

BMJ Open Trends in complementary feeding indicators in Nigeria, 2003–2013

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ABSTRACT

Objective: The study aimed to examine secular trends and determinants of changes in complementary feeding indicators in Nigeria.

Design, setting and participants: Data on 79 953 children aged 6–23 months were obtained from the Nigeria Demographic and Health Surveys (NDHS) for the period spanning 2003–2013. The surveys used a stratified two-stage cluster sample of eligible mothers aged 15–49 years from the six geopolitical zones of Nigeria. Trends in complementary feeding indicators and socioeconomic, health service and individual characteristics including factors associated with complementary feeding indicators were examined using multilevel logistic regression analyses.

Results: Minimum dietary diversity for children aged 6–23 months worsened from 26% in 2003 to 16% in 2013. Minimum meal frequency improved from 43% in 2003 to 56% in 2013 and minimum acceptable diet worsened from 11% to 9%. Among educated mothers, there was a decreasing prevalence of the introduction of solid, semisolid and soft foods in infants aged 6–8 months (67% in 2003 to 57% in 2013); minimum dietary diversity (33% in 2003 to 24% in 2013) and minimum acceptable diet (13% in 2003 to 8% in 2013). Mothers with a higher education level and mothers who reported more health service contacts were more likely to meet the minimum dietary diversity. Similarly, the odds for minimum acceptable diet were higher among mothers from higher socioeconomic status groups and mothers who reported frequent health services use.

Conclusions: Complementary feeding practices in Nigeria declined over the study period and are below the expected levels required to ensure adequate growth and development of Nigerian children. National policies and programmes that ensure sustainability of projects post-MDGs and higher health service coverage for mothers, including community-based education initiatives, are proposed to improve complementary feeding practices among Nigerian mothers.

INTRODUCTION

The WHO recommends complementary feeding defined as the introduction of appropriate and safe foods to children aged 6 months and above¹ as it allows infants and young children to meet evolving nutritional requirements necessary for optimal growth,

Strengths and limitations of this study

- Complementary feeding outcomes were based on self-report and this is a potential source of measurement bias where mothers may incorrectly recall the frequency of health service visit.
- Misclassification may also have occurred, resulting in the underestimation or overestimation of the number of health service visits (such as ANC and PNC visits), which may result in overestimation or underestimation of the association between health service visits and complementary feeding indicators.
- The study used a nationally representative sample, as selected samples were drawn from the 1991 and 2006 national census frames, with high response rates (95–98%). Thus, selection bias is less likely to affect the observed findings.

development and good health.² Globally, inappropriate complementary feeding practices have been identified as a determinant of diarrhoeal diseases, malnutrition outcomes (ie, wasting, stunting and underweight) and under-5 mortality.^{3–4} Previous studies have shown that timely introduction of appropriate and safe complementary foods to infants and young children reduces the risk of malnutrition, childhood infectious diseases and mortality.^{5–6} In Nigeria, a recent study found that inappropriate complementary feeding negatively impacted children's weight, and was associated with undernourishment.⁷

Following international recommendations, Nigeria implemented various interventions (eg, the Baby Friendly Hospital Initiative in 1992 and National Policy on Infant and Young Child Feeding (IYCF) in 2005) to improve IYCF practices.⁸ Despite these efforts, the prevalence of appropriate complementary feeding practices remains low (10%) among children 6–23 months of age,⁹ and more than half of Nigerian infants receive complementary foods either too early or too late, and these foods often lack energy, protein or appropriate micronutrients such as iron, vitamin A, zinc and iodine.^{10–11} Similar studies in other

developing countries (such as Kenya and Malawi) found that mothers initiated complementary foods too early.^{12 13} Additionally, the prevalence of breastfed and non-breastfed children aged 6–23 months living with their mothers, who were fed in accordance with IYCF practices in Nigeria, has dropped from 30% in 2008¹⁴ to 10% in 2013.⁹

A recent study from northern Nigeria identified socio-economic determinants (such as maternal education, household wealth and maternal health factors) for inappropriate complementary feeding practices.⁵ In Nigeria, complications from malnutrition remain a major health problem with prominent levels of stunting (37%), wasting (18%) and underweight (12%), in infants and young children.⁹ To date, no nationally representative studies have examined trends over time in complementary feeding indicators or examined the determinants of changes to complementary feeding indicators over time.

Accordingly, the main purpose of this study is to examine secular trends in complementary feeding indicators, that is, introduction of solid, semisolid or soft foods, minimum dietary diversity, minimum meal frequency and minimum acceptable diet (MAD)¹ for the period 2003–2013, and examine whether these trends differ by socioeconomic, health service and individual characteristics. Findings from this study will provide evidence-based information to programme managers and policymakers to evaluate the impact of previous IYCF interventions, and to identify key drivers of changes to complementary feeding behaviours among Nigerian mothers.

METHOD

Data sources

The data used were collected for the Nigeria Demographic and Health Survey (NDHS), for the years 2003, 2008 and 2013, by the National Population Commission (NPC) and ICF International.^{9 14 15} The NDHS—an important source of information on IYCF practices¹—collects information on child health characteristics, including maternal health factors, from a nationally representative sample of households using the 1991 and 2006 census frames.^{14 15} The NDHS data for 2003 (N=7620), 2008 (N=33 385) and 2013 (N=38 948) contain socio-demographic and maternal responses from mothers in a reproductive age group (15–49 years). The increase in sample size in 2008 and 2013 reflects population growth in Nigeria, and a wider scope in the survey structure to include supplementary sets of questions.¹⁴ A total of 79 953 participants were involved in the three data sets, with 95–98% response rates. A stratified two-stage cluster design was used to select the samples, and using a face-to-face questionnaire, data on sociodemographic characteristics, and maternal and child health factors, including complementary feeding practices, were collected.

Complementary feeding indicators

Using the WHO recommended definition for assessing IYCF practices,¹ the complementary feeding indicators (outcome factors) included: (1) introduction of solid, semisolid or soft foods; (2) minimum dietary diversity; (3) minimum meal frequency; and (4) MAD; and were examined using the following definitions:

- ▶ *Introduction of solid, semisolid or soft foods*: The proportion of infants 6–8 months of age who received solid, semisolid or soft foods.
- ▶ *Minimum dietary diversity*: The proportion of children 6–23 months of age who received foods from four or more food groups. The seven food groups used for tabulation of this indicator are:
 - Grains, roots and tubers
 - Legumes and nuts
 - Dairy products (milk, yogurt, cheese)
 - Flesh foods (meat, fish, poultry and liver/organ meats)
 - Eggs
 - Vitamin-A rich fruits and vegetables
 - Other fruits and vegetables
- ▶ *Minimum meal frequency*: The proportion of breastfed and non-breastfed children 6–23 months of age, who received solid, semisolid or soft foods (including milk feeds for non-breastfed children) the minimum number of times or more (ie, two times for breastfed infants aged 6–8 months, three times for breastfed children aged 9–23 months and four times for non-breastfed children aged 6–23 months, on the previous day). ‘Meals’ include meals as well as snacks (other than trivial amounts), and frequency is based on caregiver report.
- ▶ *MAD*: The proportion of children 6–23 months of age who received both *minimum dietary diversity* and *minimum meal frequency*. All other indicators were based on a 24 h recall of the infant’s dietary intake, by the mother.

Study factors

Study factors comprised a range of socioeconomic, health service and individual factors, and their inclusion in the present analysis was based on findings from previously published studies in Sub-Saharan African countries, such as Malawi, Kenya and northern Nigeria;^{12 13 5} and South-East Asian countries—Nepal, Sri Lanka, India and Bangladesh^{16–19}—where an association was found between these determinants and inappropriate complementary feeding practices. The socioeconomic status measures included mother’s highest educational level (categorised as no schooling, primary or secondary and post-secondary education), employment status (categorised as not working or working in the past 12 months preceding the survey) and father’s highest educational level (categorised as no schooling, primary or secondary and postsecondary education). A household wealth index was also used to categorise households (as ‘poor’, ‘middle’ or ‘rich’). The household wealth index was

calculated as a score of weighted household assets (such as ownership of transportation vehicles or household facilities) using a principal components analysis, and was conducted by the National Population Commission and ICF International.^{9 14}

Health service factors included the number of antenatal clinic visits, categorised as no antenatal visit, one to three antenatal visit or four and above antenatal visits, which reflects the WHO four-visit antenatal care (ANC) model for focused ANC,²⁰ the place of delivery (home or health facility) and the timing of postnatal visits (categorised as none, 0–2 days or 3–42 days). Mother's age (categorised as 15–24, 25–34 and 35–49 years) was also included in analyses.

Statistical analysis

Differences in the prevalence of each of the complementary feeding indicators were examined for each year (2003, 2008 and 2013) to investigate absolute changes in prevalence. The prevalence of complementary feeding indicators was stratified by socio-economic, health service and individual level variables, to investigate trends within strata of these variables. Adjustment of prevalence estimates was conducted using sampling weights to account for the cluster sampling design employed in the NDHS.

Relative differences between study factors were investigated using a series of univariable and multivariable multilevel logistic regression models. Trends over the period were assessed by specifying period as an ordinal variable in models, stratified by each level of a given study variable, to assess the extent to which prevalence within groups was increasing or decreasing. The extent of divergence or convergence between the slopes of period specific trends within each study variable was assessed by testing the interaction between period and a given study variable.

Multivariable models adjusted for the potential confounding factors of birth interval, sex of the baby and geopolitical zone. The selection of these factors was based on previously published studies.^{21 22} In models of investigating the association between socioeconomic factors and complementary feeding indicators, adjustment was made for health service and individual factors. In subsequent models of health service factors, additional adjustment was made for socioeconomic factors, as a confounder of the association between health service factors and complementary feeding indicators. Similarly, in models of maternal age, adjustments were made for socioeconomic and health service factors, as a common cause (confounder) of the association between individual factors and complementary feeding indicators.

Models were restricted to the youngest living children aged 6–23 months, living with respondents (eligible women aged 15–49 years). All analyses were conducted in Stata V.13.0, with prevalences calculated using the 'svy' function and regression modelling using the

'xtlogit' function to allow for the cluster sampling employed in the NDHS.

Ethics

The DHS project obtained the required ethical approvals from the National Health Research Ethic Committee (NHREC) in Nigeria, before the surveys were conducted. Informed consent was obtained from study participants before they were allowed to participate in the surveys. The survey data sets used in this study were anonymous and could be applied for online. Approval was sought from MEASURE DHS/ICF International and permission was granted for this use.

RESULTS

Trends in complementary feeding indicators in Nigeria, 2003–2013

The prevalence of Nigerian mothers who introduced solid, semisolid and soft foods to infants aged 6–8 months increased marginally over time, but this was not statistically significant ([figure 1](#)). A significant improving trend was observed among mothers who met the minimum meal frequency but minimum dietary diversity worsened significantly over the study period.

Introduction of solid, semisolid or soft foods

The proportion of women who introduced solid, semisolid or soft foods worsened significantly among mothers with higher educational achievement compared to mothers with no schooling ([table 1](#)). A similar worsening trend was also observed among children whose fathers had higher educational achievement compared to fathers with no schooling. Mothers who made frequent antenatal visits were more likely to introduce solid, semisolid or soft foods compared to mothers who made no antenatal visits, with some variability in 2013.

Minimum dietary diversity

The prevalence of mothers who met the minimum dietary diversity worsened significantly over time among mothers, regardless of household wealth status ([table 2](#)). A similar worsening trend was identified in mothers irrespective of mother's age and frequency of antenatal clinic visits. Mothers with higher educational achievement and mothers from wealthier households were more likely to meet minimum dietary diversity compared to mothers with no schooling and mothers from poorer households, respectively ([table 2](#)). Similarly, mothers who made four or more antenatal visits were more likely to meet minimum dietary diversity compared to mothers who made no antenatal visits.

Minimum meal frequency

The study showed a significant improving trend in the prevalence of minimum meal frequency in mothers with primary education and mothers with no schooling

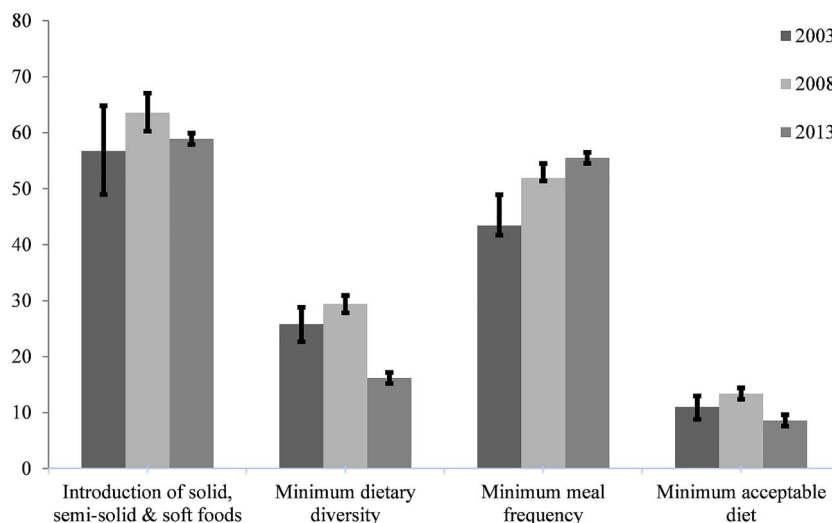


Figure 1 Trends in complementary feeding indicators in Nigeria, 2003–2013. *Bars show prevalence of complementary feeding indicators by year and 95% CIs. *Introduction of solid, semisolid or soft foods*: The proportion of infants 6–8 months of age who received solid, semisolid or soft foods. *Minimum dietary diversity*: The proportion of children 6–23 months of age who received foods from four or more food groups. The seven food groups used for tabulation of this indicator are: Grains, roots & tubers, legumes & nuts, dairy products (milk, yogurt and cheese), flesh foods (meat, fish, poultry and liver/organ meats), eggs, Vitamin-A rich fruits & vegetables, and other fruits and vegetables. *Minimum meal frequency*: The proportion of breastfed and non-breastfed children 6–23 months of age who received solid, semisolid or soft foods (including milk feeds for non-breastfed children) the minimum number of times or more (ie, 2 times for breastfed infants aged 6–8 months, three times for breastfed children aged 9–23 months and four times for non-breastfed children aged 6–23 months, on the previous day). ‘Meals’ include meals as well as snacks (other than trivial amounts), and frequency is based on caregiver report. *Minimum acceptable diet*: The proportion of children 6–23 months of age who received both minimum dietary diversity and minimum meal frequency. All other indicators were based on 24 h recall of the infant’s dietary intake, by the mother.

compared to that in mothers with higher educational achievement (figure 2 and table 3). Similarly, an improving trend was evident among mothers regardless of household wealth status, health service contacts and maternal age. Employed mothers were significantly more likely to meet minimum meal frequency compared to mothers not in employment in the 12 months prior to the survey (table 3). The odds for meeting the minimum meal frequency were higher among mothers who had four or more antenatal visits compared to those among mothers who made no antenatal visits.

Minimum acceptable diet

The prevalence of mothers who met the MAD (the indicator combining minimum meal frequency and minimum dietary diversity) worsened significantly in mothers irrespective of socioeconomic status (figure 2 and table 4). A similar worsening trend was observed among mothers who made more than four antenatal (ANC) visits compared to mothers who made no antenatal visits. Educated mothers were significantly more likely to meet the MAD compared to mothers with no schooling. Similarly, the odds for meeting the MAD were higher among mothers from wealthier households compared to those among mothers from poorer households. Mothers who reported frequent antenatal visits were significantly more likely to meet the MAD compared to mothers who made no ANC visits.

DISCUSSION

Over the study period (2003–2013), the proportion of mothers who met the minimum meal frequency improved among Nigerian mothers but there was a decrease in minimum dietary diversity. The analysis showed a worsening trend in the introduction of solid, semisolid and soft foods, minimum dietary diversity and MAD among educated mothers. Similarly, a worsening trend of these indicators (minimum dietary diversity and MAD) was evident among wealthier mothers and mothers who reported frequent health service use. An improving trend of minimum meal frequency was identified among mothers of low socioeconomic status and mothers who reported less health service access.

A number of methodological considerations need to be taken into account when interpreting these findings. First, complementary feeding outcomes were based on self-report, and this is a potential source of measurement bias where mothers may incorrectly recall the frequency of health service visit. Likewise, misclassification in key study variables may also have occurred, for example, underestimation or overestimation of the number of health service visits (such as ANC and post-natal care (PNC) visits), which may result in overestimation or underestimation of the association between health service visits and complementary feeding indicators. In addition, geopolitical variability and cultural differences in Nigeria may also be a limitation in this study,

Table 1 Introduction of solid, semisolid and soft foods by socioeconomic, health service and individual characteristics, Nigeria 2003–2013

	2003 (%)*	Adjusted OR (LCI-UCI)	p Value	2008 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2013 (%)*	Adjusted OR (LCI-UCI)	p Value	P trend	P for interaction
<i>Socioeconomic</i>											
Mother's employment											
Not working	53.9	1.00		55.9	1.00		56.9	1.00		0.632	0.433
Working	58.2	1.05 (0.55 to 2.00)	0.887	68.6	1.34 (1.00 to 1.81)	0.051	60.1	1.05 (0.79 to 1.38)	0.746	0.297	
Mother's education											
No schooling	41.5	1.00		59.7	1.00		57.8	1.00		0.319	0.022
Primary education	59.6	1.26 (0.56 to 2.86)	0.574	65.5	0.90 (0.60 to 1.35)	0.617	62.4	1.23 (0.82 to 1.84)	0.311	0.957	
Secondary and above education	79.0	2.38 (0.92 to 6.11)	0.071	70.0	1.19 (0.75 to 1.87)	0.445	58.5	1.21 (0.83 to 1.75)	0.320	0.015	
Father's education											
No schooling	40.1	1.00		60.4	1.00		61.2	1.00		0.077	0.021
Primary education	66.7	1.77 (0.86 to 3.64)	0.122	67.4	1.29 (0.91 to 1.84)	0.153	55.8	0.94 (0.66 to 1.34)	0.728	0.026	
Secondary and above education	67.2	1.53 (0.54 to 4.32)	0.421	61.8	0.80 (0.45 to 1.40)	0.432	56.6	0.82 (0.51 to 1.32)	0.418	0.572	
Household wealth											
Poor	46.5	1.00		62.3	1.00		59.0	1.00		0.326	0.105
Middle	67.5	3.19 (1.44 to 7.05)	0.004	63.6	1.01 (0.74 to 1.38)	0.940	61.9	1.24 (0.89 to 1.73)	0.196	0.243	
Rich	57.4	1.53 (0.57 to 4.11)	0.400	67.5	0.90 (0.56 to 1.45)	0.667	53.0	0.82 (0.56 to 1.19)	0.292	0.244	
<i>Health service</i>											
Place of delivery											
Home	47.0	1.00		61.0	1.00		57.0	1.00		0.738	0.267
Health facility	70.8	0.64 (0.24 to 1.71)	0.371	69.1	1.01 (0.67 to 1.54)	0.937	61.7	1.16 (0.81 to 1.68)	0.417	0.368	
Postnatal visits											
None	55.4	1.00		57.2	1.00		56.7	1.00		0.158	0.078
0–2 days	65.7	1.18 (0.77 to 4.56)	0.160	74.0	2.01 (1.35 to 2.99)	0.001	62.6	1.15 (0.81 to 1.65)	0.435	0.230	
3–42 days	55.0	0.90 (1.88 to 4.31)	0.895	73.4	1.85 (1.13 to 3.04)	0.015	60.2	0.94 (0.60 to 1.47)	0.797	0.126	
Antenatal visits											
None	36.4	1.00		58.7	1.00		58.4	1.00		0.024	0.003
1–3	64.4	3.21 (1.26 to 8.17)	0.014	75.7	2.20 (1.27 to 3.80)	0.001	59.3	1.02 (0.65 to 1.62)	0.922	0.183	
4+	66.7	2.79 (1.14 to 6.79)	0.023	68.5	1.42 (0.95 to 2.11)	0.015	59.1	1.05 (0.71 to 1.53)	0.817	0.065	
<i>Individual</i>											
Mother's age, in years											
15–24	49.0	1.00		60.6	1.00		56.8	1.00		0.768	0.262
25–34	63.6	1.57 (0.71 to 3.48)	0.263	64.5	1.09 (0.74 to 1.61)	0.648	58.0	1.02 (0.71 to 1.47)	0.888	0.190	
35–49	44.9	0.86 (0.79 to 2.63)	0.793	66.5	1.26 (0.73 to 2.18)	0.401	64.4	1.29 (0.78 to 2.17)	0.316	0.240	

(%)*=Proportion of mothers who introduced solid, semisolid or soft foods in the study population (6–23 months); P trend=trend in each variable over the study period; P for interaction=interaction between a given study variable and the study period (2003–2013).

Multivariable models adjusted for the potential confounding factors of birth interval, sex of the baby and geopolitical zone. LCI, lower confidence interval; MDGs, Millennium Development Goals; UCI, upper confidence interval.

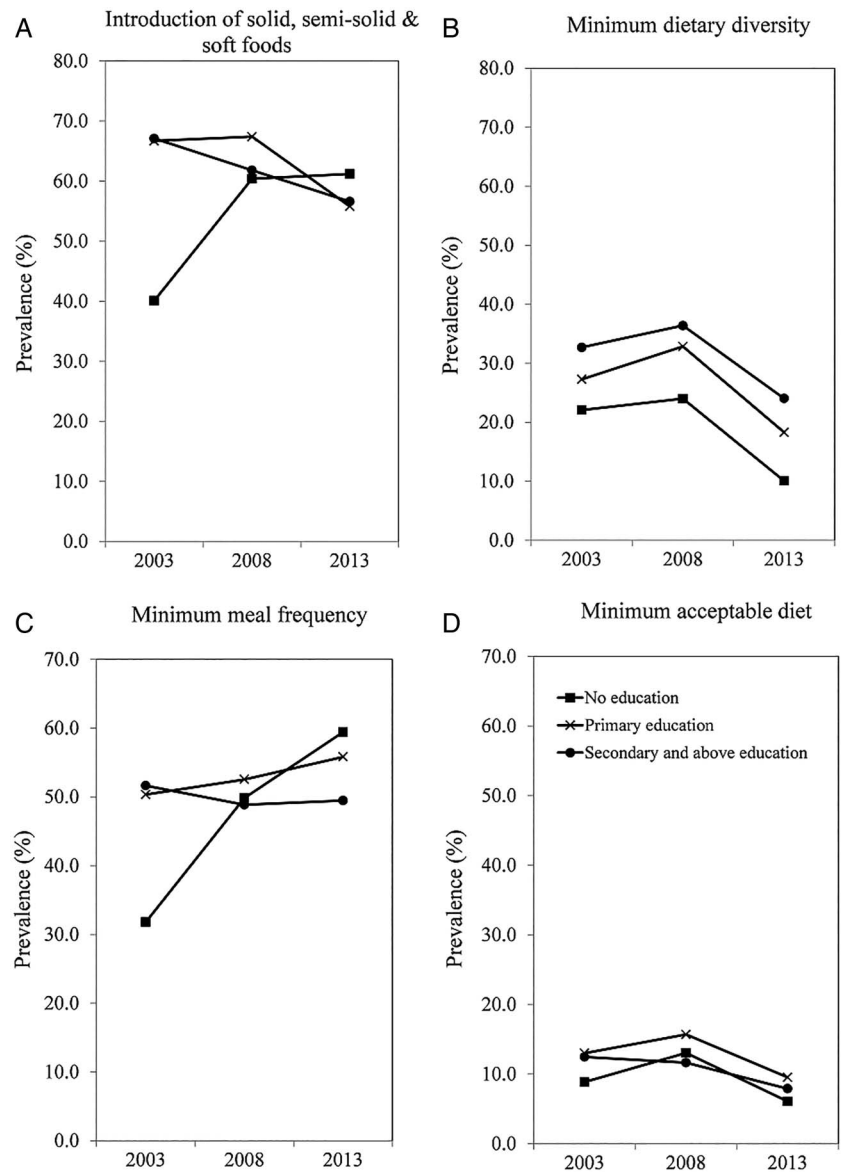
Table 2 Minimum dietary diversity by socio-economic, health service and individual characteristics, Nigeria 2003–2013

	2003 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2008 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2013 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	P trend	P for interaction
<i>Socioeconomic</i>											
Mother's employment											
Not working	23.2	1.00		24.0	1.00		14.7	1.00		<0.001	0.018
Working	27.9	1.19 (0.91 to 1.56)	0.210	33.2	1.36 (1.20 to 1.55)	<0.001	17.3	1.18 (1.01 to 1.38)	0.041	<0.001	
Mother's education											
No schooling	22.1	1.00		24.0	1.00		10.1	1.00		<0.001	<0.001
Primary education	27.3	1.63 (1.17 to 2.29)	0.004	32.9	1.07 (0.90 to 1.26)	0.437	18.3	1.54 (1.26 to 1.90)	<0.001	<0.001	
Secondary and above education	32.7	2.21 (1.55 to 3.13)	<0.001	36.4	1.17 (0.98 to 1.40)	0.089	24.1	2.11 (1.72 to 2.60)	<0.001	<0.001	
Father's education											
No schooling	21.5	1.00		23.0	1.00		10.2	1.00		<0.001	0.001
Primary education	26.4	1.32 (0.97 to 1.80)	0.078	33.2	1.20 (1.03 to 1.39)	0.020	19.3	1.50 (1.24 to 1.82)	<0.001	<0.001	
Secondary and above education	38.3	2.54 (1.68 to 3.85)	<0.001	37.9	1.40 (1.13 to 1.73)	0.002	23.9	2.14 (1.69 to 2.70)	<0.001	<0.001	
Household wealth											
Poor	22.3	1.00		25.1	1.00		10.8	1.00		<0.001	0.443
Middle	27.2	1.36 (1.02 to 1.80)	0.035	30.7	1.25 (1.09 to 1.44)	0.002	15.9	1.38 (1.14 to 1.66)	0.001	<0.001	
Rich	37.1	2.27 (1.55 to 3.32)	<0.001	38.6	1.63 (1.35 to 1.97)	<0.001	23.7	2.11 (1.69 to 2.64)	<0.001	<0.001	
<i>Health service</i>											
Place of delivery											
Home	25.0	1.00		25.9	1.00		12.3	1.00		<0.001	0.002
Health facility	28.2	1.57 (1.16 to 2.12)	0.003	37.4	1.28 (1.11 to 1.48)	0.001	23.2	1.51 (1.29 to 1.78)	<0.001	<0.001	
Postnatal visits											
None	8.0	1.00		12.0	1.00		4.0	1.00		<0.001	0.134
0–2 days	18.1	2.36 (0.95 to 5.89)	0.064	16.0	1.05 (0.69 to 1.61)	0.812	5.3	1.10 (0.59 to 2.04)	0.768	0.236	
3–42 days	0.0	1.00 (0.00 to 0.00)	0.000	13.8	0.77 (0.44 to 1.34)	0.347	8.0	1.51 (0.72 to 3.17)	0.275	0.014	
Antenatal visits											
None	19.4	1.00		21.7	1.00		10.0	1.00		<0.001	0.066
1–3	21.7	1.34 (0.89 to 2.01)	0.164	31.5	1.28 (1.05 to 1.58)	0.017	13.8	1.16 (0.91 to 1.47)	0.244	<0.001	
4+	31.8	2.13 (1.53 to 2.98)	<0.001	35.4	1.42 (1.21 to 1.67)	<0.001	20.8	1.69 (1.40 to 2.05)	<0.001	<0.001	
<i>Individual</i>											
Mother's age, in years											
15–24	26.2	1.00		27.6	1.00		14.7	1.00		<0.001	0.470
25–34	25.5	1.07 (0.77 to 1.48)	0.686	31.1	1.12 (0.96 to 1.31)	0.137	17.7	1.22 (1.02 to 1.45)	0.025	<0.001	
35–49	27.6	1.14 (0.71 to 1.81)	0.587	30.3	1.18 (0.96 to 1.46)	0.112	16.1	1.27 (1.01 to 1.61)	0.045	<0.001	

(%)*=Proportions of mothers who introduced solid, semisolid or soft foods in the study population (6–23 months); P trend=trend in each variable over the study period; P for interaction=interaction between a given study variable and the study period (2003–2013).

Multivariable models adjusted for the potential confounding factors of birth interval, sex of the baby and geopolitical zone.

Figure 2 Trends in complementary feeding indicators by mother's education.



however, geopolitical zone was adjusted for in the analysis. Selection bias is less likely to affect the observed results, due to the nationally representative sampling and high response rate of the surveys. Selected samples were drawn from the 1991 and 2006 national census frames, with response rates of between 95–98%.

The introduction of timely, appropriate and safe complementary feeding is important for the healthy growth and development of children aged under 2 years, and has been shown to improve childhood nutrition and reduce mortality in children under 5 years of age, especially in resource poor countries.^{2 11} In the current study, a higher frequency of antenatal visits by mothers was associated with timely introduction of solid, semi-solid and soft foods (complementary foods) compared to mothers who reported no antenatal (ANC) visits, suggesting that mothers who attended ANC—mothers who were more likely to have better access to health services and respond to health information messages^{23 24}—received appropriate information on introduction of

complementary foods. Evidence from regional Nigeria suggested that mothers introduced complementary foods too early (before 6 months of age) because of convenience and pressure to resume official work,^{25 26} and a notion that breast milk is no longer sufficient for the baby, or because of maternal health status.¹⁰ This suggests that sociocultural belief systems and employment can play an important role in IYCF practices.

Other broader contextual determinants that can also influence complementary feeding practices have been suggested, and include civil disturbances and natural disasters, labour laws, child care services, workplace rights and benefits, resource control, independence of the caregiver, female labour force participation and education.²⁷ Nigeria has the largest economy in sub-Saharan Africa,²⁸ with increasing female labour force participation.²⁹ These factors may be additional economic factors that can promulgate those socioenvironmental determinants associated with inappropriate feeding behaviours among Nigerian mothers, including changing

Table 3 Minimum meal frequency by socioeconomic, health service and individual characteristics, Nigeria 2003–2013

	2003 (%)*	Adjusted OR (LCI-UCI)	p Value	2008 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2013 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	P trend	P for interaction
<i>Socioeconomic</i>											
Mother's employment											
Not working	35.3	1.00		44.4	1.00		54.7	1.00		<0.001	<0.001
Working	45.2	1.28 (1.00 to 1.64)	0.047	53.3	1.44 (1.29 to 1.61)	<0.001	55.6	1.16 (1.05 to 1.29)	0.047	0.001	
Mother's education											
No schooling	31.8	1.00		49.8	1.00		59.4	1.00		<0.001	<0.001
Primary education	50.4	1.73 (1.28 to 2.33)	<0.001	52.5	1.10 (0.95 to 1.28)	0.197	55.8	1.21 (0.71 to 0.96)	0.012	0.035	
Secondary and above education	51.7	2.01 (1.46 to 2.77)	<0.001	48.9	1.03 (0.88 to 1.21)	0.725	49.5	1.09 (0.79 to 1.07)	0.275	0.277	
Father's education											
No schooling	34.3	1.00		49.6	1.00		60.4	1.00		<0.001	<0.001
Primary education	42.9	0.96 (0.72 to 1.28)	0.780	51.2	1.11 (0.97 to 1.26)	0.132	52.5	1.01 (0.88 to 1.15)	0.914	0.001	
Secondary and above education	52.8	1.94 (1.30 to 2.89)	0.001	49.4	1.04 (0.86 to 1.26)	0.673	51.2	0.98 (0.82 to 1.16)	0.788	0.526	
Household wealth											
Poor	35.4	1.00		50.7	1.00		58.4	1.00		<0.001	<0.001
Middle	46.5	1.58 (1.22 to 2.05)	<0.001	50.3	1.09 (0.97 to 1.24)	0.145	56.0	0.95 (0.84 to 1.08)	0.418	0.001	
Rich	48.8	1.72 (1.20 to 2.45)	0.003	48.3	0.99 (0.83 to 1.18)	0.905	50.1	0.88 (0.75 to 1.03)	0.108	0.547	
<i>Health service</i>											
Place of delivery											
Home	36.0	1.00		50.6	1.00		58.8	1.00		<0.001	<0.001
Health facility	51.4	1.51 (1.15 to 1.99)	0.003	49.3	1.00 (0.88 to 1.15)	0.972	49.7	0.84 (0.74 to 0.95)	0.007	0.264	
Postnatal visits											
None	46.6	1.00		54.0	1.00		53.0	1.00		0.929	0.185
0–2 days	46.9	1.53 (0.65 to 2.52)	0.460	63.7	1.60 (1.20 to 2.14)	0.001	58.9	1.21 (0.91 to 1.61)	0.183	0.575	
3–42 days	43.9	1.06 (0.25 to 4.41)	0.926	65.3	1.51 (1.05 to 2.17)	0.027	59.1	1.13 (0.79 to 1.61)	0.518	0.274	
Antenatal visits											
None	29.2	1.00		49.7	1.00		60.8	1.00		<0.001	<0.001
1–3	42.6	1.55 (1.07 to 2.23)	0.019	53.2	1.13 (0.94 to 1.36)	0.189	54.4	0.79 (0.66 to 0.94)	0.007	0.101	
4+	49.2	1.59 (1.14 to 2.20)	0.006	51.7	1.19 (1.03 to 1.39)	0.021	52.7	0.96 (0.83 to 1.11)	0.590	0.522	
<i>Individual</i>											
Mother's age, in years											
15–24	38.8	1.00		51.0	1.00		55.2	1.00		<0.001	0.141
25–34	42.5	1.08 (0.80 to 1.45)	0.612	49.8	0.93 (0.81 to 1.06)	0.272	55.0	1.13 (1.00 to 1.29)	0.056	<0.001	
35–49	43.4	1.11 (0.73 to 1.70)	0.621	49.7	0.93 (0.77 to 1.12)	0.451	56.3	1.10 (0.92 to 1.31)	0.282	<0.001	

(%)*=Proportions of mothers who introduced solid, semisolid or soft foods in the study population (6–23 months); P trend=trend in each variable over the study period; P for interaction=interaction between a given study variable and the study period (2003–2013).

Multivariable models adjusted for the potential confounding factors of birth interval, sex of the baby and geopolitical zone.

Table 4 Minimum acceptable diet by socio-economic, health service and individual characteristics, Nigeria 2003–2013

	2003 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2008 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	2013 (%)*	Adjusted OR 95% (LCI-UCI)	p Value	P trend	P for interaction
<i>Socioeconomic</i>											
Mother's employment											
Not working	9.2	1.00		10.4	1.00		6.7	1.00		0.001	0.010
Working	11.7	1.23 (0.86 to 1.78)	0.261	14.8	1.47 (1.25 to 1.73)	<0.001	7.6	1.13 (0.93 to 1.37)	0.231	0.001	
Mother's education											
No schooling	8.9	1.00		13.1	1.00		6.1	1.00		<0.001	0.047
Primary education	13.0	1.97 (1.26 to 3.08)	0.003	15.7	1.14 (0.93 to 1.39)	0.208	9.5	1.88 (1.45 to 2.44)	<0.001	<0.001	
Secondary and above education	12.5	2.34 (1.47 to 3.73)	<0.001	11.6	0.94 (0.75 to 1.18)	0.600	7.9	1.88 (1.43 to 2.46)	<0.001	<0.001	
Father's education											
No schooling	10.9	1.00		12.7	1.00		6.7	1.00		<0.001	<0.001
Primary education	8.0	0.76 (0.49 to 1.18)	0.224	13.9	1.10 (0.92 to 1.32)	0.300	8.0	1.33 (1.04 to 1.69)	0.021	<0.001	
Secondary and above education	22.2	2.99 (1.80 to 5.00)	<0.001	13.6	1.23 (0.94 to 1.59)	0.129	7.1	1.31 (0.95 to 1.80)	0.099	<0.001	
Household wealth											
Poor	10.6	1.00		12.6	1.00		5.7	1.00		<0.001	0.290
Middle	10.0	0.97 (0.65 to 1.43)	0.860	13.9	1.26 (1.06 to 1.49)	0.009	8.1	1.25 (0.99 to 1.59)	0.060	<0.001	
Rich	13.8	1.97 (1.21 to 3.22)	0.006	12.8	1.21 (0.95 to 1.55)	0.115	7.7	1.38 (1.02 to 1.85)	0.035	<0.001	
<i>Health service</i>											
Place of delivery											
Home	11.0	1.00		13.1	1.00		7.3	1.00		<0.001	0.561
Health facility	10.5	1.60 (1.07 to 2.40)	0.022	13.4	1.16 (0.97 to 1.40)	0.107	7.4	1.09 (0.87 to 1.35)	0.467	<0.001	
Postnatal visits											
None	6.30	1.00		9.4	1.00		3.6	1.00		<0.001	0.243
0–2 days	16.2	2.80 (0.99 to 7.91)	0.052	13.8	1.30 (0.84 to 2.01)	0.241	4.5	1.02 (0.52 to 2.00)	0.948	0.206	
3–42 days	0.0	0.00 (0.00 to 0.00)	0.000	13.6	1.11 (0.63 to 1.95)	0.722	7.6	1.60 (0.72 to 3.54)	0.251	0.385	
Antenatal visits											
None	7.7	1.00		12.0	1.00		6.2	1.00		<0.001	0.254
1–3	7.7	1.34 (0.75 to 2.38)	0.323	16.1	1.33 (1.04 to 1.71)	0.025	7.8	1.09 (0.81 to 1.48)	0.913	0.001	
4+	13.3	2.33 (1.48 to 3.68)	<0.001	14.1	1.24 (1.02 to 1.51)	0.030	8.1	1.36 (1.07 to 1.72)	0.736	<0.001	
<i>Individual</i>											
Mother's age, in years											
15–24	10.9	1.00		13.9	1.00		7.1	1.00		<0.001	0.804
25–34	10.3	0.74 (0.46 to 1.18)	0.210	12.9	0.89 (0.73 to 1.08)	0.244	7.6	1.14 (0.89 to 1.44)	0.296	<0.001	
35–49	11.9	0.54 (0.28 to 1.05)	0.070	12.9	0.82 (0.62 to 1.09)	0.171	7.1	1.08 (0.78 to 1.51)	0.637	<0.001	

(%)*=Proportions of mothers who introduced solid, semisolid or soft foods in the study population (6–23 months); P trend=trend in each variable over the study period; P for interaction=interaction between a given study variable and the study period (2003–2013).

Multivariable models adjusted for the potential confounding factors of birth interval, sex of the baby and geopolitical zone.

sociocultural belief systems.³⁰ Polygamy, a decreasing trend in Nigeria,^{31 32} is a culturally accepted practice in many communities,³³ it allows men to have as many children as possible whether or not they have the material resources to provide for the household—mainly due to son-preference³⁴—and may be an additional factor for inappropriate feeding practices in Nigeria.

A study from northern Nigeria found that formula foods were the most common complementary foods introduced to infants,³⁵ and the prominent marketing (practices by major manufacturers) of infant formula as being more contemporary and desirable over any sort of local or traditional foods,³⁶ may be an additional reason for the inappropriate complementary feeding pattern observed in Nigeria. Thus, enforcement of the International Code of Marketing of Breast-milk Substitutes—of which Nigeria is a signatory³⁷—which limits the marketing practices of infant-formula companies, including a ban on gifts to health workers or promoting baby food products in hospitals and clinics, is needed to improve complementary feeding patterns in Nigeria.

A health service contact (such as ANC or PNC visit) offers an important opportunity for providing mothers with health messages on safe and appropriate complementary foods.^{20 38} However, the present study found no association between PNC visits and timely introduction of complementary foods. Nonetheless, a recent study from Ethiopia reported that women who had PNC visits were more likely to introduce safe and adequate complementary foods compared to women who had no PNC visits.³⁹

In Nigeria, a large proportion of pregnant mothers reported few or no ANC and PNC visits,⁹ and various reasons have been suggested for the poor uptake of ANC and PNC, including home delivery,⁹ lack of family support,^{40 41} high healthcare cost,^{40–42} lengthy delays at the health facility⁴² and a cultural belief system, where mother and baby are kept indoors for 1 month after birth—a period of seclusion.³⁸ A study from Pakistan found that most mothers (65%) received complementary feeding information from their mothers and mothers-in-law.⁴³ This finding is also consistent with other developing countries, such as Nigeria and Malawi, where grandmothers (maternal or paternal) often provide a significant support to new mothers and infants.^{7 44} Based on their roles, grandmothers' infant feeding experience and knowledge can significantly influence nursing mothers' decisions to engage in either appropriate or unsafe IYCF practices.⁴⁴

Educated mothers have better nutritional knowledge, and are likely to have greater assertiveness, a higher position within the household and more ability to assign household resources on their own compared to mothers with no schooling.²⁷ The present study found that higher socioeconomic status (SES) mothers and mothers who reported frequent health service contacts provided a more diverse diet to their babies compared

to lower SES mothers and mothers who reported no health service contacts, respectively. Studies from Bangladesh and Pakistan found that educated mothers were more likely to provide frequent and more diverse complementary foods to their babies in a cleaner and a more protected environment compared to mothers with no schooling, even after controlling for wealth.^{45 46}

However, in many communities in less developed countries, mothers do not have the independence to exclusively make decisions regarding feeding patterns of their children.²⁷ These decisions are frequently made by the child's father in many cases (if he is available) or by the grandmother—who has an influential and a multifaceted role usually based on experience and traditional knowledge⁴⁴—and this practice may negatively impact infant feeding behaviours and health. Studies from Senegal and Indonesia have found that inappropriate complementary feeding practices by new mothers were strongly influenced by traditional beliefs of grandmothers.^{47 48} Community-based interventions that involve fathers or grandmothers in nutrition programmes, shown to be successful elsewhere,⁴⁷ are proposed as an adjunct to interventions, and would ensure improvement in female education and financial autonomy in order to improve complementary feeding practices of Nigerian mothers.

Providing babies with required minimum meal frequency (ie, two times for breastfed infants aged 6–8 months, three times for breastfed children aged 9–23 months and four times for non-breastfed children aged 6–23 months) is important for the reduction of underweight and stunting as well as of diseases associated with undernutrition.⁴⁹ There was an improvement in meal frequency among mothers of low SES groups and mothers who reported no health service use. The improvement in meal frequency in Nigerian mothers was not unexpected. A plausible reason for this observation may be the use of a complementary food (fermented cereal) that is used by most mothers, and is usually commonly available, affordable and easy to prepare.^{10 50} Additionally, the stable political environment (shown to improve IYCF practices²⁷) over the study period in Nigeria, after more than a decade of authoritarian regimes, may also have played a role. A review of observational studies from Nigeria found that non-breastfed children would require either 5.6 more meals a day or an increase in energy density of only 0.15 kcal 1 h/kg/day (total energy intake in 12 h period per kilogram per day) compared to Peruvian children who require 1.5 meals/day or an augmentation in energy density of 0.91 kcal 1 h/kg/day to achieve an increase intake of 10 kcal 1 h/kg/day.²⁷ Interventions that focus on improving the feeding behaviours of Nigerian mothers should be context specific, and should highlight existing feeding practices, including the potential value of quantitative studies of dietary intake.

MAD was assessed as a combination of minimum dietary diversity and minimum meal frequency,¹ and

MAD findings were similar to minimum dietary diversity. Findings from a Zambian study were consistent with this finding, where results of minimum dietary diversity were similar to MAD.⁵¹ The analysis found that higher SES women and mothers who reported frequent health service use met the MAD compared to lower SES women and women who made no health service contacts, respectively. Education (particularly maternal) and frequent contacts with a skilled health provider have been reported worldwide as important determinants for maternal and child health.^{16 20}

CONCLUSION

The study found an improving trend in minimum meal frequency over the study period in Nigeria. A worsening trend of introduction of solid, semisolid and soft foods, minimum dietary diversity and MAD, was evident among educated and wealthier Nigerian women, including mothers who reported a higher frequency of health service use, but with some variability. Additionally, MAD was associated with women and mothers of higher socio-economic status, who reported frequent health service use.

National policies and programmes that can ensure the continued implementation and sustainability of key MDGs (such as eradication of extreme poverty, achieving universal primary education, and improvement in maternal and child health) in the post-MDG era are proposed to address these trends in complementary feeding behaviours. In addition, state and local government policies and community-based education initiatives (such as free maternal and child health services), which have shown to be successful in some Nigerian states,^{24 52} that target all mothers, particularly low SES mothers, are also recommended as an adjunct to improve the current complementary feeding practices of Nigerian mothers.

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