother's educational level	-0.081	-0.119, -0.043	<0.01
	Colostrum feeding	0.365	0.138, 0.592	<0.01
12	(Constant)	2.13	1.63, 2.63	<0.01
	Infant age in month	0.481	0.470, 0.492	<0.01
	Mother weight (kg)	0.034	0.028, 0.042	<0.01
	Age of mother	-0.011	-0.020, -0.002	<0.01
	Type of feeding	0.339	0.198, 0.478	<0.01
	Nature of menstrual period	-0.279	-0.438, -0.122	<0.01

	Source of water	0.158	0.088, 0.228	<0.01
	Antenatal visit	0.252	0.112, 0.392	<0.01
	Mode of living house	-0.149	-0.229, -0.069	<0.01
	Parity	-0.098	-0.138, -0.058	<0.01
	Mother's educational level	-0.081	-0.119, -0.043	<0.01
	Colostrum feeding	0.392	0.162, 0.622	<0.01
	Use of tobacco	0.188	0.042, 0.334	<0.05