Maternal Knowledge and Practices of Complementary Feeding and Child Development among Children Aged 6-24 Months in Calabar Metropolis of Cross River State, Nigeria

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Abstract: *Background:* Complementary feeding during the first two years of life plays a central role in shaping nutritional status and early child development. Despite clear global recommendations, gaps persist between maternal knowledge, actual feeding practice, and developmental outcomes, particularly in rapidly urbanizing settings in low- and middle-income countries such as Nigeria. Evidence that links these factors within a single analytical framework remains limited.

Objective: This research investigated the relationships among maternal knowledge of complementary feeding, feeding practices, and early childhood development in children aged 6-24 months. The study measures maternal knowledge level, investigates the relationship between this knowledge level and feeding practice, and also tests whether feeding practice mediates the relationship between knowledge and child development.

Methods: A community-based, cross-sectional analytical design was employed in Calabar Metropolis, Nigeria. The study involved 276 mother–child pairs selected through multistage sampling. Researchers developed a questionnaire and standardized assessment tools consistent with the WHO feeding recommendations, which were used for data collection. Instrument validity was ensured through expert review, with internal consistency (reliability coefficients) ranging from 0.78 to 0.81 across instrument sub-scales. Data were analyzed using descriptive statistics, chi-square tests, logistic regression, linear regression, and mediation analysis at a 0.05 significance level.

Results: Higher maternal knowledge was associated with increased likelihood of appropriate complementary feeding. Appropriate feeding practice was, in turn, associated with higher early child development scores. The mediation analysis suggests that feeding practices partially explain the relationship between maternal knowledge and child development.

Conclusion: Maternal knowledge appears to be associated with early child development both directly and through feeding practice. Interventions may benefit from focusing not only on knowledge improvement but also on supporting its translation into consistent feeding behavior.

Keywords: Complementary feeding, maternal knowledge, feeding practices, child development, infant nutrition, Calabar, Cross River State, Nigeria.

INTRODUCTION

The first two years of life represent a critical period of physical growth, brain development, and early learning. During this period, adequate nutrition is closely linked to later health and developmental potential. After six months, breast milk alone no longer meets all nutritional needs, and complementary feeding becomes necessary. Inadequate or delayed complementary feeding has been associated with undernutrition, greater vulnerability to illness, and poorer developmental outcomes [1, 2]. These issues are more glaring in low- and middle-income settings where caregiving decisions are often shaped by economic and social constraints.

Amidst this broader relationship between nutrition and development, maternal knowledge occupies a central, though not fully understood, role. In most settings, mothers serve as primary caregivers, responsible for food choices, meal preparation, and determining how/when young children are fed. Often, their understanding of nutrition, beliefs, and interpretations of health advice has a direct bearing on feeding practices. Studies from diverse LMIC contexts

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report that higher maternal knowledge tends to be associated with better complementary feeding practices, including increased dietary diversity and more frequent meals [3-5]. Other studies observed that these associations are far from straightforward. Most mothers demonstrate sound knowledge of recommended practices yet struggle to implement them consistently. This recurring gap between knowledge and practice highlights the limits of viewing maternal knowledge in isolation and points instead to the influence of broader socioeconomic, cultural, and environmental constraints that shape what caregivers are realistically able to do.

Adding further complexity, many existing studies concentrated on anthropometric indicators such as stunting or underweight, with relatively little attention to early child development as a related consequence of complementary feeding practices [6-10]. This imbalance is increasingly difficult to justify. Growing evidence shows that nutrition affects not only body size but also brain development, neural connectivity, and early learning capabilities. Delays in language development, motor skills, and socio-emotional functioning have been linked to poor complementary feeding during the latter half of infancy; an effect that may extend well into later childhood and even adulthood [11, 12]. Importantly, these outcomes do not result solely from nutrient intake. They emerge from broader caregiving environments in which feeding practices interact with stimulation, caregiver responsiveness, and child health. Ignoring these developmental dimensions risks underestimating the true significance of complementary feeding during early life.

Understanding how caregiver knowledge translates into child outcomes requires a clear conceptual lens. In child health and nutrition research, caregiver knowledge is often viewed as a distal determinant that shapes behavior but does not directly influence outcomes [13, 14]. Frameworks such as the Nurturing Care model and related child development theories suggest that caregiver characteristics, including knowledge and beliefs, affect children primarily through everyday caregiving practices [15]. Within this perspective, complementary feeding practices represent a proximal pathway through which maternal knowledge may influence both nutritional status and developmental processes [16]. This distinction is important because it shifts attention from knowledge alone to the behavioral mechanisms through which knowledge is expressed in daily care [14].

Recent research emphasized the need to examine pathways rather than simple associations between caregiver knowledge and child outcomes [17]. While maternal knowledge is linked to improved feeding behavior, its relationship with child development is less direct [18]. It is more likely that knowledge shapes everyday decisions such as food selection, feeding frequency, and responses to illness. These, in turn, may influence nutritional adequacy during a critical period of growth [3, 19]. Examining these relationships within a mediation framework provides a precise understanding of whether feeding practices mediate the observed link between maternal knowledge and developmental outcomes.

On this basis, this study adopts a mediation framework in which complementary feeding practices are examined as an intermediate factor linking maternal knowledge to developmental outcomes. This approach is consistent with existing models of child development that emphasize the role of caregiving behavior as the mechanism through which broader caregiver attributes are translated into measurable child outcomes [1, 2]. Rather than treating maternal knowledge and child development as directly connected, the mediation model allowed for more precise examination of whether feeding behavior accounts for part of this relationship. The hypothesised relationships among maternal knowledge, complementary feeding practices, and early child development are presented in Figure **1**.

Urban settings in sub-Saharan Africa provide a distinct context for examining child nutrition, as they combine improved physical access to food and health services with emerging constraints such as time pressure, dietary transition, and exposure to low-quality processed foods. Urban living is often assumed to improve nutritional outcomes due to proximity to services and markets, yet evidence suggests that this advantage is uneven and, in some cases, misleading [20 - 22]. In Nigeria, where urbanization is accelerating alongside enduring child undernutrition, research suggests that complementary feeding practices remain inadequate, even among mothers with moderate awareness of recommended guidelines [23, 24]. These patterns raise important questions about how maternal knowledge can be translated into everyday practice and whether current nutrition education approaches sufficiently address the structural and contextual barriers caregivers encounter in urban environments.

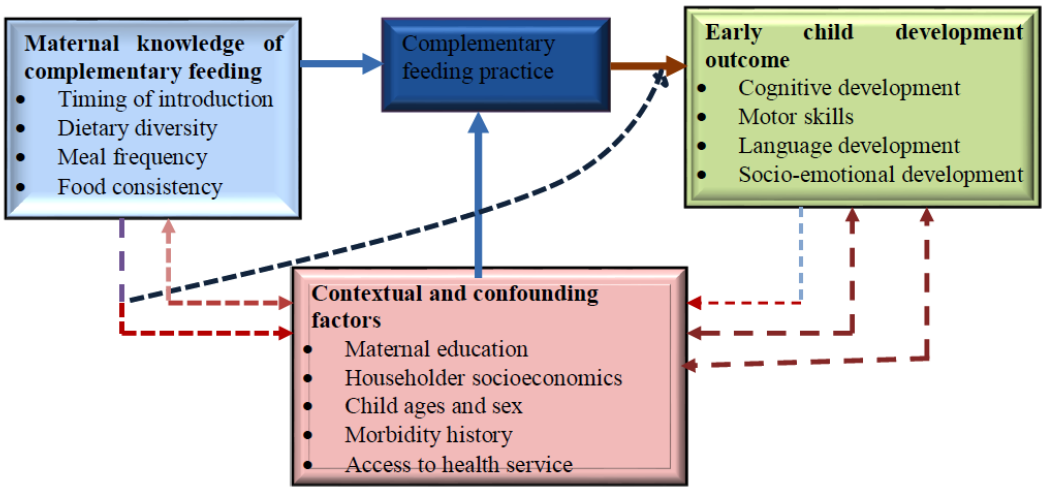

Figure 1: Conceptual framework linking maternal knowledge, complementary feeding practice and early child development.

Viewed against this background, examining the links between maternal knowledge, complementary feeding practices, and early child development in an urban Nigerian context offers insights that extend beyond the local setting. This study directly addresses the call by Black *et al.* [1] to conduct more integrated nutrition and early childhood development research in LMICs. It positions maternal knowledge in a defined pathway that links caregiver understanding to observable feeding behavior and, in turn, to developmental outcomes. By explicitly testing this pathway, the study provides empirical support for mechanisms that are often assumed but rarely examined in this context. Ultimately, this research deepened understanding of how nutrition and caregiving come together to shape children's developmental potential during one of the most formative stages of the human life course.

Although a substantial body of research has examined maternal knowledge and complementary feeding in low- and middle-income countries, much of this work treated knowledge, feeding practices, and child outcomes as separate or loosely connected factors. Few studies examined how these elements operate within a single analytical framework that reflects both behavioral pathways and developmental outcomes. In addition, existing studies often focused on anthropometric indicators, with limited attention to early child development as an outcome of feeding practices. This study contributes to the literature in two important ways. First, it integrates maternal knowledge, complementary feeding practices, and early child development within a single model that reflects both distal and proximal determinants. Second, it empirically tests a mediation pathway that is frequently implied but rarely examined, particularly in urban settings with nutritional and social transition. The present study moves beyond simple association; it provides insight into the mechanisms through which caregiver knowledge may translate into developmental outcomes.

This study aimed to examine the relationships among maternal knowledge of complementary feeding, complementary feeding practices, and early child development among children aged 6 to 24 months in an urban Nigerian setting. Specifically, the study sought to assess maternal knowledge of recommended complementary feeding practices, examine the association between maternal knowledge and complementary feeding practices, determine the relationship between complementary feeding practices and early child development outcomes, and test whether feeding practices mediate the relationship between maternal knowledge and child development.

This study addressed the following research questions.

1. What is the level of maternal knowledge regarding recommended complementary feeding practices among mothers of children aged 6 to 24 months in the study setting?

2. Is maternal knowledge of complementary feeding associated with the quality of complementary feeding practices provided to children aged 6 to 24 months?

3. How are complementary feeding practices associated with early child development outcomes, and do these practices mediate the

relationship between maternal knowledge and child development?

The following null hypotheses were tested:

1. There is no significant association between maternal knowledge of complementary feeding and complementary feeding practice.

2. Appropriate complementary feeding practices are not significantly associated with early child development outcomes among children aged 6 to 24 months.

3. Complementary feeding practice does not significantly mediate the relationship between maternal knowledge of complementary feeding and early child development.

METHODS

This study employed a community-based, cross-sectional analytical design to examine the pathways linking maternal knowledge of complementary feeding, complementary feeding practices, and early child development among children aged 6 to 24 months. This design was considered appropriate given the study's objective of assessing association and testing mediation pathways within a defined population at a single point in time. The study was conducted in Calabar Metropolis, Cross River State, Nigeria; an urban setting characterized by rapid urbanization, diverse socioeconomic conditions, and persistent challenges related to infant and young child feeding.

The study population comprised mother–child pairs, with children aged 6 to 24 months residing in the study area at the time of data collection. Eligible participants included biological mothers or primary female caregivers who were responsible for feeding the child and had lived in the study area for at least six months prior to the survey. Mothers of children with diagnosed congenital abnormalities or chronic conditions known to significantly affect feeding or development were excluded to minimize potential confounding. This eligibility criterion ensured that observed developmental outcomes were more plausibly related to feeding practices and caregiving environments.

The sample size for this study was estimated using Cochran's formula for a single population proportion [25]. A confidence level of 95% ($Z = 1.96$) and a margin of error of 5% were assumed. In the absence of a reliable prior estimate for the study area, a prevalence of 50% was used to ensure maximum variability and adequate precision. This yielded an initial sample size of 384. Given the multistage sampling design, a design effect was considered during planning to account for potential clustering. However, the final sample size was determined based on feasibility within the defined sampling frame and available resources, while still ensuring adequate representation across selected enumeration areas. An additional 10% was included to account for non-response and incomplete data.

A total of 276 mother-child pairs were successfully recruited and included in the analysis. This sample size was considered sufficient for detecting meaningful associations in cross-sectional analysis involving regression and mediation models. Although a formal post hoc power analysis was not conducted, the achieved sample size is comparable to similar cross-sectional studies that examined complementary feeding practices and related child outcomes in low- and middle-income settings, many of which report sample sizes within a similar range [26, 27]. The sample was therefore considered adequate for the analytical approach adopted in this study.

A multistage sampling technique was used to select participants within Calabar Metropolis. At the outset, wards were selected using simple random sampling. Later, enumeration areas within selected wards were identified and randomly sampled to ensure spatial representation. Households within each selected enumeration area were then selected using systematic sampling based on a calculated sampling interval. Within each selected household, eligible participants were identified as mothers or primary caregivers of children aged 6 to 24 months. When more than one eligible child was present, one child was selected by simple random sampling to reduce within-household clustering. A total of 289 eligible mother-child pairs were approached during the data collection period. Of these, 276 consented to participate and provided complete data suitable for analysis, resulting in a 95.5% response rate. Cases with incomplete responses were excluded prior to analysis to ensure data consistency. A formal post hoc power analysis was not conducted. However, the achieved sample size exceeded the minimum required to detect moderate associations, as specified in the sample size calculation. This suggests that the study had sufficient statistical power for the main analyses.

While a multistage sampling approach was used, the analysis was conducted at the individual level. The

potential influence of clustering was considered during study design; however, cluster-adjusted modeling was not applied because cluster sizes were relatively small and the primary interest was in individual-level associations. This approach is consistent with similar studies, although it may result in modest underestimation of standard errors [28].

Data were collected using a structured questionnaire and standardized assessment tools. The questionnaire captured information on maternal sociodemographic characteristics, household socioeconomic status, child characteristics, and health history. Maternal knowledge of complementary feeding was measured using a structured questionnaire adapted from the "Infant and young child feeding instrument" previously used by [29, 30] in the same settings. The knowledge scale comprises 10 items across major domains, including the age at introduction of complementary foods, mealtime, meal frequency, dietary diversity, food consistency, and feeding on illness. Example items included:

1. What is the age at which complementary foods should be introduced to an infant?

2. What is the number of times that a child, aged 6-8 months, should be fed, together with breastfeeding?

3. Which of the following categories of foods should be incorporated into the daytime meal of a child?

The correct answers were rated 1, whilst incorrect or 'don't know' got a 0, and the total score ranges from 0 to 10. Higher scores reflected greater knowledge of recommended feeding practices and vice versa. For the purpose of analysis, knowledge scores were divided into three levels based on percentage: low knowledge (0-3), moderate knowledge (4-7), and high knowledge (8-10). This classification method aligns with other studies that have evaluated maternal knowledge of infant feeding practices [26]. Cronbach's alpha reliability estimate was used to assess the internal consistency of the knowledge scale, yielding an alpha of 0.78, which is satisfactory. The instrument was reviewed by three experts for content validity and adapted to reflect locally relevant feeding practices.

Complementary feeding practices were measured using indicators from the World Health Organization (WHO) guidelines for infant and young child feeding [19]. The instrument targeted two key indicators, namely minimum dietary diversity and minimum meal frequency. Minimal dietary diversity was established as the intake of 4 or 7 standard food groups in the last 24 hours. These food groups were grains, legumes and nuts, dairy products, flesh foods, eggs, fruits and vegetables rich in vitamin A, and other fruits and vegetables. Minimal meal frequency was established based on age-specific recommendations from the WHO, taking breastfeeding status into account. For breastfed children aged 6–8 months, at least 2 meals per day were required, while children aged 9–23 months required at least 3 meals per day. Non-breastfed children were required to receive at least four feeding occasions, including milk feeds. A composite complementary feeding variable was constructed by combining these indicators. Children who met both the minimum dietary diversity and minimum meal frequency criteria were considered to have appropriate complementary feeding, and vice versa. This approach aligned with the established WHO composite indicators used by [31] to assess feeding adequacy in their study. For breastfed children aged 6–8 months, at least 2 meals per day were required; for those aged 9–23 months, at least 3 meals per day were required. Non-breastfed children must receive at least 4 feeding sessions, including a milk feed. A composite complementary feeding variable was achieved by combining the two indicators. Children who met both minimum dietary diversity and minimum meal frequency criteria were classified as having appropriate complementary feeding and vice versa. This approach was consistent with established WHO composite indicators used by Jones *et al*. [31] to assess feeding adequacy.

The composite classification was used to reflect the overall adequacy of feeding practices rather than isolated behaviors. Combining dietary diversity and feeding frequency enables the index to capture both the quality and quantity aspects of infant feeding, which may be jointly associated with nutritional adequacy. A 24-hour dietary recall was used to determine feeding practices, and it offers a practical, widely used method for capturing recent feeding behavior. Nonetheless, the method captures consumption within a day and is not necessarily indicative of normal eating habits. It is also prone to recall error and daily variation in the feeding, which can affect the accuracy of the estimates.

The Early Child Development Scale was adapted from the UNICEF Early Childhood Development Index (ECDI) [32]. The index is a caregiver-reported instrument that has been used in population-based studies, such as the study by McCoy *et al*. [33]. The

instrument tool was designed for use in low- and middle-income settings such as Nigeria, and has been used in diverse cultural contexts, including sub-Saharan Africa. The Early Child Development Scale measured four fundamental developmental domains: literacy–numeracy, physical development, learning or cognitive development, and socio-emotional development. Measurement in each domain was based on age-appropriate items that captured observable child behaviors, such as the ability to name objects, follow simple instructions, engage in social interaction, and perform basic motor tasks. If the child demonstrated the expected behavior, 1 was assigned; otherwise, 0 was assigned. Domain scores were calculated by summing relevant items, and the overall developmental score was calculated by adding all domain scores. High scores reflected advanced developmental levels of achievement relative to age expectations.

To account for differences in child age, developmental scores were reported in terms of age expectations in the instrument. ECDI was structured to reflect appropriate milestones for children in defined age ranges. This allowed for comparison of developmental status across children of different ages in the study population. In previous population-level studies of child development conducted by McCoy *et al*. [34, 35], ECDI demonstrated acceptable validity and has been widely used in low-resource environments. Although the caregiver-report scale may not be precise in describing development in clinical settings, it provides a practical, context-sensitive approach for large-scale studies. In this study, the researchers reviewed the items and adapted them to ensure cultural relevance and clarity within the Calabar local context. Internal consistency of the scale in this study was assessed using Cronbach's alpha, which yielded an alpha value of .81, indicating a good reliability.

Potential confounding variables were identified a priori based on existing literature and the conceptual framework. These included maternal education, household socioeconomic status, child age and sex, recent history of illness, and access to health services. Household socioeconomic status was assessed using respondents' responses regarding their current socioeconomic status and living conditions. Child morbidity was assessed based on reported illness episodes within the two weeks preceding the survey.

Data collection was conducted by trained research assistants with backgrounds in health or social sciences. Training emphasized ethical conduct, standardized interviewing techniques, and accurate administration of developmental assessment tools. Data collection was conducted between January, 2025 and August, 2025. The instruments were pre-tested in a similar urban setting outside the study area (Ikom), with reliability coefficients ranging from .78 to .81 across instrument sub-scales. For validity, expert validation was sought to ensure it faces content validity. Necessary revisions were made as suggested to improve clarity and cultural appropriateness. Data were entered, cleaned, and analyzed using SPSS 27 and R4.5.2. Descriptive analyses were conducted to summarise participant characteristics, maternal knowledge levels, feeding practices, and child development outcomes. Bivariate analyses were performed to examine associations between key variables. Multivariate regression models were then fitted to assess the relationships between maternal knowledge and complementary feeding practices, and between feeding practices and child development outcomes, after adjusting for identified confounders.

Mediation analysis was conducted using a causal mediation framework with nonparametric bootstrap estimation. Indirect effects were estimated using 5000 bootstrap simulations, and confidence intervals were derived using the percentile method. Maternal knowledge was entered as the independent variable, complementary feeding practice as the mediator, and early child development score as the outcome. The analysis was conducted by estimating the total effect of maternal knowledge on child development, the association between maternal knowledge and feeding practice, and the direct effect of maternal knowledge after including the mediators. Maternal knowledge was treated as an ordinal variable that reflects increasing levels of knowledge. Statistical significance was determined at the conventional 0.05 level of significance.

Model assumptions were assessed prior to analysis. Multicollinearity was examined using variance inflation factors (VIF). Observed values ranged from 1.03 to 1.19 across variables (Table **8**, panel B). This indicates no evidence of problematic collinearity. Additional model diagnostics were conducted using the overall model fit. Covariates were selected based on their potential to confound the relationship between maternal knowledge, complementary feeding practices, and early child development. These included maternal education, household socioeconomic status, child age, child sex, recent child illness, and access to health

services. These variables represent key maternal, household, and child-level factors that may associate with both feeding behavior and developmental outcomes. Their inclusion aimed to improve the validity of estimated associations.

The analytical approach was informed by the conceptual distinction between distal and proximal determinants, with maternal knowledge treated as a distal variable, complementary feeding practice as a proximal mediator, and early child development as the outcome. This analytical approach did not include multilevel or cluster-adjusted modeling. As such, findings were interpreted with consideration of potential within-cluster similarity. Ethical approval for the study was obtained from the University of Calabar research ethics committee, and permission was granted by the relevant local health authorities. Written informed consent was obtained from all participating mothers prior to data collection. Participants' confidentiality was maintained throughout the study, and data were anonymized prior to analysis.

RESULTS

Results are presented in three parts, as reflected in the main analytical steps of the study:

Association between Maternal Knowledge and Feeding Practice

There is no significant association between mothers' level of knowledge of complementary feeding and their practice of complementary feeding. Association between maternal knowledge of complementary feeding and Complementary feeding practices. A total of 276 mother–child pairs were included in the analysis. Complementary feeding practices were classified as appropriate or inappropriate according to established indicators, while maternal knowledge of complementary feeding recommendations was categorized as low, moderate, or high. Table **1** presents the distribution of complementary feeding practices by maternal knowledge level, along with the Pearson chi-square test. Binary logistic regression was conducted to assess the independent association between maternal knowledge and appropriate complementary feeding, controlling for potential confounders. Variables included in the adjusted model were maternal education, household socioeconomic status, child age, child sex, recent child illness, and access to health services. Table **2** is a binary logistic regression analysis showing factors associated with appropriate complementary feeding.

Table **1** presents the bivariate distribution of complementary feeding practices across levels of maternal knowledge. A clear gradient emerged across knowledge categories. Among mothers with low knowledge, the majority (55.8 %) practiced inappropriate complementary feeding, while only 44.2 % practiced appropriate feeding. In contrast, mothers with moderate knowledge demonstrated reversal of this pattern, with 63.7% practicing appropriate complementary feeding. The pattern became more pronounced among mothers with high knowledge: the overwhelming majority, 84.4 percent, practiced appropriate complementary feeding, while only 15.6 percent practiced inappropriate feeding.

The chi-square test confirmed that the observed distribution was not due to chance. A statistically significant association existed between maternal knowledge level and complementary feeding practices, with a chi-square value of 34.91 at 2 degrees of freedom and p = 0.001. The strength and direction of the association indicate that the probability of practicing appropriate complementary feeding increased consistently with higher maternal knowledge levels. From a descriptive perspective alone, evidence contradicts the stated null hypothesis that mothers with higher knowledge are not likely to practice appropriate complementary feeding. Instead, the analysis demonstrates a strong positive relationship between knowledge and practice.

Table 1: Complementary Feeding Practice by Level of Maternal Knowledge (n = 276)

Maternal knowledge level	Inappropriate feeding, n (%)	Appropriate feeding, n (%)	Total n (%)	χ^2	df	p-value
Low knowledge	53 (55.8)	42 (44.2)	95 (100)	34.91	2	0.001
Moderate knowledge	33 (36.3)	58 (63.7)	91 (100)			
High knowledge	14 (15.6)	76 (84.4)	90 (100)			
Total	100 (36.2)	176 (63.8)	276 (100)			

Note: Complementary feeding practices were classified according to the WHO infant and young child feeding indicators. Percentages are row percentages.

Table 2: Factors Associated with Appropriate Complementary Feeding (Multivariable Logistic Regression, n = 276)

Variable	Adjusted Odds Ratio (AOR)	95% CI	Standard Error	z-value	p-value
Maternal knowledge level					
Low knowledge	1.00 (reference)	–	–	–	–
Moderate knowledge	2.34	1.28, 4.29	0.31	2.75	0.01
High knowledge	7.49	3.64, 15.39	0.37	5.48	0.00
Maternal education	1.07	0.63, 1.84	0.27	0.26	0.79
High household socioeconomic status	1.17	0.68, 2.01	0.28	0.58	0.56
Child age	1.00	0.95, 1.04	0.02	−0.12	0.90
Child sex	0.59	0.34, 1.00	0.28	−1.95	0.05
Recent child illness	0.94	0.50, 1.75	0.32	−0.21	0.83
Access to health services	0.77	0.43, 1.35	0.29	−0.92	0.38
Model diagnostics: −2 Log likelihood = 298.6, Nagelkerke R^2 = 0.33					

Note: AOR = Adjusted odds ratio; CI = Confidence interval. Model adjusted for maternal education, household socioeconomic status, child age, child sex, recent illness, and access to health services.

Table **2** presents the adjusted effects of maternal knowledge on the likelihood of practicing appropriate complementary feeding, controlling for maternal education, household socioeconomic status, child characteristics, morbidity, and access to health services. After adjustment, maternal knowledge remained a dominant predictor of appropriate complementary feeding. Compared with mothers with low knowledge, mothers with moderate knowledge were more than twice as likely to practice appropriate complementary feeding, with an adjusted odds ratio of 2.34 (95% CI that did not include 1). This association was statistically significant (p-value = 0.006). The effect became substantially stronger among mothers with high knowledge. Mothers in this category were over seven times more likely to practice appropriate complementary feeding than their low-knowledge counterparts, with an adjusted odds ratio of 7.49 and a highly significant $p < 0.001$.

None of the covariates included in the model demonstrated comparable magnitude or consistency of association. Maternal education, household socioeconomic status, child age, morbidity status, and access to health services did not show statistically significant independent effects. A near-significant association observed for child sex suggests a potential contextual relationship; yet this did not attenuate the effect of maternal knowledge.

The model diagnostic indicated adequate explanatory power. Nagelkerke R^2 of 0.33 suggested that one-third of the variation in complementary feeding practices was explained by the included predictors, with maternal knowledge contributing substantially. Evidence from both bivariate and multivariable analyses consistently demonstrated that mothers with higher knowledge of complementary feeding recommendations are significantly more likely to practice appropriate complementary feeding than those with lower knowledge levels. Therefore, the stated hypothesis that mothers with higher knowledge are not likely to practice appropriate complementary feeding is rejected. The alternate hypothesis is retained, confirming that maternal knowledge is strongly associated with complementary feeding practices.

Feeding Practice and Child Development

Appropriate complementary feeding practices are not positively associated with better early child development outcomes among children aged 6 to 24 months. Early child development outcomes were analyzed as a continuous age-standardized developmental score encompassing cognitive, motor, language, and socio-emotional domains. Appropriate complementary feeding practices were examined as the primary exposure variable. Table **3** presents the mean developmental scores among children receiving appropriate and inappropriate complementary feeding. To assess whether complementary feeding practices were independently associated with child development outcomes, multivariate linear regression analysis was conducted. The model adjusted for maternal education, household socioeconomic status, child age, child sex, recent child illness, and access to health services. The result of the analysis is presented in Table **4**.

Table 3: Mean Early Child Development Scores by Complementary Feeding Practice

Complementary feeding practice	Mean developmental score	Standard deviation	Sample size (n)	t	p-value
Inappropriate feeding	57.04	7.63	90	8.28	0.00
Appropriate feeding	64.93	7.09	186		

Note: The developmental score represents the combined cognitive, motor, language, and socio-emotional domains.

Table 4: Factors Associated with Early Child Development Scores (Multivariable Linear Regression, n = 276)

Variable	Regression coefficient (β)	Standard error	t-value	p-value	95% C I
Appropriate complementary feeding	7.54	0.79	9.59	0.00	5.99, 9.09
Maternal education (secondary or higher)	−0.51	0.74	−0.68	0.49	−1.96, 0.95
High household socioeconomic status	0.84	0.73	1.14	0.25	−0.61, 2.29
Child age (months)	0.68	0.07	10.15	0.00	0.55, 0.81
Child sex (male)	−0.50	0.73	−0.68	0.49	−1.95, 0.94
Recent child illness (yes)	−3.41	0.79	−4.31	0.00	−4.97, −1.86
Access to health services (adequate)	−0.95	0.74	−1.28	0.20	−2.42, 0.51
Model statistics: R = .69, R^2 = 0.48, Adjusted R^2 = 0.46, F-statistic = 34.7, p < 0.00					

Note: CI = Confidence interval. Model adjusted for maternal, household, and child-level variables.

Table **3** compares the mean early child development scores between children receiving appropriate and inappropriate complementary feeding. A clear and substantial difference is observed between groups. Children exposed to inappropriate complementary feeding had a mean developmental score of 57.04 with a standard deviation of 7.63. In contrast, children receiving appropriate complementary feeding achieved a markedly higher mean score of 64.93, with lower variability, as reflected in a standard deviation of 7.09. An independent samples t-test confirmed that the observed difference was statistically significant. The test statistic of 8.28 with p = 0.001 indicates that the probability of observing such a difference by chance alone is extremely low. The direction of the difference indicates that appropriate complementary feeding is associated with superior developmental performance across measured domains. Descriptive evidence, therefore, contradicts the stated null hypothesis that appropriate complementary feeding practices are not positively associated with early child development outcomes.

Table **4** presents adjusted associations between complementary feeding practices and early child development, controlling for maternal education, household socioeconomic status, child age, child sex, recent illness, and access to health services. After adjustment, appropriate complementary feeding remained a strong and statistically significant predictor of child development. Children who received appropriate complementary feeding scored, on average, 7.54 points higher on the developmental scale than children receiving inappropriate complementary feeding. The effect size was large, the confidence interval was narrow, and the association was highly statistically significant (p < 0.001). This confirmed the independent contribution of feeding practice beyond its association with sociodemographic or health-related factors.

Child age also showed a strong positive association with developmental scores, reflecting expected maturational progression. A recent child illness demonstrated a significant negative association, indicating a detrimental effect of morbidity on development. Other covariates did not show a statistically significant independent effect and did not attenuate the relationship between feeding practice and development. Model statistics indicate robust explanatory power. The overall model accounted for 48% of the variance in early child development scores (adjusted R^2 = 0.46). F-statistic of 34.7 with p < 0.001 confirms overall model significance. Evidence from both descriptive and multivariate analyses demonstrated a strong, positive, and independent association between appropriate complementary feeding practices and early child development

outcomes among children aged 6 to 24 months. Accordingly, the stated hypothesis that appropriate complementary feeding practices are not positively associated with better early child development outcomes is rejected. The alternate hypothesis is retained.

Mediation Analysis

The relationship between maternal knowledge of complementary feeding and early child development is not mediated by complementary feeding practices, such that maternal knowledge does not relate to child development indirectly through its effect on feeding behaviors. To test the hypothesis that complementary feeding practices mediate the relationship between maternal knowledge of complementary feeding and early child development, a series of regression models was fitted in line with established mediation analysis procedures. Maternal knowledge was treated as a continuous ordinal variable reflecting increasing levels of knowledge. Early child development was analyzed as a continuous developmental score, while complementary feeding practices were treated as a binary mediator. Table **5** presents the results of the total effect model examining the association between maternal knowledge and early child development outcomes, without including the mediator. Table **6** showed the results of a logistic regression model assessing the relationship between maternal knowledge and complementary feeding practices. In the final model, complementary feeding practices were included alongside maternal knowledge to estimate the direct effect of knowledge and the mediating effect of feeding practices. Results are presented in Table **7**.

Maternal knowledge is hypothesized to relate to early child development both directly and indirectly through complementary feeding practice. The indirect pathway reflects the mediating role of feeding behavior.

Table **5** presents the total effect model examining the relationship between maternal knowledge of complementary feeding and early child development prior to the inclusion of mediators. Maternal knowledge demonstrated a strong positive association with developmental outcome. The regression coefficient (R2 = 6.54) indicates that each incremental increase in maternal knowledge level was associated with a substantial increase in the child's developmental score. Association was highly statistically significant (t = 12.90; p-value < 0.001). The confidence interval was narrow and did not include zero, confirming the robustness of the effect. Child age also showed a significant positive association with development, reflecting expected biological maturation. Recent child illness showed a negative association, though not statistically significant at the conventional threshold (p > 0.05). Overall, the model demonstrated strong explanatory capacity, accounting for 46% of the

Table 5: Total Effect of Maternal Knowledge on Early Child Development

Variable	Regression coefficient (β)	Standard error	t-value	p-value	95% C I
Maternal knowledge	6.54	0.51	12.90	0.00	5.54, 7.53
Maternal education	1.04	0.89	1.18	0.24	−0.70, 2.79
Household socioeconomic status	−0.01	0.86	−0.01	0.99	−1.70, 1.69
Child age (months)	0.67	0.08	8.48	0.00	0.51, 0.82
Recent child illness	−1.40	0.96	−1.45	0.14	−3.30, 0.50
Model statistics: R = .67, R^2 = 0.46, F-statistic = 46.2, p < 0.001					

Table 6: Association between Maternal Knowledge and Complementary Feeding Practice (Logistic Regression)

Variable	Adjusted Odds Ratio	Standard error	z-value	p-value	95% C I
Maternal knowledge	2.41	0.16	5.58	0.00	1.77, 3.28
Maternal education	1.11	0.27	0.39	0.69	0.66, 1.88
Household socioeconomic status	0.90	0.26	−0.41	0.68	0.54, 1.50
Child age (months)	0.98	0.02	−0.67	0.50	0.94, 1.03
Recent child illness	0.93	0.29	−0.26	0.79	0.52, 1.65

Table 7: Mediation Model Including Maternal Knowledge and Complementary Feeding Practice

Variable	Regression coefficient (β)	Standard error	t-value	p-value	95% C I
Maternal knowledge	5.19	0.49	10.66	0.00	4.23, 6.14
Appropriate complementary feeding	6.60	0.82	8.01	0.00	4.98, 8.22
Maternal education	0.89	0.80	1.12	0.26	−0.68, 2.47
Household socioeconomic status	0.15	0.78	0.19	0.85	−1.38, 1.67
Child age (months)	0.69	0.07	9.73	0.00	0.55, 0.83
Recent child illness	−1.29	0.87	−1.48	0.14	−3.00, 0.42
Model statistics: R = .72, R^2 = 0.52, F-statistic = 49.8, p < 0.001					

Note: Reduction in the coefficient for maternal knowledge after inclusion of feeding practice is consistent with partial mediation.

variance in developmental outcome. Evidence from this table confirms the existence of a significant total effect between maternal knowledge and early child development, satisfying the first condition for mediation.

Table **6** evaluates the effect of maternal knowledge on the likelihood of practicing appropriate complementary feeding. Maternal knowledge emerged as a strong and statistically significant predictor of feeding practices. The adjusted odds ratio of 2.41 indicates that higher maternal knowledge substantially increased the likelihood of appropriate complementary feeding. Association was highly significant, with a z-value of 5.58 and p < 0.001. The confidence interval excluded unity, confirming the stability of the effect. None of the other covariates demonstrated statistically significant associations, and none attenuated the effect of maternal knowledge. This table satisfies the second condition for mediation by demonstrating that maternal knowledge is significantly associated with the proposed mediator, complementary feeding practices.

Table **7** presents a mediation model that simultaneously includes maternal knowledge and complementary feeding practices. After the inclusion of the mediator, the effect of maternal knowledge on early child development remained statistically significant but decreased in magnitude from β = 6.54 in the total effect model to β = 5.19 in the mediation model. Appropriate complementary feeding demonstrated a strong and independent association with early child development. A regression coefficient of 6.60 indicates that children receiving appropriate complementary feeding achieved markedly higher developmental scores. Association was highly significant (p < 0.001) with a narrow confidence interval. The coefficient pattern was consistent with partial mediation. The regression coefficient for maternal knowledge decreased from 6.54 in the total effect model to 5.19 after complementary feeding practice was included; this indicates an estimated mediated effect of 1.35 developmental score units. Indirect effect of maternal knowledge on early child development through complementary feeding practice was statistically significant (ACME = 1.29, 95% CI: 0.61–1.69, p < 2.2e−16). This indicated that part of the association between maternal knowledge and child development operates through feeding behavior (Table **8**, panel A).

A reduction in the magnitude of the maternal knowledge coefficient, combined with a strong effect of feeding practices, indicates that part of the effect of maternal knowledge on child development operates through complementary feeding behaviors. The persistence of a significant direct effect further indicates partial rather than full mediation. Model statistics indicate a strong overall fit, with 52% of the variance explained. Evidence across all three models demonstrates that complementary feeding practices significantly mediate the relationship between maternal knowledge of complementary feeding and early child development. The hypothesized mediation pathway is illustrated in Figure **2**. Maternal knowledge appears to be associated with early child development both directly and indirectly through its effect on feeding behaviors. Accordingly, the stated hypothesis that the relationship is not mediated by complementary feeding practices is rejected. The alternate hypothesis is retained, confirming the existence of statistically significant partial mediation.

DISCUSSION

Findings from this study suggest that maternal knowledge, complementary feeding practice, and early

Table 8: Mediation Analysis Results and Multicollinearity Diagnostics

Panel A: Mediation analysis results			
Effect	**Estimate**	**95% CI**	**p-value**
ACME (Indirect effect)	1.29	0.61, 1.69	< 0.01
ADE (Direct effect)	2.21	1.32, 3.11	
Total effect	3.51	2.35, 4.32	
Proportion mediated	0.36	0.20, 0.49	
Panel B: Multicollinearity diagnostics			
Variable	**VIF**		
Maternal knowledge	1.19		
Complementary feeding practice	1.16		
Maternal education	1.04		
Household socioeconomic status	1.05		
Child age	1.03		
Recent child illness	1.06		

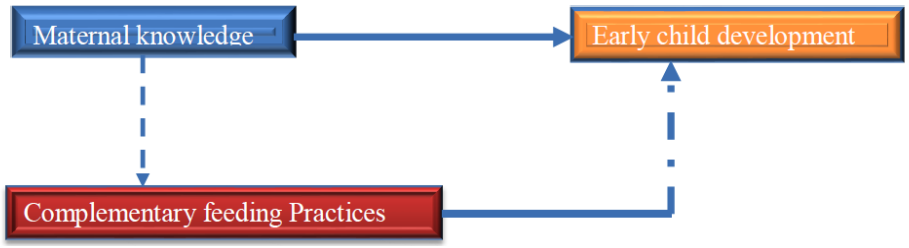

Figure 2: Conceptual mediation pathway linking maternal knowledge, complementary feeding practice, and early child development.

child development are closely associated in the study population. When interpreted within the study's conceptual framework, maternal knowledge seems to operate as a distal factor, while feeding practices represent an immediate pathway through which developmental outcomes are expressed. This pattern is consistent with evidence from several low- and middle-income settings, where caregiver knowledge has been associated with improved feeding behavior, though this association is not always translated into consistent practice [30, 35]. In the present study, this pattern appears in an urban Nigerian context, where improved physical access to services and markets may coexist with economic pressure, changing food environments, and competing caregiving demands.

The association observed between maternal knowledge and complementary feeding practice is consistent with findings from Nigeria, Ethiopia, and other sub-Saharan African settings. Research findings have shown that caregivers' knowledge is associated with improved dietary diversity and meal frequency [3, 4, 36]. At the same time, the wider LMIC literature suggests that this relationship is not uniform across settings [10]. In some contexts, knowledge shows a strong behavioral association, while in others its role appears weaker once food cost, household structure, maternal workload, and local feeding norms are taken into account [26, 37, 38]. The present findings add to this literature by suggesting that, even in an urban environment where food markets and health services are more physically accessible, knowledge still remains meaningfully associated with feeding practice. This matters because it indicates that urban residence alone does not remove the knowledge-practice gap. Rather, it may reshape the conditions under which that gap is expressed.

Findings further suggest that appropriate complementary feeding practice is positively

associated with early child development. Children who received appropriate feeding recorded higher developmental scores across the assessed domains. This pattern is consistent with biological and developmental evidence indicating that adequate nutrient intake during the second half of infancy is closely associated with brain development, motor maturation, and emerging cognitive and language abilities [2]. It also aligns with LMIC evidence indicating that poor feeding quality is often accompanied by broader developmental disadvantage [1, 39]. What the present study adds is a more integrated view in which feeding practice is examined not only as a nutritional behavior but also as a possible pathway through which caregiver knowledge becomes linked to developmental outcomes in an urban African setting.

Some covariates included in the analysis did not show statistically significant associations with feeding practice or developmental outcomes. This should not be read as evidence that these factors are unimportant. Rather, it may suggest that their role is indirect, context-dependent, or partly absorbed by other variables in the model. For instance, maternal education may improve access to health information, but it may not necessarily translate into better feeding practices when household food choices are constrained by cost. In a similar way, access to health services may have a limited observable association when counseling quality is inconsistent or when advice is not sufficiently adapted to the realities of urban caregiving. It is also possible that some null findings reflect measurement limitations or residual variation that was not fully captured by the available indicators.

The critical contribution of this study lies in the demonstration of mediation. Maternal knowledge had a significant total effect on child development, but this effect decreased when complementary feeding practices were included in the model. Concurrently, feeding practices remained strong predictors of developmental outcomes. This pattern is consistent with partial mediation; however, a cross-sectional design does not allow confirmation of causal pathways. Such findings support the contemporary framework that cautions against interpreting maternal knowledge as directly causal in the absence of behavioral translation [12]. Knowledge appeared to shape development primarily by enabling caregivers to adopt practices that translate nutritional recommendations into a daily feeding routine.

Partial rather than full mediation observed in this study warrants careful interpretation. Persistence of the direct effect of maternal knowledge suggests the existence of additional pathways linking knowledge to development. These may include improved caregiver responsiveness, increased health-seeking behaviors, improved hygiene practices, and greater engagement with stimulation activities. Prior work has demonstrated that maternal knowledge often clusters with broader caregiving competencies that jointly associate with child development [40]. Findings, therefore, reinforced the need for an integrated intervention model that combines nutrition education with broader early childhood development support.

The urban context of this study provides an important lens for interpreting the findings. Urban areas are often assumed to offer nutritional advantages because of greater proximity to food markets, health facilities, and information sources. Yet this advantage may be uneven. In settings such as Calabar Metropolis, caregivers may rely more heavily on purchased foods, face greater time pressure due to work and mobility demands, and encounter greater exposure to inexpensive, processed foods of low nutritional quality. Under such conditions, maternal knowledge may remain important, but its translation into practice is likely shaped by affordability, convenience, and the everyday organization of care. This may help explain why knowledge was associated with feeding practice in the present study, while other household and service-related variables showed weaker independent relationships. The implication is that urban nutrition intervention should not assume that information alone is enough, nor that physical proximity to services guarantees behavior change.

The negative association between recent child illness and developmental outcome observed in adjusted models further underscores the interactive nature of nutrition, health, and development. Illness may reduce appetite, disrupt feeding routines, and increase metabolic demands; thereby amplifying developmental vulnerability during early life [1]. This finding supports a call for integrated child health and nutrition strategies rather than siloed interventions. Strengths of this study include a theory-driven design, use of mediation analysis, and simultaneous examination of knowledge, practices, and developmental outcomes. However, a cross-sectional design limits causal inference, and temporal ordering cannot be definitively established. Self-reported feeding practice may be subject to recall or desirability bias. However, such bias would likely attenuate observed associations rather than inflate them. Despite these

limitations, the consistency of findings across analytical models enhanced confidence in observed relationships.

Findings provide strong empirical support for conceptual models linking maternal knowledge to child development through complementary feeding practices. Evidence suggests that improving child developmental outcomes requires more than disseminating feeding guidelines. Intervention must support caregivers in translating knowledge into sustained, developmentally supportive feeding behaviors, while addressing contextual barriers that shape everyday caregiving decisions. Such integrated approaches are essential for advancing both nutrition and early childhood development outcomes in similar urban African settings.

This study has some limitations that should be taken into account when interpreting the findings. The cross-sectional design used in the study does not allow for establishing temporal order; thus, a causal relationship cannot be inferred. Although the associations observed in the study are theoretically grounded, it is possible that the direction of association may differ or that part of the relationship may be accounted for by unmeasured variables. Further, complementary feeding was measured by caregiver self-report, which is prone to recall error, especially when assessing the frequency and diversity of foods fed over a 24-hour period. Social desirability may also play a role in the responses reported, as caregivers may report practices that align with recommended guidelines rather than their actual behavior. Although relevant maternal, household, and child-level covariates were included in the analysis, residual confounding cannot be excluded. This is particularly true for factors such as caregiver workload, household food insecurity, cultural feeding norms, and home stimulation that were not directly measured. Developmental outcome measure relied on caregiver-reported indicators adapted for the local setting. While this approach is practical in community-based research, it is less precise than direct developmental assessment and may be subject to measurement limitations. Also, this study was conducted in the urban setting of Calabar Metropolis, which may limit the generalizability of the findings to rural populations or areas with different socio-economic and cultural conditions.

However, findings from this study appear to support an interpretation in which maternal knowledge, feeding practices, and child development are linked within a broader urban caregiving environment shaped by informational and structural influences. This may help explain why behavioral association was observed even where some socioeconomic and service-related variables were not independently significant.

CONCLUSION

This research provides empirical evidence that maternal knowledge of complementary feeding is closely associated with feeding behavior and early child development in the Nigerian urban setting. The findings suggest that feeding practice represents a key pathway through which maternal knowledge is reflected in developmental outcomes. Although the observed relationships are consistent and theoretically grounded, they should be viewed with caution, given the cross-sectional design of this study. Various approaches that combine nutrition education with practical support to help caregivers translate knowledge into everyday feeding decisions may be viable for child development.

The findings have implications for both policy and program design. Interventions that focus solely on improving maternal knowledge may have a limited impact if they do not address the practical constraints caregivers face. Nutrition education programs may be more effective when combined with strategies that improve access to affordable, diverse foods and support caregivers in applying knowledge within their daily routines. In urban settings, this may include community-based counseling, workplace support for caregivers, and efforts to improve the nutritional quality of commonly available foods. These approaches recognize that knowledge is necessary but not sufficient, and that behavior change requires both understanding and enabling conditions.

RECOMMENDATIONS

The following recommendations were made based on the study's findings.

1. State and Local Health Authorities should implement structured, routine nutrition education sessions for mothers of infants aged 6 to 24 months, focusing specifically on complementary feeding recommendations. These sessions should be delivered during antenatal visits, postnatal clinics, and immunization appointments, with emphasis on practical guidance rather than general information.

2. Primary health care facilities should actively integrate complementary feeding counseling into child health and growth monitoring services. Health workers should assess feeding practices during routine child visits and provide immediate, tailored counseling to the caregivers of children receiving inappropriate feeding. This action should be implemented by primary health care facility managers and frontline health workers, under the supervision of Local Government Health Departments.

3. Third, nutrition and child development programs should be designed to simultaneously improve maternal knowledge and support translation of that knowledge into practice. Program implementers should combine feeding education with practical support, such as food preparation demonstrations and problem-solving around common caregiving barriers. This approach should be implemented by government-led nutrition programs in collaboration with non-governmental organizations and community-based organizations working in maternal and child health.

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