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RESEARCH

Relationship between child development and nutritional status of under-five Nigerian children

Adenike Oluwayemisi Jimoh[a*], Jane Oowo Anyiam[b] and Alhassan Mela Yakubu[a]

[a]*Department of Paediatrics, College of Health Sciences, Bingham University, Karu, Nigeria*
[b]*Department of Paediatrics, Ahmadu Bello University, Zaria, Nigeria*
**Corresponding author, email: oyewoao@yahoo.co.uk*

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Introduction: Nutrition is a major factor that can have long-term effects on the brain's structural and functional capacity. The interplay between nutrition and child development cannot be overemphasised, especially in developing countries.
Objectives: The study aimed to assess the nutritional status of under-fives and determine the relationship between the nutritional status and their developmental quotient.
Methodology: A cross-sectional study was undertaken involving 415 under-fives aged 6–59 months in selected pre-schools and immunisation centres. Developmental assessment was done using the Schedule of Growing Skills II. The nutritional status was assessed using the WHO growth charts for weight-for-age, weight-for-height and height-for-age. Chi-square and odds ratio with 95% confidence interval were used to determine the association between nutritional status and selected developmental domains.
Results: The mean age was 32.6 ± 15.9 months. The male to female ratio was 1.2:1. The overall prevalence of developmental delay was 35.4%, with manipulative domain accounting for the highest delay (25.8%). The prevalence of stunting, wasting and underweight was 9.1, 3.8 and 3.8% while 2.2% were overweight. Weight-for-age had a significant association with the hearing and language domain (OR 3.25, 95% CI 1.09–9.72, $p = 0.036$,) and interactive social domain (OR 5.0, 95% CI 2.0–13.0, $p = 0.001$).
Conclusion: The nutritional status of a child has an effect on certain developmental domains of that child. Interventions to improve the nutritional status of under-fives will go a long way to facilitating the development of this group of children.

Keywords: child, developmental delay, developmental quotient, nutritional status, under-fives, Nigerian

Introduction

The interplay of nutritional status and child development cannot be overemphasised, especially in developing countries, as several studies[1–3] have shown strong links between the two. Malnutrition and inadequate stimulation have been identified as major risk factors responsible for developmental deficits in cognitive skills, motor skills, social behaviour, school achievement and psychomotor development.[4–7] These factors have the potential to perturb the process of rapid brain development, which occurs in the first few years of life, with resultant long-term adverse effects on the brain's structural and functional capacity.[8] The society a child lives in is also negatively affected by the child's inability to attain his/her full social and developmental potential.[1] The apathy, poor motor development and low activity that occur in malnutrition causes such children to explore their environment less, thereby failing to acquire skills at normal speed.[9] Caretakers may also not provide age-appropriate stimulation because of the children's small size,[9] thus denying them the psychosocial stimulation needed for optimal development. Poor neurosensory integration in malnourished children has also been documented as a cause of poor development in these children.[9]

In Nigeria, the malnutrition rate constitutes a major public health challenge as reflected in the 2014 Nigerian Demographic Health Survey (NDHS). The 2014 NDHS[10] report showed that although the rate of stunting among under-fives had declined slightly from 41% in 2008 to 37% in 2013, the prevalence of underweight had worsened from 23% in 2008 to 29% in 2013 and that of wasting also worsened from 14% in 2008 to 18% in 2013. Progress in infant and young child feeding practices like exclusive breastfeeding has also been slow, from 35% in 2008 to 38% in 2013.[10] These rates vary significantly across rural–urban locations, geopolitical regions and seasons.

While there is a large pool of data on nutritional status of under-five children in the country, there is a paucity of data on how this relates to their developmental quotient. This study seeks to fill the dearth of knowledge by determining the relationship between the developmental quotient and nutritional status of under-five Nigerian children, with the view that useful baseline data will be generated. In addition, assessing these children's development and nutritional status may provide information that will help design appropriate intervention programmes to meet their long-term growth and development needs.

Methodology

Study area and participants

This community-based, cross-sectional study was conducted among well children seen at selected preschools (crèches, daycares, playgroups and nurseries) and immunisation centres in Zaria metropolis between the months of November 2013 and May 2014. Zaria metropolis is semi-urban and is located within the Guinea Savannah belt of Nigeria, about 70 kilometres north of Kaduna, the capital city of Kaduna state, north-western Nigeria. Though the Hausas, an African people inhabiting north-west Nigeria, predominantly inhabit the old city, other Nigerian ethnic groups like the Yorubas, Ibos, Idomas, Igala, Jabba, Kataf, and Kyutep. constitute a significant proportion of the other inhabitants of Zaria.

A multistage sampling method was used to select the pre-schools and immunisation centres while a systematic sampling method was used to recruit the subjects. All children aged 6 to 59 months and who had dual Nigerian parentage were included. Children previously diagnosed for developmental delay or with obvious delay from neurological causes, chromosomal abnormalities or physical disabilities were excluded.

The sample size was determined using the formula for estimation of prevalence: $n = z^2pq/ d^2$, where 'n' is the desired sample size; 'z' is the standard normal deviate corresponding to 95% confidence interval = 1.96; 'p' is the prevalence of developmental delay (assumed to be 50% since no previous published study in Nigeria was found) = 0.5; 'q' = 1– p (the proportion of children without developmental delay) = 0.5; and 'd' is the degree of accuracy desired (0.05).

Therefore, $n = (1.96)^2 \times 0.50 \times 0.50/ (0.05)^2 = 384$ children.

An allowance of 10% was made for non-response: n = 10/100 x 384 = 38.4 + 384 = 422 children.

Ethical considerations

Approval from the Scientific and Health Research Ethics Committee of the Ahmadu Bello University Teaching Hospital Zaria, Primary School Management Board, school heads and heads of administration of the immunisation centres was obtained. Written consent was obtained from the parents/caregivers of the participating children.

Procedure

The socio-demographic data were collected from the parents/guardians of all children enrolled for the study by interview method and recorded on a pre-structured questionnaire. The information obtained included the child's biodata, the nutritional history and family/social history. Each child was assigned a socioeconomic class using the method recommended by Olusanya *et al*.[11] based on father's occupation and mother's education. Upper socio-economic class constituted social classes I and II, middle socio-economic class was social class III while social classes IV and V made up the lower socio-economic class.

Developmental assessment

The developmental domains were assessed with the Schedule of Growing Skills II (SGS II) (GL Assessment, London, UK) screening tool.[12] The tool had not been previously validated in Nigeria, hence face and content validation were done before use for the study. The researchers gave clear instructions and demonstrated actions to each child, with the assistance of a parent or teacher, in order to observe the skills. One child was assessed at a time.

The skill areas assessed were passive postural, active postural, locomotor skills, manipulative skills, visual skills, hearing and language skills, speech and language skills, interactive social skills, self-care social skills and cognitive skills. Each item in the skill sets is worked through until the most advanced item the child can perform has been reached. The highest score in each skill set is added up. The total score in the skill area is the sum of the scores of the single most advanced item in each skill set. It took averagely 20–30 min to assess each child. The developmental age (DA) was obtained from the SGS II 'profile form' and a developmental quotient was calculated thereafter using the formula:

DQ (%) = developmental age/chronological age multiplied by 100

Table 1: Classification of developmental quotient score

Classification		Developmental quotient score (%)
Normal		≥ 85%
Delayed	Mild–moderate delay	71–84%
	Severe delay	≤ 70%

The developmental quotient was classified into normal and delayed development (Table 1).[13]

Anthropometry

The anthropometric variables used for this study were the weight and height. These were taken by the principal investigator with assistance of trained research assistants. Each child was weighed while undressed wearing only underwear or a light gown. Infants were placed in the bassinet and measurement taken. For children who could stand, the standing scale was placed on a flat, solid, level floor and the research assistant ensured each child stood in the centre of the scale before the reading was taken. The weight was recorded to the nearest 10 g. The weighing scale was adjusted to read zero before starting the measurements and the accuracy was assessed at the start of every session using a known weight. The recumbent length of each infant was measured using an infantometer. For each child who could stand, height was measured using a stadiometer. The reading was taken to the nearest 0.1 cm and documented immediately.

The anthropometric measures height-for-age (H/A), weight-for-height (W/H), and weight-for-age (W/A) were expressed as z-scores using World Health Organization Child Growth Standards.[14] Z-scores below minus two standard deviations (–2 SD) from the median of the reference population in terms of H/A, W/A and W/H were considered as stunted, underweight and wasted, respectively. Those whose z-score was between –2SD and –3 SD from the median reference in terms of H/A, W/A and W/H were considered moderately stunted, moderately underweight and moderately wasted. Those with z-scores below minus three standard deviations (–3 SD) from the median of the reference population in terms of H/A, W/A and W/H were considered severely stunted, severely underweight, and severely wasted, respectively. Children with z-score above plus two standard deviations (+2 SD) in terms of W/H were considered overweight.

Statistical analysis

Data were cleaned, coded and analysed using the statistical software SPSS® version 20.0.0 (IBM Corp, Armonk, NY, USA). Anthropometric data collected were entered into the WHO Anthro version 2 software (http://www.who.int/childgrowth/software/en/)[15] and analysed using the same software. The means and standard deviation were calculated for continuous variables while ratios and proportions were calculated for categorical variables. The test of association between categorical variables was done using Pearson's chi-square test or Fisher's exact test where applicable. Odds ratios with 95% confidence limits were used to calculate risk of developmental delay of a child if he/she was malnourished. A p-value of less than 0.05 was considered statistically significant in comparative analyses.

Results

Socio-demographic characteristics

Of the 422 children recruited, 415 (98.3%) were studied. Seven children withdrew from the study. The mean age was

Table 2: Socio-demographic characteristics of study population

Characteristics	Frequency (*n* = 415)	Percentage
Age (months):		
6–11	63	15.2
12–23	50	12.1
24–35	94	22.7
36–47	110	26.5
48–59	98	23.6
Sex:		
Male	227	55.0
Female	188	45.0
Ethnicity:		
Hausa	180	43.4
Yoruba	77	18.6
Ibo	30	7.2
Others	128	30.8
Socioeconomic class:		
Upper	218	52.0
Middle	74	18.0
Lower	123	30.0
Mother's educational level:		
No formal education	34	8.2
Primary	28	6.7
Secondary	126	30.4
Tertiary	227	54.7

32.6 ± 15.9 months. The male to female ratio was 1.2:1. Other sociodemographic characteristics are as stated in Table 2.

Developmental quotient

Of the 415 children studied, 268 (65.6%) had a normal developmental quotient while 147 (35.4%) had one form of delay or another. Manipulative domain accounted for the highest prevalence of developmental delay (16.6% had mild–moderate delay and 9.2% severe delay). This was followed by visual domain where 11.6% had moderate delay and 5.5% had severe delay. No child had delay in the active postural domain and only one child had delay in the passive postural domain (Table 3).

Nutritional status

Table 4 gives the prevalence of wasting, stunting and underweight, which was 3.8%, 9.1% and 3.8% respectively. Nine (2.2%) children were overweight.

Relationship between developmental quotient and nutritional status

Table 5 is a cross-tabulation of nutritional status and developmental quotient. The table shows significant association between the underweight status and two skill areas, the hearing and language skill and interactive skills. There was no significant association between any of the nutritional status parameters and the cognitive, manipulative, visual or speech and language skills.

The table also shows that an underweight child is three times as likely to have delay in hearing and language skill compared with his/her well-nourished counterpart (OR 3.25, 95% CI 1.09–9.72), and is five times as likely to have delay in interactive social skills (OR 5.0, 95% CI 2.0–13.0). The odds of delay for the underweight child in speech and language skill are 3.33 (95% CI 0.83–13.3). A stunted child is twice as likely to be delayed in hearing and language skills (OR 2.36, 95% CI 0.95–5.91).

Discussion

This study has shown that the prevalence of developmental delay of 35.4% among the study population is unacceptably high. A similarly high prevalence of 44.6% was obtained among under-fives in Ghana[16] but lower figures of 12% and 13.8% were documented among 9- and 24-month-old American children[17] and 10% among 3-year-old children in the United Arab Emirates.[18] The reason for this variance may be attributed to several factors including method of assessment, age range, and number of developmental domains assessed. This study, unlike the American and Arab studies, used the Schedule of Growing Skills II tool, which is based on direct assessment with no concern for recall bias, inflation of scores and denial of disability, which may occur in tools based on parents' report and rating. In addition, this study examined children 6–59 months across 10 developmental domains thereby increasing the chances of identifying children with developmental delay in more domains and across all developmental stages of under-fives. The similarity in prevalence of this study and the Ghana study may be a reflection of a developmental quotient pattern among children in developing countries or it may be a reflection of one of the drawbacks of using assessment tools with which children in developing countries may not be completely conversant.

Table 3: Developmental quotient pattern of study population

Factor	Developmental domains									
	Active postural	Passive postural	Locomotive	Manipulative	Visual	Hearing &language	Speech & language	Interactive social	Self-care social	Cognitive
Developmental quotient:										
Normal (DQ ≥ 85%)	415 (100.0)	414 (99.7)	405 (97.6)	308 (74.2)	344 (82.9)	389 (93.7)	398 (95.9)	391 (94.2)	397 (95.7)	359 (86.5)
Mild–moderate delay (DQ = 71–84%)	0 (0.0)	0 (0.0)	9 (2.2)	69 (16.6)	48 (11.6)	20 (4.8)	10 (2.4)	18 (4.3)	12 (2.9)	45 (10.8)
Severe delay (DQ ≤ 70%)	0 (0.0)	1 (0.3)	1 (0.2)	38 (9.2)	23 (5.5)	6 (1.5)	7 (1.7)	6 (1.5)	6 (1.5)	11 (2.7)
Total	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)	415 (100.0)

Note: Figures in parentheses represent percentages.

Table 4: Nutritional status of study population

Nutritional status	WHZ		HAZ		WAZ	
Severely malnourished (z-score ≤ −3)	1	(0.2)	3	(0.7)	1	(0.2)
Moderately malnourished (z-score −2.99 to < −2)	15	(3.6)	35	(8.4)	15	(3.6)
Normal (z-score −2 to +2)	390	(94.0)	377	(90.8)	399	(96.1)
Over-nutrition (z-score > 2 to +2.99)	9	(2.2)	–	–	–	–
Total	415	(100.0)	415	(100.0)	415	(100.0)

Note: Figures in parentheses represent percentages.

From this study, the prevalence of stunting, wasting and underweight were 9.1%, 3.8% and 3.8% respectively. The prevalence of 2.2% for overweight is lower than the national figure of 9.0%.[10] The low prevalence of stunting, wasting and underweight is also similar to the low prevalence obtained by Senbanjo *et al.*[19] among children in an urban community in Lagos state, south-west Nigeria. This finding of low prevalence of undernourished children and the presence of overweight children is not unexpected given the high educational level of the majority of mothers, the semi-urban environment of the study area and also improved standard of living and change in lifestyle in developing countries.

This study showed that nutritional status is a predictor of child development in the hearing and language domain and the interactive social domain. The effect of malnutrition on hearing and language, as observed in this study, has also been observed in other studies.[20–22] Previous studies[20–22] have shown that malnutrition causes delay in maturation of the auditory pathway and also affects both central and peripheral hearing. Nutritional deficiencies, even in acute form, impair the normal functioning of the middle ear, with negative consequences for the entire auditory system. Such children develop difficulties with oral and written language.

The finding of a positive association between underweight and interactive social domain gives support to the fact that malnutrition negatively affects the social development of children.[23] Compared with normal-weight children, malnourished children are more apathetic and they tend to explore their environment less. The mechanism by which this occurs has been linked to the overall negative effect of malnutrition on the central nervous system, leading either directly to the child being unable to effectively receive and interact with information from the environment or indirectly by producing behaviours not consistent with stimulation from the environment.[24] Some interactive social skills children develop as they grow include empathy, participation in group activities, generosity, helpfulness, communicating with others, negotiating, and problem-solving. An underweight child who is often irritable, depressed or aggressive is not likely to effectively develop these social skills. This has negative consequences for later academic achievement as the development of social skills lays the foundation for academic achievement as well as work-related skills later in life.[25]

Limitations of study

The cross-sectional nature of the study could have affected the outcome. Observing the children's development and nutritional status over a period of time would give a better insight as development and growth are dynamic.

Conclusion

In conclusion, this study revealed a high prevalence of developmental delay, especially in the manipulative domain and visual domain. It also revealed a low prevalence of under-nutrition and presence of over-nutrition in this semi-urban region. It confirmed the relationship between developmental quotient and nutritional status, with underweight children having increased risk for delay in hearing and language domain and interactive social domain. The findings in this study stimulate the need to include information on the developmental quotient of under-fives in the National Demographic Health Survey, especially as it relates to their nutritional status. It is also important to further strengthen nutrition programmes aimed at reducing the burden of under-nutrition such as food fortification, food diversification and school feeding programmes, as well as the well-established optimal infant and young child feeding

Table 5: Relationship between developmental delay in selected domains and nutritional status

Nutritional status	Developmental domains					
	Manipulative	Visual	Hearing and language	Speech and language	Interactive social	Cognitive
Underweight (*n*= 16)	4 (25.0)	3 (18.8)	3 (18.8)	2 (12.5)	4 (25.0)	4 (25.0)
Well-nourished (*n* = 399)	103 (25.8)	68 (17.0)	23 (5.8)	15 (3.8)	20 (5.0)	52 (13.0)
p-value	0.942	0.859	0.036*	0.084	0.001*	0.169
OR (95% CI)	0.968 (0.41–2.30)	1.1 (0.39–3.12)	3.25 (1.09–9.72)	3.33 (0.83–13.33)	4.99 (1.92–12.90)	1.92 (0.79–4.65)
Wasting (*n* = 16)	3 (18.8)	1 (6.2)	1 (6.3)	1 (6.3)	1 (6.3)	2 (12.5)
No wasting (*n* = 399)§	104 (26.1)	70 (17.5)	25 (6.3)	16 (4.0)	23 (5.8)	54 (13.5)
p-value	0.512	0.239	0.998	0.658	0.935	0.906
OR (95% CI)	0.719 (0.26–2.02)	0.356 (0.05–2.40)	0.998 (0.14–6.91)	1.56 (0.22–11.03)	1.08 (0.15–7.56)	0.924 (0.25–3.46)
Stunting (*n* = 38)	7 (18.4)	8 (21.1)	5 (13.2)	2 (5.3)	3 (7.9)	6 (15.8)
Well-nourished (*n* = 377)	100 (26.5)	63 (16.7)	21 (5.6)	15 (4.0)	21 (5.6)	50 (13.3)
p-value	0.276	0.498	0.066	0.703	0.558	0.664
OR (95% CI)	0.694 (0.35–1.38)	1.26 (0.65–2.43)	2.36 (0.95–5.91)	1.32 (0.31–5.57)	1.42 (0.44–4.53)	1.20 (0.55–2.59)

Note: Figures in parentheses represent percentages.
*$p < 0.05$; § = included children who were overweight.

recommendations to exclusively breastfeed for the first six months with continued breastfeeding to 2 years, together with the introduction of safe, age-appropriate and adequate complementary foods from 6 months.

Nutrient supplementation (macro- and micro-nutrient) has been found to be a promising intervention strategy to address developmental losses in children. However, designing future studies to assess the extent of this recovery in terms of improvement in developmental quotient and timing of recovery following food supplementation will be necessary. The additive effect of nutrition and other risk factors to development (parental care, cultural practices, maternal education, etc.) will help to further understand their influence on child development, especially in the Nigerian context.

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