ORIGINAL RESEARCH

Nigerian Journal of Paediatrics 2024; Volume 51(2): 114-125.
https://dx.doi.org/10.4314/njp.v51i2.05.

Association of Undernutrition with Acute Diarrhoea and Recent Hospitalisation Among Primary School Children in Nnewi, Southeast Nigeria

Obichukwu Nkechinyere G[1], Ezechukwu Clement C[1,2], Elo-Ilo Jacinta C[1,2], Odita Amalachukwu O[1]

[1]Department of Paediatrics, Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.
[2]Department of Paediatrics, Nnamdi Azikiwe University, Awka, Nigeria.

Correspondence
Dr Jacinta C. Elo-Ilo, Department of Paediatrics, Nnamdi Azikiwe University, Awka/ Nnamdi Azikiwe University Teaching Hospital Nnewi, Nigeria. E-mail address: jceloilo@gmail.com and jc.elo-ilo@unizik.edu.ng;
ORCID – https://orcid.org/0000-0002-6144-6693

Abstract
Background: Undernutrition is a major predisposing factor to common childhood infectious diseases. It contributes to about half of the deaths of children worldwide, especially in low-income countries. The prevalence of childhood undernutrition is still high despite implementing informed and directed interventional strategies. It is plausible some important aetiological factors may not yet be in focus.
Objective: To explore the relationship between acute diarrhoea and a history of recent hospitalisation for common childhood diseases and undernutrition.
Methods: This observational, cross-sectional study was conducted on 244 primary school pupils aged 6-12 years in Nnewi, southeast Nigeria. Socio-demographic and other relevant clinical details related to recent diarrhoeal episodes and hospitalisations were collected using an interviewer-administered questionnaire. The anthropometric parameters were used to determine the nutritional status using the World Health Organization (WHO) growth charts.
Results: More than half (133; 55.3%) of the participants were males, and most (106; 43.5%) belonged to the low socio-economic classes (SEC). More than half (135; 54.5%) were aged 6-8 years. Low SEC, acute diarrhoea and hospital admission in the preceding six weeks were significantly associated with undernutrition (p <0.001).
Conclusion: Acute diarrhoea and recent hospitalisation in the preceding six weeks were associated with undernutrition among primary school children in Nnewi, southeast Nigeria. Prompt treatment of acute diarrhoea to reduce its duration and prevention of common ailments that lead to hospitalisation may help reduce the incidence of childhood undernutrition.
Keywords: Acute diarrhoea, Hospitalisation, School-aged Children, Undernutrition.

Introduction

According to the World Health Organization (WHO), undernutrition is defined as deficiencies of macro and micronutrients that result in childhood underweight, stunting, wasting and micronutrient deficiencies.[1] Undernutrition contributes to more than half of childhood deaths worldwide, especially in low-income countries.[2,3] Globally, the World Bank, WHO and United Nations Children's Fund (UNICEF) jointly estimated that there will be 144 million stunted and 47 million wasted children by 2025. [4]

The impact of acute diarrhoea on a child's nutritional status could be enormous, yet very difficult to decipher, [5] especially in a low socio-economic community, with numerous risk factors of childhood undernutrition, like large family size, poor dietary intake, and household food insecurity.[6-9] According to WHO, acute diarrhoea is caused by poor personal and food hygiene and various levels of nutritional negligence, which are predominant in developing countries, Nigeria inclusive. [10] Acute diarrhoea disease leads to increased catabolism, nutrient sequestration, malabsorption and decreased nutrient intake. Therefore, this disease increases the incidence of undernutrition through a predisposition to negative energy balance with increased loss of both macro and micronutrients needed for adequate growth and development. [10,11]

Hospitalisation refers to allowing an ill individual to stay in the hospital to access medical care for any disease or ailment. [12,13] Hospital admission is a known risk factor for childhood undernutrition as increased metabolic demand caused by the disease state on a sick child with associated reduced dietary intake predisposes to undernutrition.[14,15] This can further worsen a child's nutritional status with a predisposition to undernutrition.[15] The common ailments that can lead to hospitalisation in children include fever with diarrhoea, fever with cough/catarrh, fever with micturitional pain, and fever with convulsion/loss of consciousness. [14,16] Furthermore, the duration of hospital stay may also worsen a child's nutritional status, as longer hospital stay portrays the severity grade of the ailments, with its known adverse sequelae on nutritional status. [17]

Previous studies have established chronic childhood diseases like tuberculosis,[18] HIV/AIDS [19,20] and childhood cancer, [21] as major risk factors of undernutrition. Surprisingly, the menace of childhood undernutrition is still high in our setting despite implementing dietary and chronic disease-related interventional strategies for childhood undernutrition. [22] Also, the school feeding program in the public schools was instituted as part of interventions for childhood undernutrition. [23 - 25]

The WHO reported that acute diarrhoea with other acute childhood diseases is responsible for up to one-third of global childhood undernutrition and, consequently, death. [26, 27] The Low- and Middle-Income Countries (LMIC) carry a disproportionately high share of this global burden. [28, 29] Therefore, the need to determine the association of acute diarrhoea and recent hospitalisation with childhood undernutrition is germane. This study examined the relationship between acute diarrhoea, duration of acute diarrhoea, recent hospitalisation, hospital stay and undernutrition among school-aged children in Nnewi, southeast Nigeria.

Methods

Study Site

The study was conducted in Primary Schools in the Nnewi metropolis. Nnewi is the second largest city in Anambra State, southeast Nigeria. [30] Nnewi metropolis comprises four autonomous communities: Otolo, Uruagu, Umudim and Nnewichi. [30] As of 2006, Nnewi has an estimated population of 391,227, according to the Nigerian census.[30] The city spans over 2789Km^2.[30] Trading and farming are the major occupations of the indigenes of Nnewi. At the same time, a few are civil servants.[30, 31] Each of the four autonomous communities in Nnewi has about two to three of each of the public and private types of primary schools, respectively.

Study Population

The study population included six- to twelve-year-old primary school pupils in Nnewi, southeast Nigeria.

Study design

The observational, cross-sectional study consecutively recruited 244 primary school pupils who met the inclusion criteria. The participants were selected using a multi-stage sampling technique. Children with known risk factors of childhood undernutrition, such as poor dietary intake, those from large family sizes, those who were not immunised, and those who had not been dewormed in the past six months of the data collection, were excluded from the study. Also, children with known chronic diseases, such as chronic kidney disease, chronic diarrhoeal diseases, sickle cell disease, congenital malformations, childhood cancers, seizure disorders and other diseases that, by their nature, may contribute to undernutrition, were excluded from the study. Similarly, childhood diseases that may be predisposed to frequent hospital visits and or hospitalisation were excluded from the study. Children who were overweight or obese were also excluded from the anthropometric measurements. Furthermore, children whose parents were not available to provide the required information during the periods of data collection were also excluded from the study.

Sample size determination

The sample size was calculated using the formulae for cross-sectional, observational studies thus:

$n = z^2pq/d^2$.[32, 33]

Where: n = The desired minimum sample size when the population exceeds 10,000.

z = The standard normal deviation, usually set at 1.96.

p = The proportion in the target population estimated to have a particular characteristic. The prevalence of normal-weight primary school children in Anambra state was 85.2%, so the prevalence of malnutrition among these children was 14.8%.[34] Therefore, q = 1.0-p; q =1.0-0.148 = =q =0.852.

d = degree of desired accuracy set at 0.05.

Therefore $n = (1.96)^2 \times 0.148 \times 0.852 / (0.05)^2$

n = 194.

Since some children selected for the study may not agree to participate, so a response rate of 80% was allowed. The adjusted sample size (N_s) was = n/0.8.[33] n_s= 194/0.8 = 243. The minimum sample size for this study was 243, but 244 participants who met the eligibility criteria were included in the final data analysis.

Ethical considerations

Ethical approval was obtained from the Ethics Committee of Nnamdi Azikiwe University Teaching Hospital, Nnewi, with reference number CS/66/Vol.11/132/2018/067, before the commencement of the study. The study procedure was revised per the institution's ethical standards, and the Helsinki Declaration of 1975.[35] Permission was obtained from the Ministry of Education in Anambra State (Anambra State Universal Basic Education Board- ASUBEB) before the commencement of the study. Written informed consent was obtained from the School Parent Teacher Association and parents/caregivers of each participant before recruitment into the study. Also, written informed assent was obtained from the participants aged seven years or more before enrolment into the study. The parents/caregivers of the identified malnourished children were engaged in nutritional counselling sessions on the need for immediate nutritional rehabilitation. In contrast, the malnourished children were referred to the Paediatric Gastroenterology/ Nutrition Clinic in Nnamdi Azikiwe University Teaching Hospital (NAUTH), Nnewi, for appropriate management and follow–up.

Sampling technique

The participants were selected using stratified multistage sampling methods: the 302 primary schools in Nnewi comprised 30 public schools and 272 private schools with a ratio of 1: 9.

For convenience, ten primary schools were selected from the 302 primary schools sampling frame, in the proportion of 1:9 (public -to private). In stage one of multi-stage sampling, one and nine private primary schools were randomly selected from 30 public and 272 private primary schools.[36]

In stage 2, the number of participants drawn from each of the selected ten primary schools was determined using a proportionate stratified sampling allocation formulae as follows:[37]

(Total population of index school/ Total population of all the selected schools) × Calculated sample size

For adequate representation of the different age groups, the allocated sample size for each of the selected 10 primary schools was equally divided among the six grades of each school (stage 3). The allotted sample size for each grade was also divided equally among the number of classes in each grade (stage 4). The number of participants allotted to each class was selected from the class register by a simple random method until the required number of participants for each class had been chosen (stage 5). Participants were identified by codes, and the school record of birth certificates was used to establish the age of each participant.

Data Collection

Three research assistants (Health workers) were involved in data collection following training by the investigator. During data collection, the parents/caregivers of the selected participants were met individually after school dismissal for data collection as they arrived to take their wards home.

A pre-tested, standardised, semi-structured questionnaire was used to obtain the required information. The questionnaire was interviewer-administered, and the following data were collected: age, gender, parents/caregivers occupation and the highest level of education for socio-economic classification using Oyedeji's method.[38] The research assistants participated in administering questionnaires and measuring anthropometric parameters. The height and weight measurements were used to derive each child's nutritional status using the WHO growth reference charts for school-age children and adolescents.[39] The nutritional status included stunting, defined as Height for Age Z score (HAZ) <-2, wasting defined as BMI for age Z score < -2, underweight defined as Weight for Age Z score (WAZ) <-2 and normal nutritional status, defined as Weight for Age Z- score between > -2 and < +2.[40, 41]

Information concerning the occurrence of diarrhoea, including the duration of the illness, in the preceding six weeks was obtained. The hospitalisation details for childhood diseases/ailments were also documented in the prior six weeks. This was confirmed by sighting the child's hospital admission cards. The researcher conducted a thorough clinical physical examination to identify the presence/absence of signs of undernutrition.

Weight measurement

The body weight was measured according to WHO protocol for weight measurement using a sensitive Medical flat weighing scale.[42] The scale was placed on a flat surface and adjusted to zero before every measurement. Body weight was measured without shoes, but the child was allowed to wear light clothing. The weight of each child was measured twice to the nearest 0.1kg, and the average was recorded for each child. The weighing scales were calibrated using two standardised objects weighing 10kg and 20kg each day prior to data collection.

Height measurement

The height was measured according to WHO protocol using a standardised portable wall-mounted stadiometer. [43] each child's height was taken without footwear or head covers. Each child usually stood with hands hanging at their sides, with the back of the head, heels together, buttocks and shoulders all leaning against a wall, with a horizontal line of sight. The headpiece was lowered from the top to the head, compressing the hair to make contact with the scalp, and the reading was taken when the respondent took full inspiration. The reading was recorded to the nearest 0.1cm. The stadiometer was standardised after every five measurements using a one-meter length ruler.

Data analysis

All completed questionnaires and proforma were coded before entry into the Statistical Package for Social Science (SPSS) software version 21.0 Windows for analysis. Frequencies and percentages were used to summarise categorical variables. The outcome variable was undernutrition, classified as underweight, stunting, or wasting. It was compared with normal nutritional status in terms of its association with each of the independent variables.

Categorical variables were tested for association with undernutrition (dependent/outcome variables) using Pearson’s Chi-square test (or Fisher’s Exact test where appropriate) for bivariate analysis. Probability p-value <0.05 was considered statistically significant.

Results

A total of 272 eligible children were enrolled into the study, but only the 244 children with complete data were analysed. The socio-demographic characteristics of the children are shown in Tables Ia to Ic. One hundred and thirty-three (54.5%) were males, while 111 (45.5%) were females giving a male-to-female ratio of 1.1:1. Majority belonged to the lower SEC (106; 43.4%), and more than half (135; 55.3%) were aged 6-8 years. The age distribution of the participants had right (positive) skewness with the median age of 7 years.

Association of age, gender and socioeconomic class with undernutrition

Age

In the 6-8 years and 9-12 years cohorts, 95 (57.9%) and 69 (42.1%) children had normal nutrition. Children with undernutrition were equally distributed among the 6-8 years group and the 9-12 years group: 40 (50%) in each group.

Gender

More children with undernutrition were males, 48 (60.0%) compared to 32 (40.0%) who were females ($p = 0.23$).

Table Ia: Socio-demographic characteristics of the children

Characteristics	Frequency	Percentage
Gender		
Male	133	54.5
Female	111	45.5
Age groups (years)		
6-8	135	55.3
9-12	109	44.7
Socio-economic class		
Upper	58	23.8
Middle	80	32.8
Low	106	43.4

Table Ib: Nutritional status (Weight-for-age, Height-for-age and Weight-for-height) of children distributed according to sex

Nutritional status	Gender			X^2 (p-value)
	Male Freq (%)	***Female Freq (%)***	***Total Freq (%)***	
Normal	85 (51.8)	79 (48.2)	164 (67.2)	
Underweight	1 (50.0)	1 (50.0)	2 (0.8)	
Wasting	31 (63.3)	18 (36.7)	49 (20.1)	
Severe Wasting	8 (7.7)	3 (27.3)	11 (4.5)	
Underweight and wasting	7 (46.7)	8 (53.3)	15 (6.1)	
Stunting only	0 (0.0)	2 (100.0)	2 (0.8)	
Stunting and underweight	1 (100.0)	0 (0.0)	1 (0.4)	
Total	133 (54.5)	111 (45.5)	244 (100.0)	1.45 (0.23)

Freq - Frequency, % - Percentage

Table Ic: Nutritional status (Weight for age, Height for age and weight for height) of children distributed according to age

Nutritional status	Age (years)			X^2 (p-value)
	6-8 Freq (%)	***9-12 Freq (%)***	***Total Freq (%)***	
Normal	95 (57.9)	69 (42.1)	164 (67.2)	
Underweight	0 (0.0)	2 (100.0)	2 (0.8)	
Wasting	27 (56.3)	22 (43.7)	49 (20.1)	
Severe Wasting	7 (63.6)	4 (66.4)	11 (4.5)	
Underweight and wasting	6 (40.0)	9 (60.0)	15 (6.1)	
Stunting	0 (0.0)	2 (100.0)	2 (0.8)	
Stunting and underweight	0 (0.0)	1 (100.0)	1 (0.4)	
Total	**135 (55.3)**	**109 (44.7)**	**224 (100.0)**	**1.37 (0.24)**

Freq - Frequency, % - Percentage

Socioeconomic class (SEC)

Table II shows that most of the children with undernutrition belonged to the low SEC (45; 56.3%). The influence of SEC on the occurrence of undernutrition was 19.6% (p = 0.009). Children from low SEC were nine times more likely to have undernutrition than children from higher SEC.

Association of acute diarrhoea and hospitalisation with childhood undernutrition

In Table III, 76 (95%) of children with undernutrition had a recent history of diarrhoea with statistical significance (p<0.001). Diarrhoea lasted for one to three days in most of the participants (57; 71.3%), and this was also significantly associated with undernutrition (p<0.001).

Fifty-seven (71.3%) children with a recent history of hospitalisation had undernutrition, and this accounted for 47% of all children with undernutrition (p<0.001).

Table II: Relationship between nutritional status and age, sex and socio-economic classes

Variables		Nutritional status		X^2	p-value
		Normal nutrition	***Undernutrition***		
Age (years)	6-8	95 (57.9)	40 (50.0)	1.36	0.243
	9-12	69 (42.1)	40 (50.0)		
Sex	Male	85 (51.8)	48 (60.0)	1.448	0.229
	Female	99 (48.2)	32 (40.0)		
SEC	High	38 (23.2)	6 (7.5)	9.336	0.009
	Medium	55 (33.5)	29 (36.3)		
	Low	71 (43.3)	45 (56.3)		

SEC – Socioeconomic Class

Table III: Relationship between nutritional status and patterns of diarrhoea and hospitalisation

Variables		Nutritional status		X^2	p-value
		Normal nutrition (n = 164)	***Undernutrition***		
Diarrhoea	Yes	26 (15.9)	76 (95.0)	138.5	<0.001
	No	138 (84.1)	4 (5.0)		
Duration of diarrhoea (days)	None	136 (82.9)	4 (5.0)	149.5	<0.001
	1-3	23 (14.0)	57 (71.3)		
	≥4	5 (3.0)	19 (23.7)		
Hospitalisation	Yes	37 (22.6)	57 (71.3)	53.8	<0.001
	No	127 (77.4)	23 (28.7)		
Duration of hospitalisation (days)	None	123 (76.2)	24 (30.0)	48.3	<0.001
	1-3	27 (16.5)	38 (47.5)		
	≥4	12 (7.3)	18 (22.5)		
Symptoms prompting hospitalisation	None	125 (76.2)	24 (30.0)	89.1	<0.001
	Fever/Diarrhoea/Vomiting	2 (1.2)	35 (43.0)		
	Fever/Cough	26 (15.9)	9 (43.0)		
	Fever/Convulsion	11 (6.7)	11 (6.7)		
	Fever/Micturitional pain	0 (0.0)	1 (1.3)		

The commonest symptoms warranting hospital admission were diarrhoea, vomiting and fever seen among 35 (43.8%) hospitalised pupils, followed by cough and fever (26; 15.9%). The type of symptoms accounted for 60.3% of undernutrition (p<0.001). Up to 38 (47.5%) of children with undernutrition spent 1-3 days during hospital admission, while 18 (22.5%) spent ≥4 days in the hospital. The duration of hospital stay accounted for 44.5% of undernutrition ($p<0.001$).

Discussion

This study aimed to determine the association of acute diarrhoea and recent hospitalisation with undernutrition among school-aged children in Nnewi. From this study, a recent acute diarrhoea was associated with undernutrition. This is similar to the reports by Bantamen *et al.* in Ethiopia, [44] Wong *et al.* in Malaysia, [45] Abera *et al.* in Ethiopia [46] and Owoaje *et al.*in Ibadan, Nigeria.[47] From the current study, children with acute diarrhoea had higher odds of developing undernutrition, unlike the finding by Abera *et al.* in Ethiopia. [46] This difference may be due to the differences in the methodologies adopted. This present study focused on the occurrence of acute diarrhoea in the preceding six weeks; this period is long enough for the manifestation of the effects of diarrhoeal disease on the child's nutritional status. On the other hand, Abera *et al.* noted the occurrence of acute diarrhoea two weeks before the study. In addition, the present study was done among older children who were able to recall the history of acute diarrhoea in the past six weeks and the duration of the diarrhoea before resolution, unlike in under-fives that are totally dependent on the caregivers.[48]

The pathogenesis of diarrhoea-induced undernutrition could be explained by negative energy balance from increased metabolic demand and increased nutritional loss from diarrhoea, which was not adequately compensated by nutrient intake. Most ill children usually have anorexia, limiting their nutrient intake during ill health. Also, decreased nutrient absorption due to the loss of absorptive surface from the erosion of the villi/ epithelial lining of the intestine by the infective agents of diarrhoeal disease may be contributory. Furthermore, there is a bidirectional relationship between diarrhoea and undernutrition; while diarrhoea can result in undernutrition and electrolyte imbalance, malnourished children are also more predisposed to diarrhoea.[49,50]

From the present study, the history of recent hospitalisation was associated with undernutrition. These children were 53.8 times more likely to develop undernutrition. This result was similar to Quadros *et al.*[51] and Lee *et al.*[52] The illnesses warranting hospitalisation in the present study were gastrointestinal and respiratory. Owoaje *et al.* found similar symptoms among children in Ibadan, southwest Nigeria.[47] Similar findings were reported from Ethiopia by Gelu *et al.*, [53] Bantamen *et al.* [44] and from Botswana by Etienne *et al*.[54] In variance to this finding, Abera *et al.*[53] noted that children with childhood illness were 59% less likely to have underweight than those who were not ill. The duration of the disease could account for these differences. This study noted the presence of childhood illnesses requiring hospitalisation in the preceding six weeks, which is longer and enough for the full manifestation of the disease severity on a child's nutritional status, unlike the two weeks adopted in the study done by Abera *et al*. Furthermore, this study noted that these childhood illnesses were severe enough to require hospitalisation. This is because severe childhood illness usually mounts increased metabolic demand, causing a deficit in the child's energy store. [55] When the child cannot replenish energy deficit following associated anorexia that usually occurs in such a situation, undernutrition becomes inevitable.[38] Also, the managing medical team may not have made provisions to take care of the increased energy demand of a sick child and replenish it by increasing the total energy Recommended Daily Allowance (RDA) for a hospitalised ill child.[46]

This study also found that the commonest symptoms necessitating hospital admission were fever, vomiting, and diarrhoea, followed by fever and convulsion. Therefore, there is a great need to intensify the campaign on preventing and promptly managing acute childhood illnesses characterised by fever and diarrhoea to help mitigate their contributions to childhood undernutrition.

Limitation

A longitudinal study would have been more helpful in establishing causal relationships between recent diarrhoea, recent hospitalisation for an acute illness, and nutritional status. Recall bias was also a major limitation of the present study. However, this was averted to a reasonable extent by making it mandatory that the parents/caregivers were present during data collection and with the hospital card of their ward(s).

Conclusion

Acute diarrhoea and a history of hospitalisation in the preceding six weeks may be associated with undernutrition among school-aged children in Nnewi, southeast Nigeria. It is expected that the longer the duration of acute diarrhoea and the longer the duration of hospitalisation, the higher the risk of childhood undernutrition. Parents should be encouraged to bring their sick wards early to the hospital for immediate intervention to limit the impact of the illnesses on their nutrition. Hospital administrators and healthcare providers should ensure adequate total energy requirements for the hospitalised sick child to limit the negative effect of energy deficit on nutritional status. Health education should focus on preventive measures for acute diarrhoeal diseases and other common childhood illnesses.

Acknowledgement: The authors immensely appreciate the support and consent of the school's Parent Teacher Association (PTA) in carrying out this work. The input of the research assistants and the statistician are also appreciated.

Authors' Contributions: ONG, ECC and EJC conceived and designed the study. ONG and OAO did the literature review. ONG did data analysis and interpretation. All the authors drafted and revised the draft for sound intellectual content. All authors approved the final version of the manuscript.

Conflict of Interest: None declared.

Financial Support: The authors received no funding for the research and publication of this article.

Accepted for publication: 26th May 2024.

References

1. WHO Definition of Malnutrition. [Internet] (Cited 2023 January 21st). Available from: https://www.who.int/health-topics/malnutrition.
2. Group W Multicentre GRS. WHO Child Growth Standards: Lenght/height-for-age, Weight-for-age, Weight-for-height and Body Mass Index-for-age: Methods and Development. Available from: https://www.who.int/publications/i/item/924154693X.
3. Herohalli SR. Malnutrition: Practical Essence. 2017. p.1–5. Available from: https://emedicine.medscape.com/article/985140-overview.
4. Kelishadi R. Childhood Overweight, Obesity and Metabolic Syndrome in Developing Countries. *Epidemiol Rev* 2007;29(1):62–76. doi:10.1093/epirev/mxm003.
5. Scrimshaw NS. Effect of infection on nutritional status. *Proc Natlsci Counc Repub China* 1992;16:46–64.
6. Chowdhury MR, Rahman MS, Khan MM, Mondal MN, Rahman MM, Billah B. Risk Factors for Child Malnutrition in Bangladesh: A Multilevel Analysis of a Nationwide Population-Based Survey. *J Pediatr.* 2016;172:194-201.e1. doi:10.1016/j.jpeds.2016.01.023.

7. Odunayo SI, Oyewole AO. Risk factors for malnutrition among rural Nigerian children. *Asia Pac J Clin Nutr.* 2006;15(4):491-495.
8. Owoaje E, Onifade O, Desmennu A. Family and socioeconomic risk factors for undernutrition among children aged 6 to 23 months in Ibadan, Nigeria. *Pan Afr Med J* 2014;17. doi: 10.11604/pamj.2014.17.161.2389.
9. Ajibuah BJ, Ololoto EA, Halima A, Oluseyi O, Kazeem L. Evaluation of Nutritional Status of Under-5 Children in Borno and Kano States of Nigeria. *Ife Soc Sci Rev* 2018; 26(1), 66–73.
10. Diarrhea Disease. [Internet] (Cited 2022 February20th): Available from: https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease
11. Jain A, Shah D, Das S, Saha R and Gupta P. Aetiology and outcome of acute diarrhoea in children with severe acute malnutrition: a comparative study. *Public Health Nutr*. 2020;23(9):1563-1568. doi: 10.1017/S1368980019003069.
12. Definition and meaning of Hospital admission. [Internet] (Cited 2023 April 12th). Available from: https://www.collinsdictionary.com/dictionary/english/hospital-admission.
13. Admission of patient to the hospital. [Internet] (Cited 2023 April 20th). Available from: https://www.vmfh.org/content/dam/vmfhorg/pdf/legacy-vm/workfiles/hospital-admission-policy.pdf
14. Chiang KL, Huang CY, Fan HC, Kuo FC. Prolonged length of stay for acute hospital admissions as the increasing of age: A nationwide population study forTaiwon's patients with cerebral palsy. *J Paediatr Neonatol* 2018;04:60(1). doi:10.1016/j.pedneo.2018.04.004
15. Ostrowska J, Sulz I, Tarantino S, Hiesmayr M and Szostak-Wegierek D. Hospital malnutrition, nutritional risk factor and elements of Nutritional care in Europe: Comparism of Polish results with all European countries Participating in then Day Survey. *Nutrients* 2021;13:263.doi: 10.3390/nu13010263.
16. When to take your child to the Paediatricians 'Immediate Care or ER. [Internet] (Cited 2023 April 20th). Available from: https://www.luriechildrens.org/en/blog/when-to-take-your-child-to-the-pediatrician-immediate-care-or-er/
17. Maia I, Xara S, Vaz D, Shiang T, Amaral TF. Undernutrition risk at hospital admission and length of stay among pulmonology in patients. *J Pulmonol* 2018;24:330–336. doi:10.1016/j.pulmoe.2018.01.004.
18. Chhetri U, Mishra A, Jain KC. Childhood tuberculosis and its relation with Nutrition: A five-year Retrospective study. *J Lumbini Med Coll.* 2018;6:48–53. https://doi.org/10.22502/jlmc.v6i2.217.
19. Ozoka CN. Burden of Malnutrition in Children Under 5 Years in Nigeria: Problem Definition, Ethical Justification and Recommendations. *J Trop Dis.* 2018;06(03). doi:10.4172/2329-891X.1000268.
20. Kalu RE, Etim KD. Factors associated with malnutrition among underfive children in developing countries: A review. *Global J Pure App Sci*. 2018;24(1):69. doi:10.4314/gjpas.v24i1.8.
21. Brisksma A, Huizinga G, Sulkers E, Kamps W, Roodbol P, Tissing W. Malnutrition in childhood cancer patients: A Review on its prevalence and possible causes. *Crit Rev Oncol Hematol* 2012;83:249–275.doi:10.1016/j.critrevonc.2011.12.003.
22. NTBLCP Reiterates TB test, treatment free in Nigeria. [Internet] (Cited 2024 March 24th). Available from: https://lisdel.org/ntblcp-reiterates-tb-test-treatment-free-in-nigeria/.
23. Agu CI, Ossai EN, Ogah EO, Agu CI, Akamike I, Ugwu GO, *et al*. An appraisal of the implementation of the national school feeding programme and its effect on enrolment and attendance in public primary schools in Southeast, Nigeria: perception of heads of schools. *BMC Nutr* 2023;9:37. doi:10.1186/s40795-023-00695-z.
24. Adebisi OA, Adebisi LO, Jonathan A, Ajani OO, Asogwa UG. Effect of National Home Growing School Feeding Program

(NHGSFP) on the nutritional status of children of rural households in Osun State, Nigeria. J Agric Food Sci. 2020;17(2):148–163. doi:10.4314/jafs.v17i2.12.

25. Muhammad RK, Ali IS, Ibrahim GA. Effect of School Feeding Programme on nutritional balance in primary school pupils in Kano metropolis. *FUDMA J Sci* 2023;7(2):256–264. doi:10.33003/fjs-2023-0702-1689.
26. Johns Hopkins B School of Public Health. International Vaccine Access Center (IVAC). Pneumonia and Diarrhea progress through equitable investments and action.[Internet] (Cited 2023 April 25th). Available from: https://www.jhsph.edu/research/centers-and-institutes/ivac/resources/pneumonia-diarrhea-progress-report.html.
27. World Malaria Report.WHO, Geneva [Internet] (Cited 2023 March 28th). Available from: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022.
28. Perin J, Mulick A, Yeung D, Villavicencio F, Lopez G, Stronk KL, *et al.* Global, regional and national causes of under -5 mortality. *Lancet Child Adolesc Health* 2022;6:106–115. doi:10.1016/S2352-4642(21)00311-4.
29. UN Inter-Agency Groups for Child Mortality Estimation, Levels and Trends in Child Mortality Report.[Internet] (Cited 2024 February 26th). Available from: https://data.unicef.org/resources/levels-and-trends-in-child-mortality-2021/
30. Description of Nnewi Town, in Anambra Southeast, Nigeria [Internet] (Cited 2023 June 2nd) Available from: https://en.wikipedia.org/wiki/Nnewi
31. Dashboard of List of Primary Health Centers in Nnewi. [Internet] (Cited 2018 June 20th). Availablefrom:http://library.procurementmonitor.org/backend/files/List%20of%20Coded%20Health%20Facilities%20in%20Anambra%20State.pdf
32. Yadav SS, Yadav ST, Mishra P, Mittal A, Kumar R, Singh J. An Epidemiological Study of Malnutrition Among Under Five Children of Rural and Urban Haryana. *J Clin Diagn Res.* 2016;10(2):7-10. doi: 10.7860/JCDR/2016/16755.7193.
33. Araoye MO. Research Methodology with Statistics for Health and Social Sciences. Nathadex Publications, Saw-mill, Ilorin. 2nd Edition. 2008. p.115-122.21. Available from: https://www.scirp.org/reference/referencespapers?referenceid=1810828.
34. Nwabueze AS, Ilika LA, Azuike EC, Nwabueze NC, Obi KM, Onebunne ME, *et al.* Assessment of Nutritional status among primary school pupils in rural and urban areas of Anambra State. *Eur J Prev Med* 2015;3:34. https://doi.org/10.11648/j.ejpm.20150302.14.
35. World Medical Association. World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. JAMA 2013; 310: 2191-2194. doi:10.1001/jama.2013.281053. Bardara ME, Alison EB. Biomarkers of Nutritional Exposure and Nutritional Status, Markers of the Validity of Reported Energy Intake. *J Nutr Suppl* 2003;133:895s-920s. doi:10.1093/jn/133.3.895S.
36. Proportionate Stratified Sampling Method. [Internet] (Cited 2023 October 15th). Available from: https://www.oxfordreference.com/display/10.1093/oi/authority.20110803100349910.
37. Oyedeji GA. Socio-economic and cultural background of hospitalised children in Ilesha. *Niger J Paediatr* 1985;12:111–117.
38. De Onis M, Onyango AW, Borghi E, Siyam A, Nishida C, Siekmann J. Development of a WHO growth reference for school-aged children and adolescents. *Bull World Health Organ.* 2007;85(9):660-667. doi:10.2471/blt.07.043497.
39. World Health Organization, Growth Reference 5-19years: Age for Height and BMI. [Internet] (Cited 2023 October 12th). Available from: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators
40. Definition of stunting, underweight and wasting. UNICEF 2019 [Internet] (Cited 2018 July 20th). Available from:https://www.unscn.org>recent-news. Choosing the Right Patient Weighing Scale.

Medical Expo. https://guide.medicalexpo.com/choosing-the-right-patient-weighing-scale/

41. Measuring a child's growth. [Internet] (Cited 2024 January 20th). Available from: World Health Organization who.int>trainingpd.
42. Bantamen G, Belaynew W, Dube J. Nutrition & Food Assessment of Factors Associated with Malnutrition among Under Five Years Age Children at Machakel Woreda, Northwest Ethiopia : A Case-Control Study. *Nutr Food Sci* 2014;4(1):1–7. doi:10.4172/2155-9600.1000256.
43. Wong HJ, Moy FM, Nair S. Risk factors of malnutrition among preschool children in Terengganu, Malaysia : A case-control study. *BMC Public Health* 2014;14:785. https://doi.org/10.1186/1471-2458-14-785.
44. Abera L, Dejene T, Laelago T. Prevalence of malnutrition and associated factors in children aged 6–59 months among rural dwellers of Damotgale District, South Ethiopia: Community-based Cross-sectional Study. *Int J Equity Health* 2017;16:111–119. doi: 10.1186/s12939-017-0608-9.
45. Owoaje E, Oluwadolapo DO. Family and socio-economic risk factors for undernutrition among children aged 6 to 23 months in Ibadan, Nigeria. *Pan Afr Med J* 2014;17:161–167. doi:10.11604/pamj.2014.17.161.2389.
46. Mgbagbeola DD, Tosin FI, Adetokumbo TS. Prevalence and determinants of diarrhoea among infants in selected primary health centres in Kaduna North local Government area, Nigeria. *Pan Afr Med J* 2017;28:109. doi: 10.11604/pamj.2017.28.109.8152
47. Nel ED. Diarrhea and malnutrition. *South Afr J Clin Nutr* 2010;23:1suppl. doi: 10.1080/16070658.2010.11734262.
48. Abolurin O, Adegoke S, Oyelami OA. Effect of malnutrition on diarrhoeal disease in Nigerian children. *Ann Biomed Sci*. 2020;19(1).
49. Quadros DS, Kamenwa R, Akech S, Macharia WM. Hospital-acquired malnutrition in children at a tertiary care Hospital. *South Afr J Clin Nutr*. 2018;31:8–13. doi:10.1080/16070658.2017.1322825.
50. Lee WS, Ahmad Z. The prevalence of undernutrition upon hospitalisation in children in a developing country: A single hospital study from Malaysia. *Pediatr Neonatol* 2017;58(5):415-420. doi:10.1016/j.pedneo.2016.08.010.
51. Gelu A, Edris M, Derso T, Abebe Z. Undernutrition and associated factors among children aged 6 to 59 months living in a slum area of Goudarcity Northwest Ethiopia: A Cross-Sectional Study. *Pediatr Health Ther* 2018;9:81–88. doi:10.2147/PHMT.S172317.
52. Etienne KY. Factors influencing malnutrition among children under 5 years of age in Kwenga West District of Botswana. 2012.[Internet] (Cited 2018 July 20th). Available from: https://uir.unisa.ac.za/handle/10500/10605
53. Herrador Z, Sordo L, Gadisa E, Moreno J, Nieto J, Custodio E, *et al*. Cross-Sectional Study of Malnutrition and Associated Factors among School-Aged Children in Rural and Urban Settings of Fogera and Libo, Kemkem Districts, Ethiopia *PLoS ONE* 2014;9(9):1–11.doi: 10.1371/journal.pone.0105880.