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Nutritional Status of Diarrhoeic Patients under Five Years Attending Selected Hospitals in Kaduna State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author JBO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author IM managed the analyses of the study. Author ROC managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Poor nutritional status show physical, mental and health wise consequences such as diarrhoea, stunting, wasting and underweight and often times lead to death, depending on their severity. This study evaluated the nutritional status of diarrhoeic children under five years in Kaduna State, Nigeria, using standard isolation methods, VTEC-ELISA tests, latex agglutination tests, Chi-square (SPSS Version 19) and World Health Organisation Antro (Version 3.2.2). Random sampling was used to select 350 children presenting with diarrhoea in six government hospitals within the three senatorial zones of Kaduna State. The nutritional status assessment showed 34.3, 24.3 and 13.1% of the children were stunted, wasted and underweight, respectively and Kaduna South senatorial zone also recorded the highest prevalence of undernutrition, indicating poor nutrition and poor health accumulated overtime. The study therefore recommends the implementation of programmes geared towards good hygiene, good nutrition and good health.

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Keywords: Nutrition; status; diarrhoeic; patients; hospitals.

1. INTRODUCTION

Nutrition is a science that concerns itself with the relationship between food and the functioning of the human body and it encompasses the ingestion of food, digestion, absorption, metabolism and excretion of waste products. Nutrition plays a key role in physical, mental and emotional development of children and much emphasis has been given to provide good nutrition to growing populations especially in the formative years of life, which is one thousand (1,000) days. Globally, more than one- third of child deaths are attributable to under nutrition. Malnutrition refers to a case of faulty nutrition causing diseases like Obesity, Marasmus, Kwashiorkor, Protein-Energy Malnutrition (PEM), underweight and other chronic diseases [1]. Diarrhoeal illness is often attributed to contaminated water (or food) consumption, although the percentage specifically due to waterborne pathogens is still unknown [2]. Transmission of agents that cause diarrhoea are usually by the faecal oral route, which include the ingestion of faecal contaminated water or food, person to person contact and direct contact with infected faeces. Host factors that increase susceptibility to diarrhoea include under nutrition, current or recent measles and immune deficiency or immunosupression [3]. Among the bacterial pathogens of diarrhoeal diseases, the most commonly implicated in the endemic form of childhood diarrhoea on a global scale are strains of *Escherichia coli* [4,5,6]. Diarrhoeal diseases and other related gastrointestinal disorders are one of the most important causes of illness and death all over the world, particularly among infants and young children [7,8]. The major causes of diarrhoeal illness include, among others, limited access to / or poor quality of water, poor food hygiene, and sanitation. The bacterial pathogens usually responsible for diarrhoeal illness include *Escherichia coli*, *Shigella, Salmonella, Campylobacter, Yersinia, Aeromonas* [9]. The relationship between diarrhoea and malnutrition is bidirectional: diarrhoea leads to malnutrition while malnutrition aggravates the course of diarrhoea. Many factors contribute to the detrimental effect of diarrhoea on nutrition. Reduced intake (due to anorexia, vomiting, and withholding of food), maldigestion, malabsorption, increased nutrient losses, and the effects of the inflammatory response are some of the factors involved in malnutrition. Diarrhoeal disease may cause, precipitate, or exacerbate protein-energy and micronutrient malnutrition through five possible mechanisms: 1) reduced food intake-reduction of food intake during diarrhoea may be due to the child's anorexia, maternal food-withholding behaviour, or both; 2) decreased absorption of nutrients due to structural damage to the intestine, as well as the physical action of increased intestinal movement and reduced fluid transit time, all interact to produce decreased absorption of nutrients; 3) increased catabolic losses-under the influence of the inflammatory process, diarrhoea of infectious origin induces an average daily negative nitrogen balance of 0.9 g/kg/day, as muscle protein is converted to glucose through gluconeogenesis by the liver; this glucose is used as a fuel by tissues to sustain the hypermetabolism associated with fever; 4) nutrient loss from the intestine-in diarrhoea nutrients are lost directly from the intestinal tract; 5) metabolic inefficiency due to micronutrient deficiency-the increased rate of tissue synthesis displayed by children recovering from protein-energy malnutrition may be hampered by a limited supply of nutrients from the body pool, which in turn may not be replenished fast enough by dietary intake [10].

1.1 Aim

This study was aimed at determining the nutritional status of diarrhoeic patients under-five years with the following objectives:

1. Determine the nutritional status of the diarrhoeic children using Z-scores (internationally accepted reference standards).
2. Obtain demographic data and risk factors associated with diarrhoea using pre-adopted questionnaire.

2. MATERIALS AND METHODS

2.1 Study Area

The study area consisted of six hospitals namely General Hospital Makarfi, Gambo Sawaba Memorial Hospital Zaria, Yusuf Dantsoho Memorial Hospital Tudun-wada, Gomna Awan General Hospital Kakuri, Kwoi General Hospital and Kafanchan General Hospital, selected from the three senatorial zones in Kaduna State, Nigeria.

2.2 Study Population

The study population consisted of children between the ages of 0-5 years, presenting with diarrhoea, whose parents gave consent and the exclusion criteria were children under the ages of 0-5 years, whose parents did not give their consent.

2.3 Sample Size

The sample size was determined using the formula of [11] which is as follows: N = Z2Pq/L2 Where N is sample size Z is the standard normal distribution at 95% confidence interval = 1.96 P is the prevalence rate, which is taken as 34.1% [12] qis 1 –P L is the allowable error, which is taken as 5% = 0.05 Therefore N = (1.96)2 x 0.341 x (1-0.341) (0.05)2 =3.8416 x 0.341 x 0.65 = 345.3 0.0025 The sample size calculated is 345.3 samples. A total of three hundred and fifty samples were collected from the diarrhoeic children for this study.

2.4 Assessment of Nutritional Status

Anthropometric assessment: Anthropometry refers to comparative measurements of the human body. The four measures used for anthropometric assessment are: age, sex, length (or height) and weight. Each of these variables provides one piece of information about a person and when they are used together they can provide important information about a person‘s nutritional status. Collection of anthropometric data, was done using a standard measuring tape to measure height and the children were weighed using a UNICEF UNISCALE to the nearest 100 grams [13]. Medical history, dietary history, socioeconomic/demographic records were obtained using the proffered answers to the questionnaires.

2.5 Reference Standards

References were used to standardize a child‘s measurement by comparing the child‘s measurement with the average measure for children at the same age and sex. The [14] International Reference Standard was used for standardizing the anthropometric data using Z-scores. The Z-score or standard deviation unit (SD) is defined as the difference between the value for an individual and the median value of the reference population for the same age or height, divided by the standard deviation of the reference population. The distribution of Z-scores follows a normal distribution, and the commonly used cut-offs are -3,-2, and -1 Z-scores. The use of a cut-off enables the different individual measurements to be converted into prevalence statistics. The most commonly used cut-off with Z-scores is -2 Standard deviations. Hence, children with a Z-score for underweight, stunting or wasting below -2 SD were considered moderately or severely malnourished. WHO reference standards that were used for standardizing the anthropometric data obtained include, weight-for-length/height (45 to 110 cm), weight-for-age (65 to 120 cm), BMI-for-age (22 kg/m^2) [14].

2.6 Questionnaire Administration

The nutritional status of individuals revolves around general well-being. Questionnaires containing questions on demographic factors, such as socioeconomic backgrounds of the children and their families, dietary history, medical history, risk factors were administered to the parents and care givers of the children who consented to this study. The data obtained there from, were used to assess the nutritional status of the children and also to show further, the relationship between diarrhoea and nutrition.

2.7 Inclusion and Exclusion Criteria

The inclusion criteria included diarrhoeic children (0-5 yrs), whose parents gave consent. Children below or above 5 years, whose parents did not give their consent, were excluded from the study. Diarrhoeic cases in this study were defined as the occurrence of three or more loose or watery stools in a 24 h period at least one bloody loose stool [15].

2.8 Statistical Analysis

Data collated from the questionnaires were subjected to the appropriate statistical analysis. Chi-square analysis was used to determine association between variable and infection at 95% CI and at 0.05 significant levels (SPSS, version 19) and nutritional status assessment was done using WHO Anthro statistical software (Version 3.2.2).

3. RESULTS

The nutritional status of subjects within the study population can be seen in Fig. 1. The results

obtained, show the percentage of children underweight as 13.1%, 34.3% of the population were stunted and 24.3% of the children were wasted.

Fig. 2 shows the graph of weight-for-age Z-score of diarrhoeic children less than five years. Severe pathological deficits in weight for age are known as long term underweight. Weight-for-age reflects body mass relative to age. It is a composite measure of weight-for-age and weight-for-height. It combines the effect of long term and short term health, nutritional problems, and represents a convenient measure of both linear growth and body proportion. Weight-for-age can be used for the diagnosis of underweight in children. The graph shows that the subjects were underweight for their ages in comparison with World Health Organization standard.

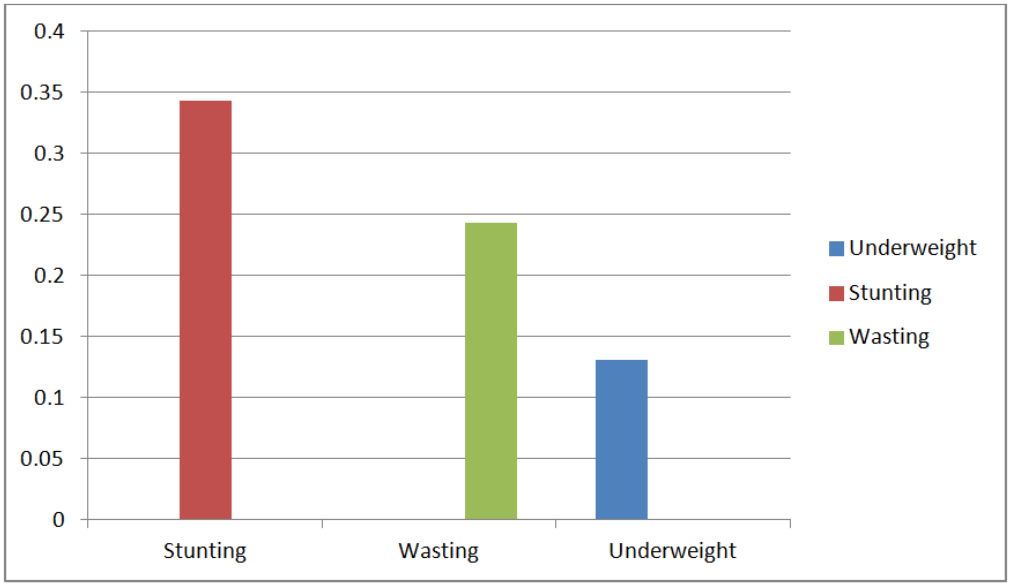

Fig. 1. Prevalence of underweight, stunting and wasting amongst children (0-5years) in Kaduna State

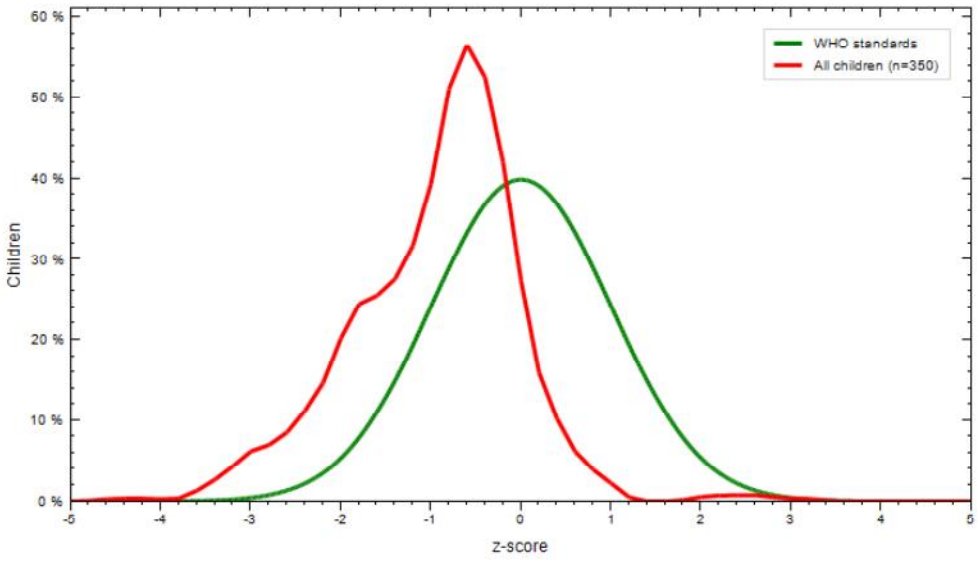

Fig. 2. Weight for age Z-score of diarrhoeic children (0-5years) in Kaduna

Fig. 3 shows the weight-for-height Z-score of the diarrhoeic children less than five years. Low weight-for-height which is also referred to as wasting is normally used as an indicator of current nutritional status and can be used for screening of children at risk of childhood mortality and for measuring short term changes in nutritional status. It reflects a recent and severe process that has led to substantial weight loss. The subjects in the study population did not meet the required World Health Organization standard for weight-for-height as they fell below the -2 standard deviation cut off for weight-for-height.

Table 1 shows the mean ranges of the anthropometric characteristics of the diarrhoeic children less than five years of age in the study population. The mean values for weight and height of the 207 male subjects obtained were 11.30±3.50 kg and 84.86±14.55 cm respectively, whereas values obtained for the 143 females were 10.63±3.21 kg and 83.87±14.48 cm respectively and the differences in the two mean values were not actually significant. Also reflected in this table are the average Z-scores of weight-for-age, weight-for-height, height-for-age (WAZ, WHZ and HAZ) for both male and female, all of which had negative values or mean Z – scores of less than 0.

Low height-for-age (Stunting) or linear growth retardation is the best measure of child health inequalities as it is a multi-facet nutritional indicator which captures various dimensions of child health, development and environmental influence. It reflects chronic malnutrition accumulated during pre or post natal periods because of poor nutrition and health (e.g chronic insufficient protein and energy intake). The subjects in study population were highly stunted as they had cut-offs below the -2 standard deviation for height-for-age.

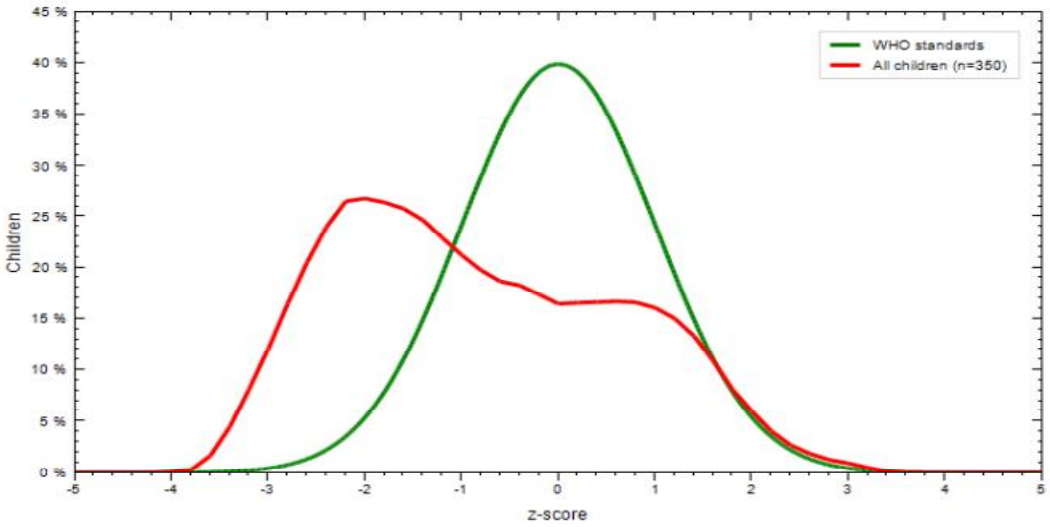

Fig. 3. Weight-for-height Z-score of diarrhoeic children (0-5years) in Kaduna

Table 1. Mean anthropometric characteristics of the diarrhoeic male and female children (0-5 Years) in Kaduna State

Gender	Male(N=207) Mean value ± SD	Female (N=143) Mean value ± SD
Anthropometric indices		
Height (cm)	84.86 ± 14.55	83.87 ± 14.48
Weight (kg)	11.03 ± 3.50	10.63 ± 3.21
Weight for Age (Z-Score)	-1.14 ± 0.96	-0.66 ± 0.76
Weight for Height/length (Z-Score)	-0.90 ±1.41	-0.68 ± 1.44
Length/height for Age	-0.86 ± 1.76	-0.18 ± 2.13

Key: WAZ= Weight for Age Z-score, HAZ= Height for Age Z-score, WHZ= Weight for Height Z-score,SD= Standard Deviation

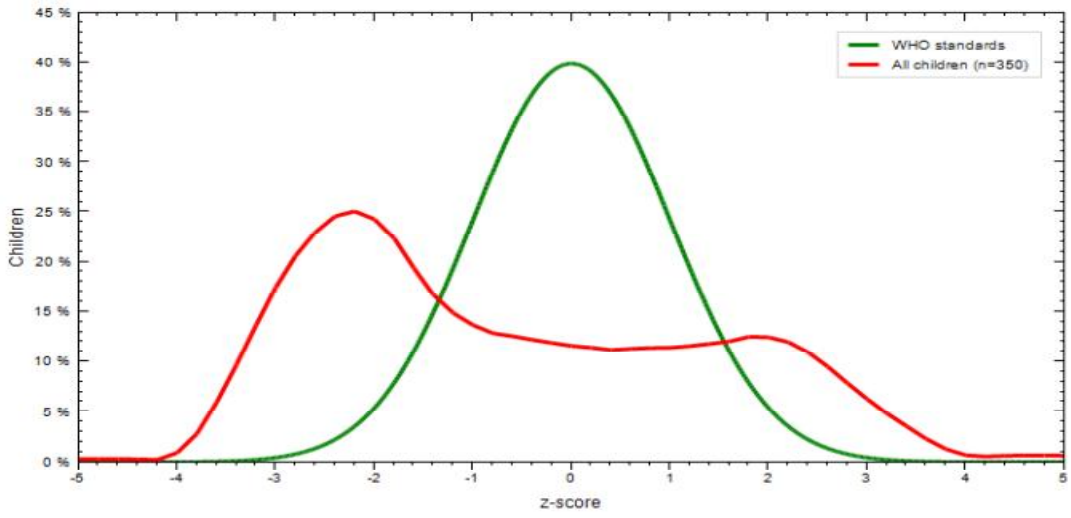

Fig. 4. Height for Age Z-score of diarrhoeic children (0-5years) in Kaduna

Table 2. Prevalence of low weight-for-length/height (wasting) by gender and age group in a sample of 350 diarrhoeic children in Kaduna State

Age range (Months)	Sex	N	wt/ht Z-Score Below -3SD n(%)	wt/ht Z-Score Below -2SD n(%)	Mean±SD
	Male	60	0(0.0)	8(13.3)	-0.74±1.41
≤12	Female	54	0(0.0)	5(9.3)	-0.33±1.34
Combined		114	0(0.0)	13(11.4)	-0.54±1.39
	Male	62	1(1.6)	25(40.3)	-1.60±1.09
13-24	Female	38	0(0.0)	15(39.5)	-1.48±1.10
Combined		100	1(1.0)	40(40.0)	-1.56±1.09
	Male	27	0(0.0)	13(48.1)	-1.56±1.04
25-36	Female	23	0(0.0)	9(39.1)	-1.29±1.43
Combined		50	0(0.0)	22(44.0)	-1.43±1.22
	Male	26	0(0.0)	3(11.5)	-0.16±1.27
37-48	Female	18	0(0.0)	1(5.6)	-0.23±1.21
Combined		44	0(0.0)	4(9.1)	-0.03±1.25
	Male	32	0(0.0)	5(15.6)	0.10±1.42
49-60	Female	10	0(0.0)	1(10.0)	0.29±1.56
Combined		42	0(0.0)	6(14.3)	0.14±1.44
	Male	207	1(0.5)	54(26.1)	-0.90±1.41
Grand Total	Female	143	0(0.0)	31(21.7)	-0.68±1.44
Combined		350	1(0.3)	85(24.3)	-0.81±1.43

X2 =0.894, P value=0.344

In this Table 2, the prevalence of wasting can be obtained and children who are below minus two standard deviations (-2 SD) and minus three standard deviations (-3 SD) from the median of the reference population are regarded as either wasted or severely wasted. Wasting indicates acute malnutrition. The highest prevalence of wasting across the age groups was observed in 25-36 months and the lowest observed amongst ages 37-48 months, with children that were severely wasted falling between age groups 13-24 months. Males also recorded a slightly higher prevalence (26.1%) in this category than females (21.7%).

Table 3 shows the distribution of the three malnutrition indices obtained from diarrhoeic children under five years of age in relation to location. It can be seen from the table that Kaduna South senatorial district, under which General Hospital Kafanchan falls, was mostly

affected nutritionally, as it recorded the highest prevalence in all three indices.

Table 4 shows the distribution of *E. coli* isolated according to age and gender. With respect to gender, the result shows that out of the 350 diarrhoeic stool samples obtained, 208 where from male subjects and 142 from female subjects. The females had a higher prevalence of 23.9% as against the males which was 20.2% but the difference in the distribution was not statistically significant (p =0.403, odds ratio = 0.804, CI= 0.481-1.342). With respect to age, the differences in the distribution observed were also not statistically significant within ages.

Table 5 shows the demographic factors considered in this study as, parent's level of education, mother's occupation and an estimated level of income. From the results obtained, there was a statistical significance (p-value = 0.026) in the distribution of differences obtained in the parent's level of education, in which children whose parents had Primary or no education at all had higher prevalence of 34.6%, children whose mothers were unemployed had a prevalence of 23.7% and 36.7% prevalence was obtained for those whose parents earned 10,000 and below. A statistically significant difference (p= 0.003) was observed amongst those whose earnings are ₦10,000 and below.

Table 6 shows the risk factors considered in this study include, source of water, type of water treatment, mode of feeding and type of toilet. In the source of water category, a prevalence of 25% was obtained for those whose source is river/stream, 25.6% obtained for those who did not employ any form of treatment for their water, 28% prevalence obtained for children whose mode of feeding is the feeding bottle and 25% prevalence obtained for those whose toilet is an open field. Although, the above listed risk factors are routes for contamination and infection, the results obtained shows that statistical significance was observed in the treatment of water as a risk factor (p = 0.012), where it can be seen that, not treating water before use could expose these children to risk of diarrhoeal infections.

Table 3. Prevalence of underweight, wasting and stunting amongst the diarrhoeic children with respect to region

Region	N	Wasting (wt/ht) <-3	<-2 (%)	Underweight (wt/age) <-3	<-2 (%)	Stunting (ht/age) <-3	<-2 (%)
Kaduna-Central (YDMH and GAGH)	180	0.6	22.8	2.2	14.4	0.0	35.0
Kaduna- North (GSMH and GHM)	124	0.0	20.2	2.4	7.3	0.8	30.6
Kaduna – South (GHK and KGH)	46	0.0	41.3	2.2	23.9	2.2	41.3
Total	350	0.3	24.3	2.3	13.1	0.6	34.3

Key: GSMH- Gambo Sawaba Memorial Hospital, GHM- General Hospital Makarfi, YDMH- Yusuf Danstoho Memorial Hospital, GAGH- Gomna Awan General Hospital, GHK- General Hospital Kafanchan, KGH- Kwoi General Hospital

Table 4. Prevalence of *E. coli* isolated from diarrhoeic stool of children under five years with respect to age and gender

Factor	No examined	No positive (%)	X^2	P. value
Gender				
Male	208	42(20.2)		
Female	142	34(23.9)	0.699	0.403
Age (months)				
≤12	114	31(27.2)	3.631	0.458
13 -24	100	21(21.0)		
25 -36	50	10(20.0)		
37 –48	44	7(15.9)		
49 –60	42	7(16.7)		
Total	350	76(21.7)		

Gender Odds Ratio= 0.804, CI= 0.481-1.342,
Key: x2-chi-square, p-value, (%) =Prevalence, No=Number

Table 5. Prevalence of *E. coli* isolated from diarrhoeic stool of under five children in relation to some demographic factors

Demographic factors	no examined	No positive (%)	X2	p-value
Level of Parent's Education				
None	10	3(30.0)	11.068	0.026*
Primary	52	18(34.6)		
Secondary	170	38(22.1)		
Tertiary	98	12(12.2)		
Adult Literacy	18	5(27.8)		
Mother's Occupation				
Unemployed	139	33(23.7)	1.071	0.899
Civil servant	53	12(22.6)		
Trader	75	16(21.3)		
Farmer	30	5(16.7)		
Others	53	10(18.9)		
Estimated Level of Income (₦)				
<5000	30	9(30.0)	16.068	0.003*
5001-10000	60	22(36.7)		
10001-20000	154	33(21.4)		
20001-40000	53	5(9.4)		
>40000	53	7(13.2)		
Total	350	76(21.7)		

Key: X^2-chi-square, p-value, (%) =Prevalence, No=Number, (*) = Statistically significant

Table 6. Prevalence of *E. coli* in relation to some risk factors associated with diarrhoea in children under five years

Risk factors (%)	Total examined	Positive	X2	p-value
Sources of water				
Pipe borne	125	28(22.4)	2.347	0.672
Well	142	33(23.2)		
Borehole	51	7(13.7)		
River/stream	4	1(25.0)		
Others	28	7(25.0)		
Treatment of water				
Boiling	37	3(8.1)	10.912	0.012*
None/Raw	258	66(25.6)		
Filtering	39	3(7.7)		
Others	16	4(25.0)		
Mode of feeding				
Personal plate	147	30(20.4)	3.087	0.214
Feeding bottle	93	26(28.0)		
Communal	110	20(18.2)		
Type of toilet				
Pit latrine	203	48(23.6)	1.353	0.717
Open field	12	3(25.0)		
Water closet	112	21(18.8)		
Others	23	4(17.4)		
Total	350	76(21.7)		

Key: x2-chi-square, p-value, (%) =Prevalence, No=Number,(*)=Statistically significant

Table 7 shows the prevalence of diarrhoea with respect to clinical symptoms and symptoms associated with diarrhoea such as, fever, blood in stool, number of episodes and duration in days were all taking into consideration in the course of this study. The subjects in this study who experienced diarrhoeal episodes of more than 7 times had a prevalence of 41.7 and 42.9% for those who had the symptoms for a duration of 4-6 days. The results obtained showed statistical

Table 7. Prevalence of diarrhoea with respect to clinical symptoms presenting in the children

Clinical	No examined	No positive (%)	X2	P-Value
Symptoms				
Fever				
Yes	211	49(23.29)	0.711	0.399
No	139	27(19.4)		
Bloody stool				
Yes	44	12(27.3)	0.915	0.339
No	306	64(20.9)		
No of Episodes				
≤3	141	27(19.1)	9.409	0.009*
4-6	173	34(19.7)		
≥7	36	15(41.7)		
Duration (days)				
≤3	321	66(20.6)	6.173	0.046*
4-6	21	9(42.9)		
≥7	8	1(12.5)		
Total	350	76(21.7)		

Key: X^2-chi-square, p-value,(*)=Statistically significant (%) =Prevalence, No= Number

Table 8. Prevalence of *Escherichia coli* isolated from diarrhoeic stool samples according to hospital location

Location	No of samples collected	Samples positive (%)	*X2*	p-value
GSMH	56	11(19.64)	22.192	0.000**
GHM	68	11(16.18)		
YDMH	83	29(34.94)		
GAGH	97	11(11.34)		
GHK	27	11(40.74)		
KGH	19	3(15.70)		
Total	350	76(21.7)		

X2=chi-square,p-value<0.05, (*)=Statistically significant, (%) =Prevalence, GSMH- Gambo Sawaba Memorial Hospital, GHM- General Hospital Makarfi, YDMH- Yusuf Danstoho Memorial Hospital, GAGH- Gomna Awan General Hospital, GHK- General Hospital Kafanchan, KGH- Kwoi General Hospital

significance in the differences in distribution in terms of number of episodes (p = 0.009) and the duration in days (p = 0.046).

Table 8 shows the distribution of *E. coli* isolates in the stool samples, with respect to the hospital location from where the samples were obtained. There was statistical difference observed in the prevalence obtained from the various hospitals (p >0.05). General Hospital Kafanchan, had the highest percentage prevalence of 40.74%, while those in Yusuf Danstoho Memorial Hospital had a prevalence of 34.94%. The prevalence of *E. coli* infection on patients in Gambo Sawaba Memorial Hospital was 19.64%, General Hospital Makarfi (16.18%), General Hospital Kwoi had (15.79%) and Gomma Awan General Hospital had (11.34%).

4. DISCUSSION

Prevalence of the *E. coli* isolates in relation to risk factors indicates that twenty five percent (25%) was obtained for children, whose source of drinking water is from rivers and streams, showing high contamination of these untreated waters by *E. coli*. This is in agreement with work done by [16] in Kaduna. It can also be tied to the high percentage of *E. coli* in the stools of the children who are given water from wells, since these raw waters are the surface waters treated for drinking, irrigation and recreation. There is also poor sewage disposal which leads to the rains washing these surface waters into rivers and streams. In this study, 7.4% of the children presented with diarrhoea showed no signs of dehydration, and this was second to the 9.2% obtained in moderately dehydrated cases which

follow the trend of reports made, in which majority of the children did not show any signs of dehydration. The severity of dehydration obtained, which was 5.4%, tallies with the 5.2% obtained by [17]. The higher rate of *E. coli* being isolated from females (23.9%) more than males (20.2%) correlates the result obtained by [12], though disagreeing with the reports of [18,19] in relation to gender. However there is an agreement on the necessity for prolonged breastfeeding of children until about age one to reduce their risk of infection, though this can be only achieved if the mother takes strictly to personal hygiene.

The odds of having diarrhoea was not significantly associated with sex (females, 23.9% and males, 20.2%). This agrees with a study done in a teaching hospital in Nigeria where males affected were 54% and female 40%, with the odds of having diarrhoea not significantly related to sex [20], but disagrees with a previous study carried out in Kaduna, in which 156 males were affected, as against the 114 females affected [21]. A study done on the children living in urban slums in Salvador, Brazil on incidence of diarrhoea revealed that male children were associated more with episodes of diarrhoea as compared to their female counterparts [22]. A similarity was also reported in a study conducted by [23] in Lagos, Nigeria. A similar study done in Denmark found that being a male, one stands a chance of getting diarrhoea [23], and this contradicts our finding in this study. Children in the age group less or equal to 1year had the highest prevalence of diarrhoea followed by those in age group 1 to 2years and this agrees with the reports of [24,25,26,27] on the prevalence of diarrhoea with respect to age, attributing this high prevalence to changes like the introduction of contaminated weaning foods and risk of ingesting contaminated materials while crawling. [28,29,30] had a contrary result from this study, as regards diarrhoea and its relationship with age group. [31] reported ages 0-5years as the most afflicted with diarrhoeal diseases in Abuja. According to a study done in Saudi Arabia by Mazrous and others, incidence of diarrhoea was significantly associated with fathers‘ occupation ($p = 0.0011$) but no significant association was found between the incidence of diarrhoea and parents‘education [26].

In this study we obtained an association between the parent‘s level of education, mother‘s occupation, estimated level of income and diarrhea. [25] also reported an association between the parent‘s level of education and diarrhoea, and this disagrees with our findings. [32] reported that the risk of diarrhoea in children whose mothers had only primary education is 2.2 times higher than those whose mothers had higher level of education. Comparing with primary education, higher levels of education of mothers, such as secondary and tertiary, are associated with decreased risk of diarrhoea. This is contrary to our findings in which children whose mothers have only secondary education were more at risk of the disease. They also reported low income in particular and poor economic status in general as associated with increased diarrhea. This also agrees with our findings. The nutritional status of the subjects used in this study showed underweight percentage as 13.1%, higher in prevalence and disagreeing with work done in Kaduna (11%), Niger (7%) and Anambra (0.8%) states which reported lower rates of underweight in the children, suggesting that enough has not been done in the area of eradication of childhood malnutrition. It has long been recognized that there is an intimate relationship between diarrhoeal disease and undernutrition in pediatric populations in developing countries [33,34]. The results obtained in this study on the prevalence of underweight, stunting and wasting with respect to location (Kaduna-central, Kaduna-north and Kaduna-south senatorial districts) with Kaduna-south senatorial district having the highest prevalence in all three indices, agrees with reports obtained from previous studies conducted in Anambra [34].

The rate of stunting amongst the children was also on the high side with 34.3% and this was higher than the 1.1% reported by [34], showing that the population is retarded in linear growth. This reflects chronic malnutrition accumulated during pre or post natal periods due to poor nutrition and poor health [35,36,37] and this high rate of stunting only goes to show that the children are more at risk of having low mental development, reduced work capacity by the time they attain adulthood and increased obstetric risks [38]. Also the rate of stunting (34.3%) reported in this study indicates a rise towards the 42% stunting rate of National average rate of stunting recorded by the Nigerian Food Consumption and Nutrition Survey [39]. This study presents a higher prevalence of 34.3%, for stunting amongst the test subjects, as against the reported expected global prevalence of stunting which was supposed to reduce from

26.7% to 21.8% by the year 2010, [36]. Available data from the United Nations Children's Fund (UNICEF) estimates that the prevalence of childhood stunting in Nigeria at about 41% making it a major public health problem in the country, and needing quick attention [14]. [40] reported that 48.7% of under five children in Kaduna State are stunted. This is more than the 34.3% obtained in this study and although showing a lot of decrease, it is also still on the high side and there is a need for more action to be taken to fully combat this menace, so as to achieve the standard nutritional status possible for these children. The prevalence of 34.3% obtained in this study for stunting agrees with the report of [40] about childhood stunting in Nigeria being higher in the Northern States and further buttressing the point that these variations could be attributed to special causes, noting the fact that Northern States have higher poverty rates and health deprivation index than other states.

The result obtained in this study reflects that 24.3% of the population sampled were wasted (thinness or a severe process of weight loss) and the prevalence decreased as the age increased, this is in consonance with the 24.9% prevalence reported by [34] and this could be due to poor access or scarcity to staple foods due to increased poverty levels. This study records a much higher rate of wasting (24.3%), an indication of chronic malnutrition than that reported in 2006 by the Nigerian Demographic and Health Survey (DHS) which indicated that 14% of Nigerian children aged 0-59months were wasted [41] and studies conducted by [33] also showed Kaduna State as having a much lower rate of wasting (10.38%) in children of the same age (0-5 years). [42] also reported a 7% rate of wasting in children in Zaria city, which is lower than the 24.3% prevalence of wasting obtained in this study. Another prevalence of 3.7%, also lower than our own findings was reported by [43] as the prevalence obtained in a study conducted in Northern Nigeria. From this study, we see that the most prevalent form of malnutrition observed in the State was stunting (34.3%).

The data obtained shows the percentage prevalence of children classified as malnourished according to height-for-age, weight-for-height and weight-for-age indices by age and gender. Generally, males in this study had slightly higher mean weight and height than the females in this study. This is contrary to reports on mean weight and height of males and females in another study on Northern Nigeria by [43]. The results obtained in this study show that 24.3% of the children under five years of age are considered to be too thin for their age or wasted and 0.3% are severely wasted. It also shows wasting hitting a very high peak between age 2-3years with a percentage prevalence of 44%. This is higher than the 18% and 9% respectively reported for wasted and severely wasted, and a peak at age 9-11 months (27) reported in the [41] survey for children in the same age range as well as the 2.4% prevalence of wasting reported by [44]. The results obtained in this study for wasting indicate that 24.3% fell below the -2 and -3 standard deviation cut-offs for World Health Organization reference standard, making them severely wasted for their ages. The results obtained were also higher than the 3.7% prevalence for wasting obtained in a previous study conducted in Kaduna by [43]. With respect to the percentage prevalence of weight-for-age (underweight) of the said children, a total of 13.1% was considered as underweight and 2.3% as severely underweight, with underweight at the peak of age 1-2years with a prevalence of 18%. This was less than the 28% underweight and 12% severely underweight, with the proportion of children underweight increasing sharply to 29% at age 6-8months [41] and the 15.6% prevalence reported by [43] but higher than the 10.3% prevalence reported in a study conducted in Jos-Plateau [44]. Approximately 34.3% of the children were classified as being too short for their age or stunted, and 0.6% were severely stunted and peaks at age 3-4years with a prevalence of 50%. This corresponds with the [41] survey, with data showing 37 percent prevalence reported of children under the age of 5 considered to be too short for their age or stunted and 21% as severely stunted and peaking. [43] reported a 44.9% prevalence of stunting in children under five years in Kaduna and reports from a study in Jos-Plateau showed an 11.1% prevalence of stunting in pre-school aged children [44].

The anthropometric data for wasting, stunting and underweight in children under five years report on the trends in nutritional status of children under five years of age from 2003-2013 [41]. The mean Z-scores for stunting (-2.4), wasting (-1.4), and underweight (-2.3), obtained in this study were all negative values and less than zero, suggesting that the distribution of an index has shifted downward, showing that most or all of the children suffer from undernutrition relative to the reference population and this could be due to poverty and poor health in the state.

5. CONCLUSION

The dangers of diarrhoeal diseases and its effect on the nutritional status of children under five years of age have long been established. To this end, the following conclusions have been drawn from this study.

1. The presence of the three indices of malnutrition (stunting, wasting and underweight) reflect a high level of undernutrition and a case of current nutritional problems in the study population, posing serious public health issues.
2. The significant results recorded in the study population for demographic factors (level of parent's education, mothers occupation and estimated level of income) and risk factors (source of water, treatment of water, mode of feeding and type of toilet) indicate serious issues of poor hygiene and poor health.

6. RECOMMENDATIONS

The following recommendations are made from the findings obtained from this study

I. Personal and environmental hygiene strategies should be embarked upon and maintained by parents and society in general.
II. Government should establish programs that are centered on the fortification and supplementation of foods and making them readily available especially in rural areas, and if possible free of charge for the low income earners who reside more in these rural areas. This would help improve the nutritional status of children, thereby reducing the incidence of diarrhoeal diseases which have so far been established to be bidirectional.
III. Awareness creation and perception on the dangers of diarrhoeal diseases should be intensified as it is one thing to be aware and another to believe that it actually does exist and is a killer.
IV. Agent–specific risk factors identified as existent can now be monitored and eradicated or avoided.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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