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Original Article

Determinants of suboptimal complementary feeding practices among children aged 6–23 months in four anglophone West African countries

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Abstract

Suboptimal complementary feeding practices have a detrimental impact on a child's growth, health and development in the first two years of life. They lead to child malnutrition, which contributes to the high prevalence of stunting (38%) and underweight (28%) reported for children <5 years of age in Sub-Saharan Africa. This study analysed complementary feeding practices in four anglophone West African countries (Ghana, Liberia, Nigeria and Sierra Leone) using the most recent Demographic and Health Surveys. The study covered 12 623 children aged 6–23 months from four anglophone West African countries (Ghana: 822 children: Liberia: 1458 children, Nigeria: 8786 children and Sierra Leone: 1557 children). Four complementary feeding indicators were examined against a set of individual-, household- and community-level factors, using multiple regression analysis. Multivariate analyses found that lack of post-natal contacts with health workers, maternal illiteracy and geographical region were common determinants of delayed introduction of solid, semi-solid or soft foods across all four countries. Predictors for minimum dietary diversity, minimum meal frequency and minimum acceptable diet included children aged 6–11 months, administrative/geographical region, poorer household income and limited access to media. The authors recommend that the four anglophone West African countries studied should prioritise efforts to improve complementary feeding practices in order to reduce child morbidity and mortality. Interventional studies on complementary feeding should target those from poor and illiterate households.

Keywords: complementary feeding, dietary diversity, meal frequency, acceptable diet, West Africa, child development, child growth, paediatric, nutrition.

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Introduction

Studies show that breast milk alone is nutritionally insufficient for children aged 6 months and over (Caulfield *et al*. 1999). Therefore, the World Health Organization (WHO) recommended commencement of complementary feeding at this juncture. This practice results in the infant gradually transitioning to consumption of family foods. According to guidelines set by the WHO (2003), an infant should be exclusively breastfed for the first 6 months of life; thereafter, complementary foods may be introduced alongside continued breastfeeding (up to 2 years) in order to achieve optimal growth, development and health (Jones *et al*. 2003; WHO 2009; Adebayo 2013). This period (the first 2 years of life) is what is often referred to as the 'critical window' for the promotion of optimal growth, health and development of a child (McCann *et al*. 1981). During this period, children can become malnourished, which may result in stunting, if

they do not receive sufficient quantities of quality complementary foods, even with optimum breastfeeding (Black *et al*. 2008). Not only does malnutrition harm a child's body physically, it is also associated with poorer intellectual development. Past research reveals that poor diet during a child's early years of development (0–3 years) may also lead to learning and memory deficits, low intelligence quotient, school achievement, and behavioural problems in childhood and adolescence (Grantham-McGregor 1995; Liu *et al*. 2004).

Optimal complementary feeding is one of the most effective practices that can significantly reduce stunting during the first two years of childhood (Renfrew *et al*. 1999; Dewey & Adu-Afarwuah 2008). Merely giving complementary feeding does not ensure quality of the nutritional status of the child. Children need initiation of complementary foods at the correct age with minimum meal and of adequate quality. Many developing countries face the challenge of meeting the minimum standards of dietary quality for children.

In 2008, WHO introduced a set of new indicators to serve as the benchmark for assessing the quality of infant and young child feeding (IYCF) practices (WHO 2010). However, many children in developing countries still do not meet the standards for optimal complementary feeding. For example, the percentage of children who received the minimum meal frequency was 51% for Ghana and Liberia, 55% for Nigeria and 42% for Sierra Leone (Kothari *et al*. 2010). These low proportions indicate that there might be other factors that posed risks for children to meet the minimum standards for complementary feeding. The current study was conducted to determine the risk factors associated with inappropriate complementary feeding practices using the most recent Demographic and Health Surveys (DHS) data for the four anglophone West African countries; results of which may facilitate development of better public health interventions to improve the effectiveness of existing IYCF programmes in the countries concerned.

Methods

Data sources

Analysis for this study made use of the most recent DHS data of Ghana 2008 (Ghana Statistical Service 2009), Liberia 2007 (Ministry of Health and Social Welfare, and LIoS, Geo-Information Services, Program NAC 2008), Nigeria 2013 (National Population Commission 2009) and Sierra Leone 2008 (Statistics Sierra Leone, Ministry of Health and Sanitation 2009). Details of the survey methodology, sampling procedure and questionnaires are available in the respective DHS reports and are also described in the individual country papers (Ministry of Health and Social Welfare, and LIoS, Geo-Information Services, Program NAC 2008; National Population Commission 2008; Ghana Statistical Service 2009; Statistics Sierra Leone, Ministry of Health and Sanitation 2009).

Survey designs

All surveys have used a multistage cluster sampling design. Ever-married women in the reproductive age

Key messages

- Introduction of solid, semi-solid or soft foods improved with increasing age in all four countries, but infants whose mothers did not have any antenatal clinic visits had a higher risk of not meeting the requirements for this indicator.
- Children from the youngest age bracket (6–11 months) were a risk factor to appropriate dietary diversity in all four countries. Mothers and care givers should endeavour to diversify their children's diet.
- There were large regional variations in complementary feeding practices across all the countries. Cultural feeding practices that jeopardise appropriate complementary feeding practices should be discouraged in regions where they exist.
- Children from mothers with low socioeconomic status were associated with inappropriate complementary feeding practices in these anglophone countries.

group from selected households were interviewed. The response rate for ever-married women in the age group 15–49 years was 97% in Ghana, 95% in Liberia, 97% in Nigeria and 94% in Sierra Leone. The study was limited to last-born children aged 6–23 months living with the respondent. This included 822 children in Ghana, 1458 children in Liberia, 8786 children in Nigeria and 1557 children in Sierra Leone. Similar data collection methods (using a standardised questionnaire) were adopted in all surveys. Because of the different country-specific foods available for young children, the number of individual food items listed in the questionnaires differed from country to country.

Complementary feeding indicators

The new and updated IYCF indicators prescribed by the WHO (Daelmans *et al*. 2009; WHO *et al*. 2010) were used in this study. These were based on a mother's recall of foods offered to her child in the 24 h prior to the survey. The indicators are defined as follows (WHO 2010):

- *Introduction of solid, semi-solid or soft foods*: the proportion of infants 6–8 months of age who received solid, semi-solid or soft foods.
- *Minimum dietary diversity*: the proportion of children aged 6–23 months who received foods from four or more of the seven food groups: (1) grains, roots and tubers; (2) legumes and nuts; (3) dairy products; (4) flesh foods; (5) eggs; (6) vitamin A-rich fruits and vegetables; and (7) other fruits and vegetables.
- *Minimum meal frequency*: the proportion of children aged 6–23 months who received solid, semi-solid or soft foods (including milk feeds for non-breastfed children) the minimum number of times or more. 'Minimum' was defined as: 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. All feeding took place the previous day.
- *Minimum acceptable diet for the breastfed child*: the proportion of breastfed children 6–23 months of age who had at least the minimum dietary diversity and the minimum meal frequency during the previous day.

Independent variables were grouped in terms of individual-, household- and community-level characteristics. Characteristics of the child, mother and father constituted individual-level characteristics while household wealth index constituted household-level characteristics and the type of residence and geographical/administrative regions constituted community-level characteristics. Explanatory variables and their categorisation were made as consistent as possible in order to facilitate comparisons across the four countries.

Statistical analysis

The prevalence and factors associated with inappropriate feeding practices for the four complementary feeding indicator variables were examined against a set of independent variables described above. Stata version 12.0 (Stata Corp., College Station, TX, USA) was used to execute statistical analysis. The statistical significance of the prevalence of the complementary feeding indicators was completed using the χ^2 test. The 'svy' command allowed for adjustment for the cluster sampling design used in the surveys when estimating confidence intervals (CIs) around prevalence values. Factors significantly associated with inappropriate feeding practices were determined using multiple logistic regression analysis. Stepwise backwards regression was used to estimate the odds ratios (OR) adjusted for independent variables. A framework of variables was used to guide the analyses. This framework was also used to individually examine each model while non-significant variables were eliminated. To assess the adjusted risk of independent variables, the OR with 95% CI were calculated. Variables with $P < 0.05$ were retained in the final model. Details of the modelling strategy and the considered variables have been reported in each of the country-specific papers discussed in a later section of this paper.

An alternative to the method used in this analysis is the multilevel modelling approach. The survey method adopted in this study compares closely with the multilevel modelling approach in terms of the effects of primary interest. This highlights the robustness of the results obtained in this paper.

Results

Complementary feeding indicators

Table 1 shows a summary of basic characteristics of the DHS samples for the four anglophone West African countries. The samples ranged from 822 children (Ghana) to 8786 children (Nigeria). Both female and male children were almost equally represented in all four countries. The proportion of mothers in paid employment in all four countries was quite high, ranging between 62% (Liberia) and 82% (Ghana). Less than 50% of mothers in all the countries attained secondary education or higher. According to the mothers' recall, approximately 30–41% of children in all the countries were of average size at birth. All four countries had predominantly rural households. The proportions of rural population in these countries are: 62.4% (Ghana), 67.3% (Liberia), 64.0% (Nigeria) and 72.7% (Sierra Leone). Approximately 13–25% of mothers had made at least one antenatal clinic visit during pregnancy. Less than a fifth of children came from rich households, with the majority coming from poor households in all four countries.

Determinants of inappropriate feeding practices

Tables 2–5 show the adjusted ORs (AOR), 95% CI and *P*-values (*P*) for factors associated with inappropriate complementary feeding indicators based on multivariate statistical modelling. As shown in Table 2, young age of child was a significant risk factor to delayed introduction of complementary feeding in Liberia and Nigeria. Regional differences in the introduction of complementary feeding were observed in Liberia, Nigeria and Sierra Leone. Children whose mothers did not attend any antenatal clinics were significantly associated with non-introduction of complementary feeding in Liberia and Sierra Leone. Other factors significantly associated with non-introduction of complementary feeding were: children of illiterate and non-Christian mothers (Ghana), children whose mothers had a body mass index of more than 25 kg m^{-2} (Nigeria) and children whose fathers had no schooling (Sierra Leone).

Table 3 shows that dietary diversity was poor among children in the youngest age bracket (6–11 months) in all the four countries. Regional differences in dietary diversity were found in Ghana, Liberia and Nigeria. Children from poor households were found to be significantly associated with inadequate dietary diversity in Ghana and Nigeria. In Nigeria and Sierra Leone, poor dietary diversity was found to be significantly associated with children whose mothers had no schooling, whilst, in contrast, children whose fathers had only primary education in Liberia posed risk to the requirement for minimum dietary diversity. In Sierra Leone, father's education was found to be significant when it replaced mother's education in the final model [OR = 0.63; 95% CI: 0.45, 0.89) for secondary education or higher]. Other factors found to be significantly associated with inadequate dietary diversity were: children whose mothers perceived them to be small in size at birth and those who were delivered at home (Ghana), children who had acute respiratory infection in the previous 2 weeks and whose fathers worked in a non-agricultural industry (Liberia), rural children who did not contract diarrhoea in the past 2 weeks and whose mothers had limited or no access to the newspaper/magazine (Nigeria) and children who did not contract fever in the past 2 weeks, whose mothers were non-Muslim, unemployed and had limited or no access to the radio (Sierra Leone).

Table 4 shows the factors associated with inadequate meal frequency among breastfed children aged 6–23 months in all four countries. Children of the oldest age bracket (18–23 months) showed significantly inadequate meal frequency in Nigeria and Sierra Leone. Significant regional differences in inadequate meal frequency were observed in all the four countries. Other factors significantly associated with inadequate meal frequency were: children from poor households, who were perceived to be small by their mothers at birth, whose mothers had no schooling and had limited or no access to television (Liberia), mothers who had limited or no access to the media (radio and television) (Nigeria) and children who were delivered through a non-caesarean section (Sierra Leone). Our analysis indicated that children from rich households were a risk factor to adequate meal frequency in Nigeria. However, when we replaced household wealth index with number of

Table 1. Individual-, household- and community-level characteristics of children aged 6–23 months and their parents across four anglophone West African countries (2007–2013)

Characteristic	Ghana (n = 822)		Liberia (n = 1458)		Nigeria (n = 8786)		Sierra Leone (n = 1557)	
	n	%	*n*	%	*n*	%	*n*	%
Individual-level factors								
Mother's working status								
Non-working	152	18.5	560	38.5	3177	36.2	374	24.2
Working (past 12 months)	670	81.5	894	61.5	5601	63.8	1175	75.8
Father's occupation								
Non-agricultural	501	60.8	824	56.5	8451	96.2	1406	90.3
Agricultural	322	39.2	634	43.5	335	3.8	151	9.8
Mother's education								
No schooling	257	31.2	653	44.8	4146	47.2	1152	73.9
Primary	198	24.1	530	36.4	1565	17.8	213	13.7
Secondary and higher	368	44.7	274	18.8	3075	35.0	193	12.4
Father's education								
No schooling	174	23.8	316	26.5	3255	38.3	978	69.8
Primary	74	10.1	234	19.6	1558	18.3	132	9.4
Secondary and higher	484	66.2	642	53.9	3694	43.4	290	20.7
Mother's literacy								
No	560	68.1	933	64.5	5034	57.3	1310	84.1
Yes	258	31.9	514	35.6	3753	42.7	247	15.9
Mother's age (years)								
15–24	241	29.4	581	39.9	2659	30.3	448	28.7
25–34	409	49.7	595	40.8	4248	48.4	759	48.7
35–49	172	21.0	282	19.3	1879	21.4	351	22.5
Mother's age at child's birth (years)								
Less than 20	88	10.7	266	18.3	1292	14.7	237	15.2
20–29	459	55.8	736	50.5	4670	53.2	839	53.9
30–39	234	28.5	366	25.1	2428	27.6	425	27.3
More than 40	42	5.1	91	6.2	396	4.5	56	3.6
Maternal BMI (kg m^{-2})								
Less than 18	45	5.5	81	5.7	627	7.2	69	8.6
18–25	542	65.9	1154	80.3	6127	70.5	533	66.4
More than 25	235	28.6	201	14.0	1935	22.3	201	25.0
Marital status								
Currently married	738	89.7	1111	76.2	8395	95.6	1377	88.4
Formerly married*	85	10.3	347	23.8	391	4.4	181	11.6
Mother's religion								
Muslim and others	176	21.4	225	15.4	5392	61.7	1218	78.2
Christian	647	78.6	1233	84.6	3349	38.3	340	21.8
Birth order								
Firstborn	183	22.3	349	23.9	1751	19.9	282	18.1
Second to fourth	471	57.3	670	46.0	3979	45.3	811	52.1
Fifth or more	168	20.4	439	30.1	3057	34.8	465	29.8
Preceding birth interval								
No previous birth	183	22.3	349	24.0	1751	20.0	282	18.2
<24 months	81	9.8	146	10.1	1251	14.3	167	10.7
>24 months	557	67.8	959	66.0	5763	65.8	1104	71.1
Gender of baby								
Male	400	48.6	760	52.1	4423	50.3	763	49.0
Female	423	51.4	698	47.9	4364	49.7	795	51.0

Table 1. Continued

Characteristic	Ghana (n = 822)		Liberia (n = 1458)		Nigeria (n = 8786)		Sierra Leone (n = 1557)	
	n	%	n	%	n	%	n	%
Perceived baby size								
Small			324	22.3	1305	14.9	281	18.6
Average			572	39.4	3546	40.6	454	30.0
Large			555	38.3	3893	44.5	776	51.4
Child's age (months)								
6–11	297	36.1	572	39.2	3198	36.4	599	38.4
12–17	304	36.9	422	29.0	3306	37.6	613	39.4
18–23	222	27.0	464	31.8	2282	26.0	346	22.2
Place of delivery								
Home	346	42.1	875	60.0	5432	61.8	1158	74.4
Health facility	476	57.9	583	40.0	3354	38.2	399	25.6
Child had diarrhoea (last 2 weeks)								
No	567	69.0	1047	72.0	7310	83.2	1271	82.4
Yes	255	31.0	407	28.0	1477	16.8	271	17.6
Child had ARI (past 2 weeks)								
No	114	13.8	294	54.9	8299	94.5	207	51.9
Yes	113	13.7	241	45.1	487	5.5	192	48.2
Child had fever (last 2 weeks)								
No			886	61.2	7253	82.6	1053	68.5
Yes			563	38.9	1534	17.5	484	31.5
Type of delivery assistance								
Health professional	507	63.3	703	48.5	3725	42.5	616	40.4
Traditional birth attendant	242	30.3	641	44.2	1800	20.6	702	46.0
Other untrained personnel	51	6.4	107	7.4	3233	36.9	209	13.7
Mode of delivery								
Non-caesarean	771	93.9	1403	96.2	8595	97.8	1536	98.6
Caesarean	51	6.1	54	3.7	192	2.2	21	1.4
Antenatal clinic visits								
None	33	4.1	44	3.4	2889	34.8	92	7.3
1–3	150	18.7	291	22.7	1085	13.1	311	24.7
4+	620	77.2	948	73.9	4333	52.1	857	68.1
Timing of post-natal check-up								
0–2 days	202	24.6	432	29.6	2556	29.1	563	36.2
3–6 days	339	41.3	594	40.7	558	6.4	526	33.7
Seventh day or later	90	11.0	129	8.8	606	6.9	150	9.6
Missing/do not know	190	23.1	304	20.9	5066	57.7	319	20.5
Mother read the newspaper/magazine								
No	736	89.7	1200	83.2	7464	85.0	1471	94.8
Yes	85	10.3	242	16.8	1322	15.0	81	5.2
Mother listened to the radio								
No	147	17.9	679	46.9	3447	39.2	768	49.6
Yes	675	82.1	767	53.1	5340	60.8	780	50.4
Mother watched television								
No	388	47.3	969	66.6	4635	52.8	1385	89.7
Yes	433	52.7	485	33.4	4152	47.2	158	10.3

Table 1. Continued

Characteristic	Ghana (n = 822)		Liberia (n = 1458)		Nigeria (n = 8786)		Sierra Leone (n = 1557)	
	n	%	*n*	%	*n*	%	*n*	%
Household-level factors								
Household wealth index								
Poor	388	47.1	637	43.7	3948	44.9	673	43.2
Middle	317	38.6	627	43.0	3279	37.3	642	41.3
Rich	117	14.3	194	13.3	1559	17.8	242	15.5
Source of drinking water								
Unprotected	610	74.2	517	35.5	3881	44.2	784	50.3
Protected	212	25.8	941	64.5	4906	55.8	774	49.7
Community-level factors								
Residence								
Urban	309	37.6	476	32.7	3164	36.0	427	27.4
Rural	513	62.4	982	67.3	5623	64.0	1130	72.6
Geographical/administrative region								
1	74	9.0	339	23.3	1178	13.4	316	20.3
2	84	10.2	142	9.8	1502	17.1	686	44.0
3	87	10.6	233	16.0	3234	36.8	328	21.1
4	75	9.2	99	6.8	809	9.2	228	14.6
5	79	9.6	98	6.7	839	9.5		
6	160	19.5	547	37.5	1226	14.0		
7	77	9.4						
8	116	14.1						
9	45	5.4						
10	25	3.0						

BMI, body mass index; ARI, acute respiratory infection. 1 = Western (Ghana), Monrovia (Liberia), North Central (Nigeria) and Eastern (Sierra Leone); 2 = Central (Ghana), North Western (Liberia), North East (Nigeria) and Northern (Sierra Leone); 3 = Greater Accra (Ghana), South Central (Liberia), North West (Nigeria) and Southern (Sierra Leone); 4 = Volta (Ghana), South Western (Liberia), South East (Nigeria) and Western (Sierra Leone); 5 = Eastern (Ghana), South Eastern (Liberia) and South West (Nigeria); 6 = Ashanti (Ghana), North Central (Liberia) and South South (Nigeria); 7 = Brong Ahafo (Ghana), 8 = Northern (Ghana), 9 = Upper East (Ghana) and 10 = Upper West (Ghana). *Separated, divorced or widowed.

antenatal clinic visits, it was found to be significant [AOR = 1.21, 95% CI: (1.01, 1.46) for 1–3 visits and AOR = 1.09, 95% CI: (0.94, 1.26) for 4 or more visits].

Factors significantly associated with not meeting the requirement for minimum acceptable diet among breastfed children aged 6–23 months are summarised in Table 5. Administrative/geographical region was a risk factor for not meeting the required acceptable diet in Ghana and Nigeria. Children of the highest age bracket (18–23 months) were significantly associated with insufficient acceptable diet in Ghana and Nigeria. Children whose mothers did not have any postnatal check-ups (Ghana), children whose mothers had no schooling (Liberia and Nigeria) and non-working mothers who had limited or no access to the radio (Sierra Leone) were the other factors that posed risks to minimum acceptable diet. In Nigeria, other factors that posed risks to acceptable diet were: male children from poor households who did not have diarrhoea in the past 2 weeks, and whose mothers did not have any previous birth.

Discussion

Complementary feeding indicators have been used as the main outcome variable in this series of papers because these indicators have been recommended by the WHO to access appropriate complementary feeding practices among children. Assessing these indicators in the four countries revealed the

Table 2. Factors associated with not introducing solid, semi-solid or soft foods among children aged 6–8 months across four anglophone West African countries

Country	Variable	OR	95% CI	*P*-value
Ghana	Mother's religion			
	Christian	1.00		
	Muslim and others	2.46	[1.06, 5.75]	0.037
	Mother's literacy			
	No	1.00		
	Yes	3.55	[1.05, 12.02]	0.042
Liberia	Child's age (in months)	0.55	[0.34, 0.88]	0.014
	Antenatal clinic visits			
	None	1.00		
	1–3	0.13	[0.03, 0.55]	0.006
	4+	0.17	[0.04, 0.68]	0.012
	Timing of post-natal check-up			
	No check-ups/missing	1.00		
	0–2 days	0.55	[0.23, 1.30]	0.171
	3–6 days	0.44	[0.17, 1.14]	0.091
	Seventh day or later	0.27	[0.09, 0.80]	0.018
	Administrative region	See details below*		
Nigeria	Child's age (in months)	0.60	[0.52, 0.70]	<0.001
	Maternal BMI (kg m^{-2})‡			
	Less than 18	1.00		
	18–25	1.31	[0.802.15]	0.289
	More than 25	1.91	[1.09, 3.35]	0.025
	Geographical region	See details below†		
Sierra Leone	Antenatal clinic visits			
	None	1.00		
	1–3	0.05	[0.01, 0.33]	0.002
	4+	0.07	[0.01, 0.42]	0.004
	Geographical region	See details below‡		
	Father's education			
	No schooling	1.00		
	Primary	0.78	[0.19, 3.20]	0.730
	Secondary and higher	0.35	[0.14, 0.86]	0.022

OR, odds ratio; CI, confidence interval; BMI, body mass index. Adjusted ORs by multivariate logistic regression analyses, 2007–2013. *Compared with the Monrovia region, the odds for non-introduction of solid, semi-solid or soft foods was significantly higher in the South Eastern 'a' [OR = 4.11, 95% CI: (1.27, 13.28)] region in Liberia. †Compared with the North Central region, the odds for non-introduction of solid, semi-solid or soft foods was significantly higher in the North West [OR = 1.84, 95% CI: (1.21, 2.80)] region in Nigeria. ‡Compared with the Eastern region, the odds for non-introduction of solid, semi-solid or soft foods was significantly lower in the Southern [OR = 0.32, 95% CI: (0.12, 0.90)] region in Sierra Leone.

socio-demographic characteristics associated with sub-optimal complementary feeding practices. It is hoped that countries can improve complementary feeding practices among children by critically examining these indicators. The main risk factors for the introduction of solid, semi-solid or soft foods in the four countries were age of the child, household wealth index, contact with health authorities and regional differences. The main factors significantly associated with minimum dietary diversity in the four countries were: child's age, household wealth index, child illness, access to the media and father's education. For minimum meal frequency and minimum acceptable diet, the main risk factors were regional differences and child's age.

Complementary feeding indicators

Introduction of solid, semi-solid or soft foods

Our analysis revealed that in Ghana and Nigeria, younger age of the child was significantly associated

Table 3. Factors associated with inappropriate dietary diversity among children aged 6–23 months across four anglophone West African countries

Country	Variable	OR	95% CI	*P*-value
Ghana	Administrative region	See details below*		
	Child's age (months)			
	18–23	1.00		
	12–17	1.10	[0.70, 1.70]	0.748
	6–11	4.30	[2.70, 6.80]	<0.001
	Household wealth index			
	Rich	1.00		
	Middle	1.50	[0.90, 2.50]	0.107
	Poor	1.90	[1.10, 3.10]	0.017
	Perceived baby size			
	Large	1.00		
	Average	1.40	[1.00, 2.00]	0.079
	Small	1.70	[1.00, 2.70]	0.039
	Place of delivery			
	Health facility	1.00		
	Home	1.90	[1.20, 2.80]	0.003
Liberia	Child's age (months)			
	6–11	1.00		
	12–17	0.46	[0.31, 0.70]	<0.001
	18–23	0.38	[0.26, 0.56]	<0.001
	Child had ARI (past 2 weeks)			
	No	1.00		
	Yes	0.57	[0.32, 1.00]	0.049
	Father's education			
	No schooling	1.00		
	Primary	1.96	[1.22, 3.15]	0.005
	Secondary and higher	1.05	[0.71, 1.56]	0.793
	Father's occupation			
	Not working	1.00		
	Agricultural	1.79	[1.10, 2.93]	0.020
	Non-agricultural	4.08	[1.16, 14.39]	0.029
	Administrative region	See details below†		
Nigeria	Child's age (months)			
	6–11	1.00		
	12–17	0.39	[0.32, 0.47]	<0.001
	18–23	0.32	[0.26, 0.39]	<0.001
	Mother read the newspaper/magazine			
	No	1.00		
	Yes	0.71	[0.58, 0.87]	0.001
	Timing of post-natal check-up			
	No check-ups/missing	1.00		
	0–2 days	0.86	[0.70, 1.05]	0.138
	3–6 days	1.07	[0.77, 1.48]	0.685
	Seventh day or later	0.68	[0.51, 0.90]	0.008
	Geographical region	See details below‡		
	Household wealth index			
	Poor	1.00		
	Middle	0.69	[0.53, 0.90]	0.006
	Rich	0.64	[0.48, 0.84]	0.001

Table 3. Continued

Country	Variable	OR	95% CI	*P*-value
	Child had diarrhoea (past 2 weeks)			
	No	1.00		
	Yes	0.79	[0.64, 0.97]	0.022
	Mother's education			
	No schooling	1.00		
	Primary	0.69	[0.54, 0.87]	0.003
	Secondary and higher	0.67	[0.52, 0.86]	0.002
	Preceding birth interval			
	No previous birth	1.00		
	<24 months	0.75	[0.59, 0.95]	0.017
	>24 months	0.91	[0.75, 1.10]	0.339
	Type of delivery assistance			
	Health professional	1.00		
	Traditional birth attendant	0.72	[0.50, 1.03]	0.074
	Other untrained personnel	0.67	[0.48, 0.94]	0.019
	Residence			
	Urban	1.00		
	Rural	1.33	[1.06, 1.68]	0.014
Sierra Leone	Child's age (months)			
	6–11	1.00		
	12–17	0.37	[0.28, 0.48]	<0.001
	18–23	0.18	[0.13, 0.26]	<0.001
	Mother's education			
	No schooling	1.00		
	Primary	0.83	[0.55, 1.26]	0.387
	Secondary and higher	0.62	[0.41, 0.93]	0.020
	Mother's religion			
	Muslim	1.00		
	Christian and others	1.68	[1.19, 2.37]	0.003
	Child had fever (last 2 weeks)			
	No	1.00		
	Yes	0.76	[0.58, 0.99]	0.043
	Mother listened to the radio			
	No	1.00		
	Yes	0.70	[0.54, 0.90]	0.006
	Timing of post-natal check-up			
	No check-ups/missing	1.00		
	0–2 days	0.76	[0.541.06]	0.104
	3–6 days	1.65	[1.04, 2.63]	0.034
	Seventh day or later	0.75	[0.53, 1.07]	0.111
	Mother's working status			
	Non-working	1.00		
	Working (past 12 months)	0.69	[0.50, 0.94]	0.020

OR, odds ratio; CI, confidence interval; ARI, acute respiratory infection. Adjusted ORs by multivariate logistic regression analysis, 2007–2013. *Compared with the Volta region, the odds for not meeting requirement for minimum dietary diversity was significantly higher in the Northern [OR = 2.40, 95% CI: (1.10, 5.30)] region in Ghana. †Compared with the Monrovia region, the odds for not meeting requirement for minimum dietary diversity was significantly higher in the South Central [OR = 4.08, 95% CI: (1.16, 14.39)] region in Liberia. ‡Compared with the North Central region, the odds for not meeting requirement for minimum dietary diversity was significantly higher in the South South [OR = 1.89, 95% CI: (1.29, 2.79)] and significantly lower in the South East [OR = 0.59, 95% CI: (0.42, 0.83)] regions in Nigeria.

Table 4. Factors associated with not meeting the requirements for minimum meal frequency among children aged 6–23 months across four anglophone West African countries

Country	Variable	OR	95% CI	*P*-value
Ghana	Administrative region	See details below*		
Liberia	Household wealth index			
	Poor	1.00		
	Middle	0.65	[0.43, 0.99]	0.043
	Rich	0.86	[0.51, 1.44]	0.573
	Mother watched television			
	No	1.00		
	Yes	0.68	[0.48, 0.96]	0.031
	Mother's education			
	No schooling	1.00		
	Primary	0.84	[0.62, 1.14]	0.265
	Secondary and higher	0.66	[0.44, 0.97]	0.034
	Perceived baby size			
	Small	1.00		
	Average	0.57	[0.40, 0.82]	0.003
	Large	0.86	[0.58, 1.29]	0.475
	Administrative region	See details below†		
Nigeria	Child's age (months)			
	6–11	1.00		
	12–17	0.85	[0.75, 0.96]	0.012
	18–23	1.10	[0.96, 1.27]	0.175
	Mother watched television			
	No	1.00		
	Yes	0.79	[0.67, 0.94]	0.008
	Household wealth index			
	Poor	1.00		
	Middle	1.04	[0.88, 1.22]	0.665
	Rich	1.23	[1.01, 1.50]	0.043
	Mother listened to the radio			
	No	1.00		
	Yes	0.79	[0.69, 0.90]	<0.001
	Geographical region	See details below‡		
Sierra Leone	Child's age (months)			
	6–11	1.00		
	12–17	1.67	[1.27, 2.19]	<0.001
	18–23	1.90	[1.33, 2.69]	<0.001
	Geographical region	See details below§		
	Timing of post-natal check-up			
	Missing/do not know	0.84	[0.60, 1.16]	0.286
	0–2 days	1.00		
	3–6 days	0.63	[0.44, 0.89]	0.008
	Seventh day or later	0.77	[0.49, 1.21]	0.251
	Mode of delivery			
	Non-caesarean	1.00		
	Caesarean	0.40	[0.16, 1.00]	0.05

OR, odds ratio; CI, confidence interval. Adjusted ORs with multivariate logistic regression analysis, 2007–2013. *Compared with the Volta region, the odds for not meeting requirement for minimum meal frequency was significantly higher in the Central [OR = 3.10, 95% CI: (1.40, 6.80)], the Greater Accra [OR = 3.20, 95% CI: (1.40, 7.80)], the Western [OR = 9.10, 95% CI: (3.70, 22.50)], the Eastern [OR = 9.10, 95% CI: (3.80, 22.30)], the Ashanti [OR = 4.20, 95% CI: (1.90, 9.50)], the Brong Ahafo [OR = 7.50, 95% CI: (3.30, 17.10)], the Northern [OR = 11.10, 95% CI: (4.90, 25.00)], the Upper East [OR = 8.60, 95% CI: (3.30, 22.70)] and the Upper West [OR = 3.80, 95% CI: [1.70, 8.50)] regions in Ghana. †Compared with the Monrovia region, the odds for not meeting requirement for minimum meal frequency was significantly higher in the North Western [OR = 2.73, 95% CI: (1.37, 5.41)] region in Liberia. ‡Compared with the North Central region, the odds for not meeting requirement for minimum meal frequency was significantly higher in the South South [OR = 1.45, 95% CI: (1.13, 1.87)] and lower in the North East [OR = 0.51, 95% CI: (0.41, 0.64)] and the North West [OR = 0.52, 95% CI: (0.42, 0.64)] regions in Nigeria. §Compared with the Eastern region, the odds for not meeting requirement for minimum meal frequency was significantly higher in the Northern [OR = 1.65, 95% CI: (1.10, 2.49)] and lower in the Southern [OR = 0.67, 95% CI: (0.51, 1.12)] region in Sierra Leone.

Table 5. Factors associated with not meeting the requirements for minimum acceptable diet among children aged 6–23 months across four anglophone West African countries

Country	Variable	OR	95% CI	*P*-value
Ghana	Administrative region	See details below*		
	Child's age (months)			
	18–23	1.00		
	12–17	0.30	[0.20, 0.50]	<0.001
	6–11	0.90	[0.50, 1.50]	0.692
	Timing of post-natal check-up			
	No check-ups/missing	1.00		
	0–2 days	2.10	[1.30, 3.50]	0.005
	7+ days	1.00	[0.70, 1.60]	0.859
	3–6 days	1.50	[0.80, 2.80]	0.242
Liberia	Mother's education			
	No schooling	1.00		
	Primary	1.04	[0.60, 1.81]	0.896
	Secondary and higher	0.48	[0.27, 0.85]	0.012
Nigeria	Geographical region	See details below†		
	Child's age (months)			
	6–11	1.00		
	12–17	0.60	[0.48, 0.75]	<0.001
	18–23	1.36	[1.01, 1.83]	0.045
	Mother's education			
	No schooling	1.00		
	Primary	0.54	[0.41, 0.72]	<0.001
	Secondary and higher	0.62	[0.46, 0.84]	0.002
	Household wealth index			
	Poor	1.00		
	Middle	0.62	[0.46, 0.85]	0.003
	Rich	0.66	[0.45, 0.95]	0.025
	Timing of post-natal check-up			
	No check-ups/missing	1.00		
	0–2 days	0.85	[0.65, 1.12]	0.256
	7+ days	1.29	[0.81, 2.05]	0.290
	3–6 days	0.66	[0.47, 0.93]	0.016
	Preceding birth interval			
	No previous birth	1.00		
	<24 months	0.70	[0.51, 0.97]	0.033
	>24 months	0.85	[0.65, 1.10]	0.215
	Child's sex			
	Male	1.00		
	Female	0.72	[0.60, 0.87]	0.001
	Child had diarrhoea (last 2 weeks)			
	No	1.00		
	Yes	0.71	[0.55, 0.93]	0.011
Sierra Leone	Mother listened to the radio			
	No	1.00		
	Yes	0.58	[0.41, 0.80]	0.001
	Mother's working status			
	Non-working	1.00		
	Working (past 12 months)	0.62	[0.40, 0.95]	0.028

OR, odds ratio; CI, confidence interval. Adjusted ORs with multivariate logistic regression analysis, 2007–2013. *Compared with the Volta region, the odds for not meeting requirement for minimum acceptable diet was significantly higher in the Central [OR = 3.7, 95% CI: (1.50, 8.80)], the Western [OR = 7.1, 95% CI: (2.70, 18.6)], the Eastern [OR = 7.0, 95% CI: (2.90, 16.8)], the Ashanti [OR = 4.90, 95% CI: (2.40, 10.10)], the Brong Ahafo [OR = 4.70, 95% CI: (1.80, 11.90)], the Northern [OR = 5.70, 95% CI: (2.7, 11.9)], the Upper East [OR = 4.2, 95% CI: (1.80, 10.00)] and the Upper East [OR = 2.40, 95% CI: (1.10, 5.60)] regions in Ghana. †Compared with the North Central region, the odds for not meeting requirement for minimum acceptable diet was significantly higher in the South South [OR = 1.83, 95%CI: (1.09, 3.08)] and significantly lower in the North West [OR = 0.54, 95% CI: (0.35, 0.85)] and the North East [OR = 0.45, 95% CI: (0.29, 0.72)] regions in Nigeria.

with non- introduction of solid, semi-solid or soft foods. This meant that the rate of introduction of solid, semi-solid or soft foods significantly improved with increasing age in these 2 countries. This finding is consistent with a previous study in 5 South Asian countries (Senarath *et al*. 2012). In this study, it was revealed that children in Liberia and Sierra Leone whose mothers did not attend any antenatal clinics had a significantly high risk of non-introduction of solid semi-solid or soft foods. This is consistent with previous studies (Brown *et al*. 1989; César *et al*. 1999; Patel *et al*. 2010) which showed that antenatal care visits positively influence the introduction of solid, semi-solid or soft foods in the age group 6–8 months. In Liberia, Nigeria and Sierra Leone, our study found regional differences to be a significant predictor of poor introduction of solid, semi-solid or soft foods. Such regional differences have been observed in previous studies (Patel *et al*. 2012; Senarath *et al*. 2012).

Other factors significantly associated with non-introduction of solid, semi-solid or soft foods were illiterate and non-Christian mothers in Ghana. This finding may reflect the role of early Christian missionaries (Comaroff & Comaroff 1986) in providing crucial social services such as education and health care in many African countries including Ghana. The finding may also be a result of greater poverty and illiteracy in the section of the population. This finding supports a previous study in India (Patel *et al*. 2010) where mothers from Christian communities were found to be more likely to introduce solid foods in the age group of 6–8 months. There are many other studies that support our finding that maternal illiteracy could be associated with delayed and inappropriate complementary feeding practices (Vaahtera *et al*. 2001; WHO 2002; Hendricks *et al*. 2006). Unlike a finding from a previous study in South Asia (Senarath *et al*. 2012), which reported working mothers in Nepal to have a significantly high risk of not meeting the requirement for introduction of solid, semi-solid or soft foods, we found no significant association between a mother's work status and introduction of solid, semi-solid or soft foods in the four countries surveyed.

Minimum dietary diversity

Previous studies (Kabir *et al*. 2012; Patel *et al*. 2012; Victor *et al*. 2012) have found that young children were significantly associated with inadequate dietary diversity. This is consistent with a finding in our study in which children from the youngest age bracket (6–11 months) were a risk factor for adequate dietary diversity in all four countries. This indicated that the adequacy of diet intake for children only improved with increasing age; and that should not be surprising, as the 'first solid foods' introduced to young children in all West African countries is a thin cereal gruel that is called by different names depending on the type of cereal or the West African country (Onofiok & Nnanyelugo 1998). From 6 months onwards, infants are given the family diet alongside breastfeeding. The family foods on which the children are fed include dishes made from cereal and starchy tubers. These traditional 'first solid foods' in West Africa are known to be of low nutritive value (Akinrele & Bassir 1967; Guiro *et al*. 1987) and lack diversity. It has been well documented that the quality and quantity of food needed by children transitioning to family foods are often not understood by mothers, and food taboos are maintained by older family members, especially the grandmothers, who do not recommend oils and fats and eggs as suitable for young children, further restricting dietary diversity (Roy *et al*. 1993). It is recommended that households should do away with food taboos that do not allow children to enjoy diversity of nutritious foods.

Using household wealth index as a proxy indicator for the socio-economic status of the household, our study found household poverty to be significantly associated with inadequate dietary diversity in Ghana and Nigeria. Similar negative associations between minimum dietary diversity and low socio-economic status have been found in studies from other developing countries (Hatloy *et al*. 1998; Vaahtera *et al*. 2001; Faber 2005; Kabir *et al*. 2012; Ng *et al*. 2012). These findings highlight the fact that household capacity to purchase necessary foods is a prerequisite to the achievement of dietary diversification for children (Kabir *et al*. 2012). Most mothers and caregivers may be aware of the role dietary diversity plays in the

health of a child; however, the lack of resources acts as a barrier to those mothers or caregivers to put knowledge into practice (Kikafunda *et al*. 2003).

In this study, we found that children who did not have acute respiratory infection (Liberia), fever (Sierra Leone) or diarrhoea (Nigeria) were significantly less likely to receive adequate dietary diversity. This implied that children who were healthy in these three countries were the ones that were more likely to not to meet the minimum dietary diversity criterion. This finding was contrary to a previous finding in Sri Lanka (Senarath *et al*. 2012). In that study, children who had acute respiratory infection had a poor dietary diversity. A potential reason for our finding may explained by mothers offering children greater varieties of nutritious foods to unwell children, in an attempt to interest them in eating in order to facilitate their recovery from illness. It is recommended that mothers should endeavour to feed their children with greater varieties of nutritious foods at all times rather than doing so only when the children are taken ill.

Children whose mothers had limited or no access to newspapers and/or magazines (Nigeria) or the radio (Sierra Leone) had a higher risk of not meeting the minimum dietary diversity requirement. This finding is consistent with previous studies in India (Patel *et al*. 2012). The role of the mass media in educating mothers and caregivers about appropriate child feeding practices is crucial; therefore, governments of West African countries should consider making the prices of radios and televisions affordable to mothers. Once they have easy access to these services, they can benefit from health and child nutrition programmes when they are shown on television and through the radio. Solutions to the lack of access to media may include 'face to face' communication between skilled child nutrition personnel and mothers as well as the use of modern technology such as the use of messaging by mobile phones.

There is evidence in the literature (Kabir *et al*. 2012) to suggest that children whose fathers had a lower level of education had a higher risk of not meeting the requirement for minimum dietary diversity. This is consistent with our finding where infants in Liberia and Sierra Leone whose fathers had no schooling were a risk factor to appropriate dietary diversity.

Our study found large variations in minimum dietary rates across the administrative/geographical regions of three out of the four countries. Such regional variations have been reported in recent studies in Bangladesh (Kabir *et al*. 2012), India (Patel *et al*. 2012), Indonesia (Ng *et al*. 2012), Nepal (Joshi *et al*. 2012) and Sri Lanka (Senarath *et al*. 2012).

Minimum meal frequency and minimum acceptable diet

Close attention should be paid to child feeding patterns such as timeliness and frequency of meals (Lutter 2003). The attitude (including the level of encouragement given to the child during feeding, the frequency at which the child is fed and the feeding environment) of mothers or other caregivers is one of the independent variables that is likely to interact with the intake of complementary foods (Daelmans *et al*. 2003; Dewey & Brown 2003; Lutter 2003; Pelto *et al*. 2003). In Nigeria and Sierra Leone, children of the oldest age bracket (18–23 months) were not strongly associated with meal frequency. Children in the oldest age bracket in Ghana also had a negative association with acceptable diet.

Being a non-working mother in Sierra Leone was found to pose a risk to acceptable diet. A recent study in South East Asia (Senarath *et al*. 2012) found that while non-working mothers in India were a risk factor to adequate meal frequency, they were a protective factor to this indicator in Nepal. These findings therefore suggest that there is no clear-cut relationship between the risk of inappropriate complementary feeding practices and work status of mothers.

There is evidence in the extant literature (Kabir *et al*. 2012) that a low level of maternal education was associated with poor complementary feeding practices. In the present study, we found that mothers with no schooling had a significantly higher risk of not meeting the requirement for minimum meal frequency (Liberia) and minimum acceptable diet (Liberia and Nigeria).

One key finding of this study was the large variation in complementary feeding practices across the administrative/geographical regions in all the countries. Of major concern was the high risk of not meeting the requirements for complementary feeding among

children from the Northern, Western and Eastern regions of Ghana; South South region of Nigeria and the Northern region of Sierra Leone. These large regional variations in complementary feeding practices have been observed in recent surveys from India (Pandey *et al*. 2010), Bangladesh (Kabir *et al*. 2012), Indonesia (Ng *et al*. 2012), Nepal (Joshi *et al*. 2012), Sri Lanka (Senarath *et al*. 2012) and Tanzania (Victor *et al*. 2012). Some of these variations in the other countries could be attributed to cultural feeding practices and levels of adult education (Kabir *et al*. 2012; Ng *et al*. 2012). Poverty might also be a contributory factor to these variations. This is because the different regions of the various countries have different poverty levels. For example, in Ghana, the Northern, Upper East and Upper West administrative regions are the poorest in the country; the South East region is the poorest in Liberia; the Northern and Southern provinces are the poorest in Sierra Leone, and the North East and North West regions are the poorest in Nigeria. Such regional divides are a hindrance to achieving the Millennium Development Goals of these countries. Possible reasons for such regional differences may include the geographical locations, access roads and other relevant investments for economic development. There is also a possibility of these regions experiencing food insecurity. Governments and other stakeholders in these countries should make an effort to tackle the poverty problem in these regions. For instance, in 2008, development experts in Ghana, international aid agencies and residents of the three regions of that country argued that much more need to be done to narrow the country's regional divide (Harsch 2008). The three regions need concerted and conscious national effort to increase investments in education, health and economic development. A similar national effort is needed in the other three countries. Further research is needed to determine the factors associated with poor economic status in such regions.

This study has implications for policy, practice and research. Determinants that featured prominently can be used to inform interventions. The findings in this study can be of relevance to researchers in designing and evaluating interventions in order to improve IYCF practices and also reduce child morbidity and mortality.

Our study has a number of strengths. Firstly, the most recent DHS of the four anglophone West African countries are nationally representative surveys that used standardised methods to yield high individual and household response rates (99% in Ghana, 95% in Liberia, 97% in Nigeria and 94% in Sierra Leone). Secondly, the recently recommended WHO infant feeding indicators (WHO 2010) were used in the analyses. This is the first time that these indicators were used to analyse IYCF practices in a number of anglophone West African countries. The indicators will serve as a guide to the development of appropriate programmes to improve complementary feeding practices in these countries. Thirdly, appropriate adjustments for the complex analyses of the DHS of the individual countries concerned were used in the analyses.

There are a number of limitations that are worthy of note in interpreting these results. Firstly, whether the observed findings represent causal associations cannot be clearly established given the cross-sectional study design. Secondly, variables available to measure household- and community-level factors were limited. Finally, the 24-h maternal recall is likely to cause respondent bias such as the tendency to give socially desirable answers.

Conclusion

Our results have implications for the design of interventions to improve IYCF practices in anglophone West African countries. We suggest new strategies for child survival interventions, which could be achieved by examining how social and economic factors are combined to support optimal complementary feeding practices in such populations.

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Conflicts of interest

The authors declare that they have no conflicts of interest.

Contributions

A.I.I. designed the study, performed the analysis and prepared the manuscript; K.E.A. provided advice on the study design and data analysis. P.L.B., A.N.P., G.J.S. and M.J.D. provided revision of the final manuscript. All authors read and approved the manuscript.

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