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Correlation of non-biological factors with anthropometric and haemoglobin measurements of children under 10 years old in southeast, Nigeria: Community-based study

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Abstract*: Background*
Childhood malnutrition also has non-biological determinants and little is known about it.
Objective: To determine the differences in children's height, weight and haemoglobin concentration across different sociodemographic characteristics.
Design: The study was community-based study. The weight and height of the children were measured. The Z-scores were calculated. Blood was taken for haemoglobin estimation. Regression analysis was done to determine correlates.
Results: More rural children (32%) have stunting and the difference was statistically significant (p=0.003). There was no difference in the prevalence of underweight among under urban (32.4%) and rural (33.4%) children. Children from the rural areas were more likely to be moderate-severely anaemic (19.7%) and the difference was statistically significant (p = 0.003). Household size significantly relates to underweight and childhood anaemia (p = 0.002 and p = 0.036 respectively). Mother's education were significantly related to tunting and childhood anaemia (p = 0.010 and$p$ = 0.001 respectively). Childhood anaemia was significantly related to mother's education (p = 0.001) and household (p = 0.036).
Conclusions: Maternal age and education, household size and place of resident of a child affect children nutritional status. Improved education, and family planning can contribute to the reduction in the burden of malnutrition.

Key words: Stunting, Underweight, Children, Nigeria, Non-biological determinants.

Introduction

There are reports of high prevalence of childhood anaemia[1-5], stunted and underweight [6-9] among children especially in sub-Saharan African regions. In Nigeria, anaemia contributes to 13.6% of under-five mortality[10], while malnutrition contributes to a much higher mortality. Presently, a lot is known about the biological factors like malaria, intestinal helminths, malignancies e.t.c. which are capable to causes of anaemia and malnutrition [11-13]. According to reports, the infant and under five mortality have dropped from 97 per 1000 live births and 158 per 1000 live births to 70 and 120 respectively. But malnutrition among children under age five has worsen nationwide with highest concerns being in the northern part of the country. Wasting and stunting have increased from 24.2% and 34.8% to 31.5% and 43.6% respectively. [14] A study has shown that beyond biological factors, other non-biological factors can contribute to childhood anaemia and malnutrition.[15] However, little is known about the role non-biological determinants like mothers' age, maternal education, household size, socioeconomic status and place of resident play in childhood anaemia and malnutrition in Nigeria.
In this study we examined the relationship between childhood haemoglobin concentration and anthropometric indices like height-/length-for-age and weight-for-age, with some non-biological determinants among children from two regions in southeast Nigeria.

Materials and Methods

Study area and population

Abakpa and Ibagwa are an urban and a rural areas in Enugu east local government area (LGA) of Enugu State, while Umuahia and Nkwegwu are an urban and rural areas in Umuahia North LGA of Abia State. Both Enugu and Abia states are in southeast Nigeria. The study was a community-based cross-sectional and 298 households were randomly selected from the four study localities. All the children under 10 years of age living in the selected households during the period of the study July – August 2015 were selected. Prior to the study an advocacy visits were made to the study areas and the approval was obtained from the relevant authorities.

Sample size The minimum sample size was calculated based on sensitivity and specificity of clinical pallor of 70% respectively [16], 95% confidence interval and anaemia prevalence of 42%. This gave minimum sample size of 374 children, but 588 children were finally enrolled.

Patient recruitment A simple random selection was to one local government area (LGA) each from the list of LGAs in each of the study states. The wards in the selected LGA were grouped into rural and urban. A simple random selection was used to select one rural ward and one urban ward. The wards were grouped in clusters according to geographical locations and one cluster was selected from each ward. A cluster comprises streets in the urban area and hermits in the rural areas. Individual houses of households with children under 10 years were identified and numbered. The households were systematically selected in an alternate of two, and selected households were informed about the study and those that showed willingness to participate were invited to the recruitment centers (health centers)

Household questionnaire

An interviewer-administered questionnaire was used to collection information on mother's age, mother's and fathers highest educational level attained, mother's and father's occupation, household size, child's age.

Anthropometry

The World Health Organization (WHO) recommended method was used in the measurement of recumbent length and height to the nearest 0.1cm ([16]). For a child under 2 years or if he/she was not to stand unassisted, his/her length was measured using measuring mat. The height was measured using stadiometer with moveable bar and steel calibrated pole. Validated electronic weighing scale was to the measure the weight of the children to the nearest 0.01kg. A standard 10kg weight was used to frequently check the scale during the study. The children were weighed in bare feet with minimal clothing. The length/height and weight were independently measured by two clinicians (resident doctors and nurses) and the mean were used. The standard WHO growth standards for boys and girls were the references used in the calculation of the Z-scores.[15]

Those whose weight-for-age were < -2 SDs from the standard mean were categorized as underweight. The children whose length-/height-for-age were < -2 SDs from the standard mean were categorized as stunted. A child was moderately stunted or underweight if his/her z -score of height-for-age or weight-for-age were < -2 standard deviations below the WHO median but ≥ -3SD, and severely stunted or underweight if their z-score were < - 3 SD below the WHO median.

Haematologic Measures

The haemoglobin estimation of the children was assessed using the validated HemoCue 301 haemoglobinometers. The capillary blood was obtained by venipuncture of the middle finger using microlance.

A child was categorized as anaemic if their Hb was ≤ 11g/dl and non-anaemic if the Hb was > 11g/dl according to internationally-recognized classification criteria (15). All children categorized as anaemic were further classified as mild anaemic (Hb ≥ 10 g/dl -- ≤ 11g/dl), moderately anaemic (Hb > 7 g/dl – 9.9g/dl), severely anaemic (Hb < 7 g/dl). All anaemic children were given haematinics on site and referred to hospital for further evaluation.

Data analysis

The data were entered and analyzed using SPSS version 20 for windows statistical software package (SPSS Inc., Chicago, IL, USA). Means and standard deviations were calculated. Correlation between anaemia or anthropometric indices with non-biological determinants; mother's age, education, household size, socioeconomic status and place of resident. The mothers were categorized into three groups based on age: ≤ 24 years, 25 – 34 years and≥ 35 years, and categorized into four groups based on highest educational level attained: no formal education, primary, secondary and tertiary. The children were categorized into 5 socioeconomic groups based parents' education and occupation according to Oyedeji[17], group 1 & 2, group 3 and group 4 & 5 as high, middle and low socioeconomic status. The children were also categorized into four group based on household sizes (number of children in a household): 1 child, 2 children, 3 children and ≥4 children.

For multivariate analysis, certain determinants were dichotomized into two groups. Based on age, mother were categorized into two age groups, ≤ 30 years as young mothers and ≥ 31 years as older mothers. Based on education, mothers were categorized into two groups; those with no formal education or primary education were grouped as poorly-educated, while those with secondary or tertiary education were grouped as well-educated. The household size was categorized into two groups; households with ≤ 3 children as small household and those with ≥ 4 children as large household.

The statistical significant was *p* value ≤ 0.05.

Ethics

The study protocol received ethical approval from the Ethics Committee of the University of Nigeria Teaching Hospital Ituku/Ozalla, Enugu, Nigeria and Ethics Committee of Federal Medical Centre, Umuahia, Abia State The study was explained to the caregivers/parents of the children and written consent was obtained before participating in the study.

Results

A total of 552 households were identified to participate in the study and 298 households presented for the study, while 254 households did not turn out, giving cooperation rate of 54%. Out of the 298 households that reported, 602 children were recruited in the study. However, 14 questionnaire were excluded from the analysis, essentially due to missing data. Thus 588 questionnaires were finally analyzed (Fig 1).

Fig 1: The selection chart

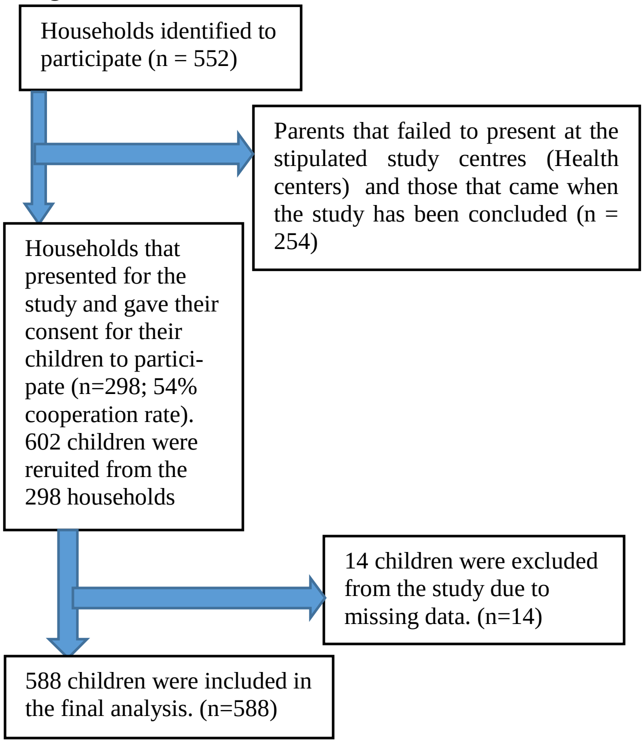


Fig 2: Weight-for-age z-score for the children, blue is rural, yellow is urban

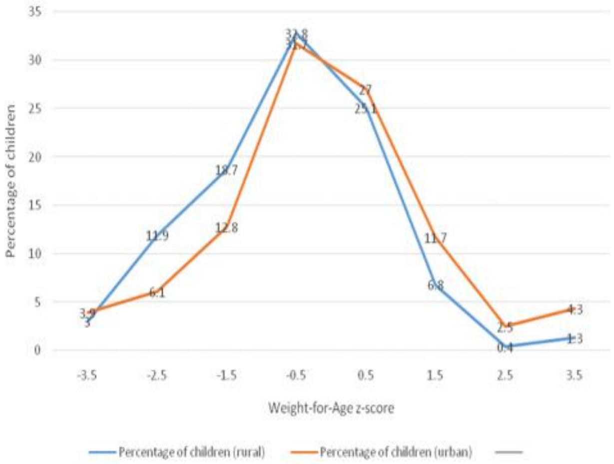
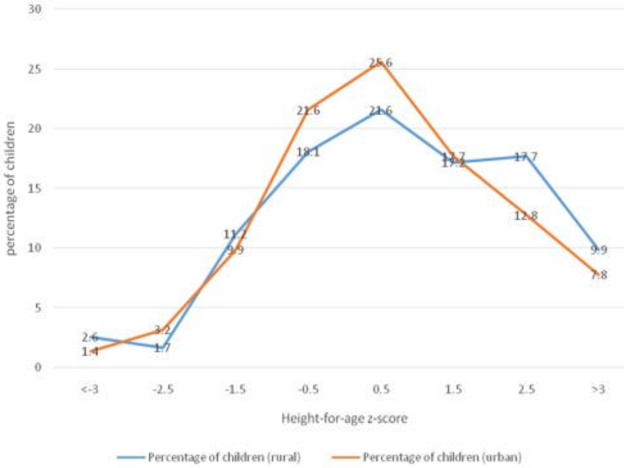


Fig 3: Height-for-age z-score for the children, blue is rural, yellow is urban.



The distribution of mothers' age, educational status, household size, socioeconomic status of the subjects were presented in Table 1. Majority (Abakpa 54.0%, Ibagwa 56.5%, Umuahia 60.2% and Nkwegwu 60.0%) of the mothers in all localities were the age range of 25 – 34 years. Majority (Abakpa 63.8%, Ibagwa 50.0%, Umuahia 44.1% and Nkwegwu 75.4%) of the mothers in all localities except Umuahia has at least secondary school education. The mean household size (Abakpa 3.53 children, and Ibagwa 3.51children) in the two localities in Enugu state were higher than the mean household size (Umuahia 2.5 children, and 2.64 children) in the two localities in Abia state. Majority (Abakpa 52.6%, Ibagwa 51.8%, Umuahia 44.6% and Nkwegwu 62.1%) of the children belong to the middle (group 3) socioeconomic group in all localities except in Umuahia. Most (Abakpa 52.2%, Ibagwa 63.1%, Umuahia 49.0% and Nkwegwu 55.0%) of the children involved in this study were male except in Umuahia.

The mean age, height-for-age, weight-for-age, haemoglobin concentration and z-scores of the children recruited in this study is presented in Table 2. The mean age was 46.43 months in the urban and 46.55 month in the rural. The mean height-for-age z-score was -0.64 (urban) and -0.88(rural). The percentage of children that were moderately stunted in the urban was 12.3% and in the rural was 16.9% and the difference was not statistically significant (p= 0.116). The percentage of children that were severely stunted in the urban was 6.6% and in the rural was 15.2% and the difference was statistically significant (p= 0.003). The mean weight-for-age z-score was -0.52 (urban) and -0.63 (rural). The percentage of children that were moderately underweight in the urban was 17.7% and in the rural was 18.69% and the difference was not statistically significant (p= 0.697). The percentage of children that were severely underweight in the urban was 12.7% and in the rural was 14.8% and the difference was not statistically significant (p= 0.859). The mean haemoglobin concentration in urban was 10.94g/dl, and in the rural was 10.16g/dl. The prevalence of moderate anaemia in urban was 9.7% and in the rural was 18.8%. The difference was statistically signifi significant (p= 0.003). The prevalence of severe anaemia in urban was 1.7% and in the rural was 0.9%. The difference was not statistically significant (p= 0.394).

Table 1: Mothers' age, Educational status, Household size, Socio-economic status, Children age, and gender

Variable	Enugu State		Abia State	
	Abakpa (Urban) n (%)	Ibagwa (Rural) n (%)	Umuahia (Urban) n (%)	Nkwegwu (Rural) n (%)
Mothers' Age (years) (n_1=83; n_2= 62; n_3=93; n_4= 60)				
≤ 24	17 (20.6)	12 (19.3)	9 (9.7)	14 (23.3)
25 – 34	45 (54.0)	35 (56.5)	56 (60.2)	36 (60.0)
≥ 35	21 (25.4)	15 (24.2)	28 (30.1)	10 (16.7)
Mothers' Education (n_1=81; n_2= 62; n_3= n_4=57)				
No formal education	0 (0.0)	1 (1.6)		1 (1.8)
Primary	11 (13.8)	20 (32.3)	0 (0.0)	6 (10.5)
Secondary	52 (63.8)	31 (50.0)	2 (2.2)	43 (75.4)
Tertiary	18 (22.4)	10 (16.1)	41 (44.1)	7 (12.3)
Household Size (number of children)			50 (53.8)	
(n_1=83; n_2= 62; n_3= 92 n_4=58)				2.64
Mean size	3.53	3.51	2.5	18 (31.0)
1 child	17 (20.0)	4 (6.7)	27 (29.4)	13 (22.4)
2 children	18 (22.2)	17 (26.6)	22 (23.9)	12 (20.7)
3 children	6 (6.7)	11 (17.8)	23 (25.0)	15 (25.9)
≥4 children	42 (51.1)	30 (48.9)	20 (21.7)	
Socioeconomic Status (n_1=79; n_2= 56; n_3=92; n_4=58)				4 (6.9)
1 & 2	13 (16.4)	6 (10.7)	44 (47.8)	36 (62.1)
3	42 (52.6)	29 (51.8)	41 (44.6)	18 (31.0)
4 & 5	24 (31.0)	21 (37.5)	7 (7.6)	
Child's Age (mnths) (n_1=176; n_2=141;n_3=151; n_4=120)				60 (50.0)
≤24	53 (30.1)	42 (29.8)	83 (55.0)	27 (22.5)
25 – 59	52 (29.4)	48 (34.0)	24 (15.9)	33 (27.5)
≥60	71 (40.5)	51 (36.2)	44 (29.1)	
Child's Gender(n_1=176; n_2=141; n_3=151; n_4=120)				66 (55.0)
Male	92 (52.2)	89 (63.1)	74 (49.0)	54 (45.0)
Female	74 (47.8)	52 (36.9)	77 (51.0)	

n_1= Abakpa; n_2= Ibagwa; n_3= Umuahia; n_4= Nkwegwu

Table 2: The prevalence of different levels of stunted (height-for-age z-score ≤<-2), underweight (weight-for-age z-score < -2) and anaemia (haemoglobin estimation ≤ 11g/dl)

Variable	Urban n=323	Rural n=259	χ^2	p-value
Age (months)				
Mean (SD)	46.43 (32.36)	46.55 (28.42)		
Mean Height-for-Age (kg) (SD)	72.0 (40.27)	87.3 (24.68)		
Mean z-score (SD)	-0.64 (2.9)	-0.88 (2.43)		
%moderately stunted (z-score <-2 ≥-3)	40(12.3)	44(16.9)	13.7	0.0003
% severely stunted (z-score < -3)	21(6.6)	39(15.2)		
Mean percentage Weight-for-Age % (SD)	44.6 (20.1)	35.5 (17.6)		
Mean z-score (SD)	-0.52 (1.76)	-0.63 (1.55)		
%moderately underweight (z-score <-2 ≥-3)	64 (19.7)	48 (18.6)		
% severely underweight (z-score < -3)	41 (12.7)	38 (14.8)	0.032	0.859
Haemoglobin estimation (g/dl)				
Mean (SD)	10.94 (1.86)	10.16 (2.62)		
%moderately anaemic (Hb 10g/dl ->7g/dl)	31 (9.7)	49 (18.8)	8.87	0.003
% severely anaemic (Hb ≤ 7g/dl)	5 (1.7)	2 (0.9)		

SD, standard deviation; n, number of children.

The distribution of stunted, underweight and anaemia of the children according to mothers' age, educational status, household size and place of resident are presented in **Table** 3. About equal percentage of children (30.6% mothers ≤ 30 years and 30.4% for mothers ≥31 years) were stunted in two age categories of mothers' age.The difference in number of children that were underweight in two age categories of mothers' (12.7% in mothers ≤ 30 years and 19.2% in mothers ≥ 31 years) was statistically significant (p = 0.032). The difference in number of children that were anaemicin two age categories of mothers' (66.5% in mothers ≤ 30 years and 65.6% in mothers ≥ 31 years) was not statistically significant (p = 0.802).

The difference in number of children that were stunted in two educational categories of mothers' (21.8% in poorly-educated mothers and 35.2% in well-educated mothers) was statistically significant (p = 0.010). The difference in number of children that were underweight in two age categories of mothers' (12.7% in poorly-educated mothers and 19.4% in well-educated mothers) was not statistically significant (p = 0.096).The difference in number of children that were anaemicin two age categories of mothers' (47.3% in poorly-educated mothers and 65.2% in well-educated mothers) was statistically significant (p = 0.01).

The difference in number of children that were stunted in two household categories (35.6% in small household and 33.6% in large household) was not statistically significant (p = 0.627). The difference in number of children that were underweight in two household categories (23.6% in small household and 13.1% in large household) was statistically significant (p = 0.002. The difference in number of children that were anaemic in two household categories (69.1% in small household and 60.7% in large household) was statistically significant (p = 0.036).

There was no statistical difference in the prevalence of stunted (p = 0.191), underweight (p = 0.917) or anaemia (p = 0.463) between urban and rural resident children.

Table 3: Factors that may affect stunted (height-for-age z-score <-2), underweight (weight-for-age z-score < -2) and anaemia (haemoglobin estimation ≤ 11g/dl) using multivariate analysis.

	Stunted	Underweight		Anaemia				
variables	n (%)	χ^2 (p-value)	n (%)	χ^2 (p-value)	n (%)	χ^2 (p-value)	Adjust OR 95%CI	p value
Mothers' age								
≤ 30 (n=338)	103 (30.6)	0.001	43 (12.7)	4.637	225 (66.5)	0.063	0.611	
≥ 31(n=244)	74(30.4)	(0.970)	47 (19.2)	(0.032)	160 (65.6)	(0.802)	(0.39-0.96)	
Mothers' education								
No formal education & Primary (n=104)	23 (21.8)	6.579	13 (12.7)	2.775	50 (47.3)	10.741	0.52	0.49
Secondary & Tertiary (n=478)	168 (35.2)	(0.010)	93 (19.4)	(0.096)	312 (65.2)	(0.001)	(0.32-0.86)	(0.32-0.76)
Household size	133 (35.6)	0.236	88 (23.6)	9.472	258 (69.1)	4.399	2.07	1.46
≤ 3 children (n=373)	70 (33.6)	(0.627)	27 (13.1)	(0.002)	126 (60.7)	(0.036)	(1.29-3.31)	(1.02-2.08)
≥4 children (n=208)								
Place of resident	78 (23.0)	1.712	113 (33.3)	0.011	226 (66.7)	0.539		
Urban (n=339)	45 (18.5)	(0.191)	82 (33.9)	(0.917)	169 (69.4)	(0.463)		
Rural (n=243)								

The distribution of weight-for-age for both rural and urban children is represented in Figure 2. There was an uneven distribution with most of the population skewed towards the left side of the mean in both urban and rural. A greater proportion of the both urban and rural children had weight that was below the standard weight for age. Thus there is a higher tendency for a child to be underweight than have normal weight or being overweight.

The distribution of height-for-age for both rural and urban children is represented in Figure 3. There was an uneven distribution with most of the population skewed towards the right side of the mean in both urban and rural. Greater proportion of both urban and rural children had normal height. Thus there is higher tendency for a child to have normal height than to be stunted.

Discussion

The prevalence of stunted growth was low among children in both urban and rural areas. This was similar to 15% that Dangour et al [18] reported but contrast to what was reported by Fernando et al. [19] The prevalence was higher among rural school children and similar to what has been reported.[20] The overall relatively equal prevalence obtained in the two localities could be due to varied dynamics that exist in these different environment. The proportion of children that were underweight was high with no inter-district variation between urban and rural. Studies among Kazakhstan and Indonesia children reported lower prevalence respectively [18,21]. This could be attributed to seasonal variation with farming seasons in the rural and nutritional deprivation when schools session in the urban.

The proportion of children that were anaemic was high and are well documented: Assefa *et* al[1], Ughasoro *et al*[11], and Dangour *et al*,[18] in their studies among Ethiopian, Nigeria and Kazakhstan children respectively reported high prevalence of moderate-severely anaemic in children. In this study, the prevalence in the rural was higher compared to the children in the urban and the difference was statistically significant. Could it be that most children in the rural tend to consume non-heme iron as their main source of dietary iron.[22] Lack of attention to the nutritional content of food children feed on could be contributory. [23] The children of well-educated mothers have more tendency to be stunted and anaemic compared to the children of poor educated mothers. This is not in accord with expected variation [24] since low maternal education is expected to affect children nutritional status adversely [25]. There is no clear hypothesis that can explain this. Could it be that most enlightened mother practice exclusive breastfeed for a shorter period before introducing cereal-based feeds early and often given their children iron supplements? Studies have shown that phytates in some cereal feeds chelate calcium and reduce its absorption. Also presence of high iron content in the intestine reduces the absorption of calcium, with resultant nutritional rickets and reduced linear length of the bones and height in general. According to the WHO malnutrition classification, when the prevalence of stunting, and wasting are ≥ 40% and ≥ 15%, it is considered as very high and serious if the range of 30 -39.9% and 10 – 14.9% in the community respectively. [26] In this study, the prevalence of stunting in the study ranged from 18.9% in the urban to 32.1% in the rural. Therefore, can be regarded as a serious public health problem in the rural, while efforts should be to keep it down in the urban.

The prevalence of underweight and anaemia among children in large households were significantly higher and this is similar to what have been reported.[27,28] This could be attributed to increased concentration of food consumption of resources in the family. [29] It stand to reason that increase in family size lead to stretch on family income with resultant reduce food availability and undernutrition, But there are various cofounding variables: household income, and maternal education, that have to be considered before drawing any conclusion. One major limitation of the study was none inclusion of biological determinants like malaria, intestinal helminths, bacteremia, human immunodeficiency virus and haemoglobin genotype. Information on these biological determinants will give insight into the complexity of factors that determine the nutritional status of a child. Another limitation is the use of Oyedeji an old model for categorizing socio-economic class. A more recent tools like use of household assets and household financial income to generate quartile or quintile groups, would have been more appropriate. Unfortunately, the data collected could provide the necessary indices require for such calculation.

Conclusion

The prevalence of stunted, underweight and aneamia in southeast Nigeria was high. There are multiple causes of malnutrition in Nigeria children, but rural dwelling, large household size, and low mother's educational level are prominent among the non-biological factors. Therefore any intervention aimed to improve on the nutritional status of children in a given community should make every effort to improve the overall maternal education, improve standard of living in the rural communities and improved family planning strategy.

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