



# **A Socio-demographic Comparison of Malnutrition and Malaria Prevalence among Primary School Children in Gombe State Nigeria**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. The article was part of author MD's thesis work. It was supervised by author SOA as the main supervisor and author HOS as co-supervisor. Author MD designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors SOA and HOS managed the analyses of the study, corrected the manuscripts and managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Background:** Despite the complex nature of inter-relationship between malnutrition and malaria, there has been continued emphasis and need to further re-examine the twin issues side-by-side with a view to forging an integrated public health care strategy.

**Objective:** This study aimed to make comparison and possibly add to the increasing body of evidence on the relationship between malnutrition and malaria among apparently healthy primary school children in Gombe state, Nigeria.

**Methodology:** Between the months of March and June 2019, a total of 745 school children aged 6 to 15 years were studied using a cross sectional design. Selection of the children was done by means of a multi-stage sampling technique, from 12 public and 6 private schools in 6 Local

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Government Areas (LGAs) of the state. Levels of malnutrition among the subjects were measured using three anthropometric indices, namely; stunting (Height-for-age Z-scores, HAZ), underweight (Weight-for-age Z-scores, WAZ) and wasting (Weight-for-height Z-score, WHZ); while screening for malaria infection was done using rapid diagnostic test (RDT) kits. The WHO AnthroPlus and IBM SPSS version 21 statistical software packages were used for data analysis. Descriptive statistics was employed to summarize research findings, while chi square statistics was used to compare proportions at 0.05 alpha significance level.

**Results:** About half (50.9%) of the subjects were boys while girls constitutes the rest 49.1%. The overall prevalence of stunting was 22.5% (19.6 - 25.6), underweight 20.9% (18.1 - 23.9), and wasting, 16.8% (13.7 - 20.4). Furthermore, malaria infection prevalence among the subjects was 13.6%. Age group and sex were found to be significantly associated with malnutrition (underweight or stunting or both) but they weren't with malaria. On the other hand, while place of residence and level of education were significantly associated with malaria, they were not associated with malnutrition. Overall, both malnutrition and malaria were found to be significantly associated with type of school, senatorial district, tribe, religion, occupation of father, occupation of mother and level of education of mother. On the whole, malnutrition and malaria were significantly associated.

**Conclusion:** In light of the above epidemiological pattern of distribution and associations between the two public health problems, the design of intervention programmes should integrate approaches targeted at the two issues among primary school children.

*Keywords: Socio-demographic, malnutrition, malaria, comparison, prevalence, school children.*

## 1. INTRODUCTION

Malnutrition and malaria are among the leading causes of morbidity and mortality among children in developing countries [1,2]. Though the relationship between the two conditions still remains controversial, there are scores of extant literature attesting to the existence of epidemiological association between malnutrition and infectious diseases generally [3-6]. The nature of such association has usually been considered to be a synergistic one - malnutrition could increase susceptibility to infection such as malaria, while episodes of infection or malaria can also precipitate nutritional deficiencies [7-9]. It is thought that malnutrition might predispose children to malaria infection because of the poor immune response that is associated with nutritional depletion [5]. Hence, there has been suggestions and efforts to design and deploy integrated intervention programmes to tackle the two issues *pari passu* [10,11].

Despite conflicting reports on the direction or nonexistence of association between malnutrition and malaria, most evidences affirm the fact that the latter is an inter-current infection that could further aggravate the problem of malnutrition [12]. In a cohort study of children less than 15 years in Brazil, Alexandre et al. [11] demonstrated that children who suffered from malaria during follow-up had poor anthropometric indices, nevertheless when compared to baseline, stunting appeared to be protective

against malaria during follow-up. In the northern region of Cameroon, Sakwe et al. [13] established that there was a significant bi-directional association between malaria and malnutrition. Oldenburg et al. [5] observed that malaria infection was common among children that were treated for uncomplicated severe acute malnutrition in Niger. They further deduced that malaria infection may impair height gain. However, an earlier study conducted in Muea, South West Cameroun reported no significant association between the two public health problems [12]. Again, a study of children living on the coast of Kenya examined the incidence of malaria in wasted and stunted children, and reported that there was no association between malaria and malnutrition [14]. During a seasonal transmission in a rural area of the Gambia, a cohort study of children under five showed that malnutrition was not associated with an increased risk of malaria [15]. In the same vein, Charchuk et al. [16] in Southern Sudan found no association between malnutrition and malaria. However, The World Health Organization's Comparative Risk Assessment Project affirm that children with moderate and severe under-weight had an increased, though not statistically significant risk of malaria attack compared with those who had improved nutritional status [17].

Although there is no gainsaying the fact that substantial progress has been recorded in the fight against malaria and malnutrition, over the past two decades both conditions have continued

to take their toll on hundreds of thousands of children in low resource countries like Nigeria [18]. In West Africa and specifically Nigeria where malnutrition is prevalent and malaria is holo-endemic it is admitted that there is a paucity of data comparing or linking malnutrition and malaria [19,20]. The forgoing undoubtedly justifies the need for more studies that examines the relationship between the two public health issues (malnutrition and malaria). This would enable a side by side comparison of the prevalence of both conditions especially among a vulnerable population like school children under varying socio-demographic environments. This study therefore aims to determine the prevalence and compare the burdens of malnutrition and malaria based on the socio-demographics of primary school children in Gombe State, Nigeria.

and Adamawa states to the east. Based on the 2006 national census Gombe state has an estimated population of 2.36 million and land area of 20,265 square kilometers [21]. There are 11 Local Government Areas (LGAs) that make up the state (see Fig. 1). The climatic condition of Gombe state is characterized by two seasons, namely; the dry season spanning through November to March and the rainy season which begins around April and ends around October with rains starting mostly around April/May and ends by October/November, and with 684.56mm mean annual rainfall in the southern zone and 650.27mm in the north (in 6-8 months in the south and 4-6 months) [22]. The main staple foods cultivated include rice, maize, beans, millet and guinea corn. The state covers a total area of about 20,265 sq km [22].

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Located in the North-Eastern region of Nigeria, Gombe state lies between latitudes 9°30' and 12°30'N, longitudes 8°45' and 11°45'E. It is bounded by Bauchi state to the west, Yobe state to the north, Taraba state to the south and Borno

### 2.2 Study Design

The study was designed to be a comparative cross sectional survey.

### 2.3 Population of Study

The Study population comprised selected primary school pupils aged 6-15 in Gombe state.

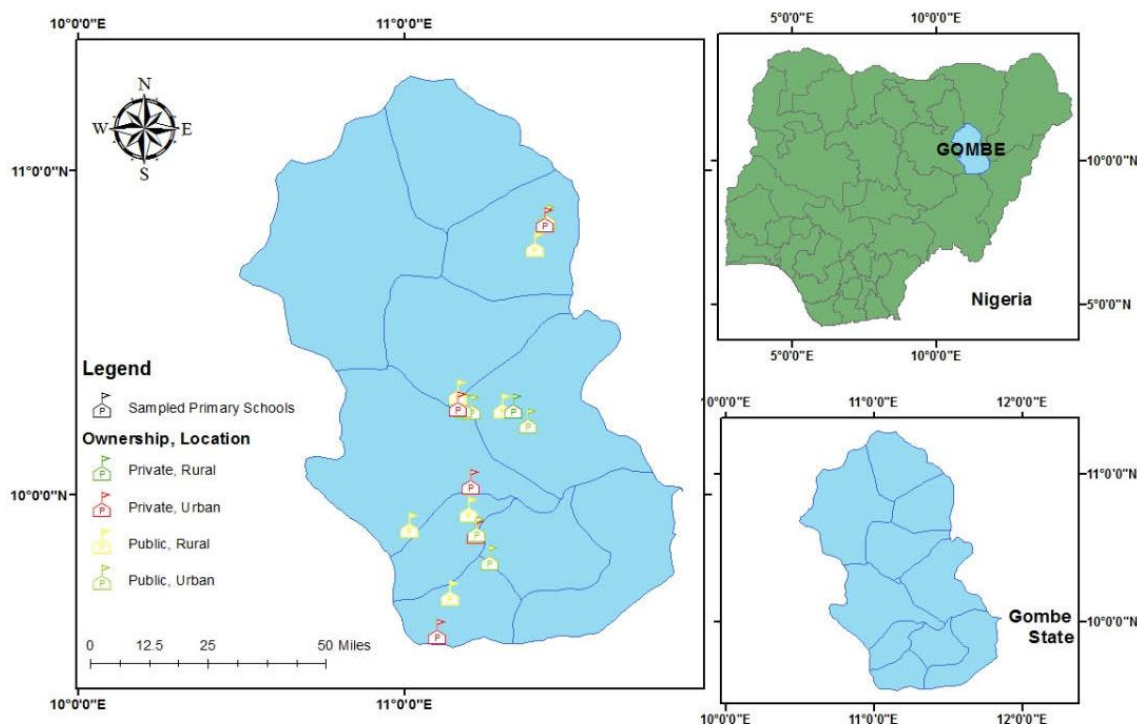


Fig. 1. Base map of Gombe state showing the 11 LGAs and the study sites [23]

## 2.4 Inclusion Criteria

All pupils male or female aged 6 - 15 who were registered in the selected primary schools in Gombe state, who agreed to participate in the study. Again, the subjects must have resided in the state for at least one year.

## 2.5 Exclusion Criteria

All school children not within the age group of 6 - 15 years who were not registered in the selected primary schools in Gombe state or pupils who did not agree to participate in the study during data collection. Subjects who may not have resided in the state for not less than a year were also excluded.

## 2.6 Sample Size Determination

The sample size for this study was determined using the sample size formula for comparing two proportions [24].

$$n = [P1(1 - P1) + P2(1 - P2)] (Z\alpha/2 + Z\beta)^2 / (P1 - P2)^2$$

Where:

n: required sample size

P1: estimated proportion for malnutrition and malaria in urban areas (about 12%) [25,26].

P2: estimated proportion for malnutrition and malaria in rural areas (comparison group) in the North East (about 36%) [25,26].

$\alpha$ : level of statistical significance.

Z $\alpha/2$ : Represents the desired level of statistical significance (usually 1.96 for  $\alpha = 0.05$ ).

Z  $\beta$ : Represents the desired power (estimated to be 0.84 for 80% power).

n for each group x 2= total sample (i.e. for the 2 groups).

The calculations ensured that the minimum detectable difference in malaria infection among the school children in rural and urban areas was 10%.

The calculated minimum sample size for the study was 295 pupils from urban schools and 295 from rural schools. Put together a minimum sample size of 590 was determined. However, this was adjusted upwards to a final sample size of 748, though only 745 were eventually found usable.

## 2.7 Sampling Technique

Multistage sampling technique was employed to select the subjects for this study. A recent

estimate puts the total number of Primary schools in Gombe state at 1, 914. This is made up of 573 private and 1, 341 public primary schools [27]. This means that private and public schools are in a ratio of 1:2.3. As such, 6 private and 12 public primary schools were randomly selected from both urban and rural areas of the state. And from the selected schools a sample of 745 children were selected in stages. Two LGAs were selected from each senatorial district using simple random sampling. In the next stage three primary schools - a public primary school from a rural area and a public and a private school from an urban or suburban area - were selected per LGA. This amounted to a total of 18 schools that were selected. In each primary school (stage three) four classes were randomly selected from among any of primary one to primary six. In the final stage (stage four), at least 10 subjects were systematically picked from each of the 4 classes (40). At any stage the subjects were free to drop out of the study.

## 2.8 Data Collection Methods

The methods used for data collection include oral interview, Malaria Rapid Diagnostic Test (mRDT) screening and anthropometric measurements for malnutrition. The exercise spanned through March to June, 2019.

### 2.8.1 Oral interview

An oral interview was first conducted with each of the subjects to collect socio-demographic and other information related to malnutrition and malaria, using a validated questionnaire/data collection template.

### 2.8.2 Malaria Rapid Diagnostic Test (mRDT) screening

The subjects were screened for malaria parasites using Rapid Diagnostic Test (RDT) kits. The kits were the SD BIOLINE Malaria Ag P.f (HRP-II)™ which uses qualitative techniques to detect histidine-rich protein II antigen of *Plasmodium falciparum* in human whole blood [25]. Peripheral blood samples from finger pricks of the school children were taken by means of micropipettes. The samples were dispensed into the small well of the test kits and 2 drops of assay buffer were then added. Within a period of 10-15 minutes the readings were taken. A positive result was detected by the presence of two color bands in the result window, while a negative result was indicated by one band. All pupils that tested positive were treated with artemisinin-based

combination therapy (ACT) in accordance with WHO guidelines [28].

### 2.8.3 Anthropometric measurements for malnutrition

Anthropometric measurements were then carried out on all the subjects using standard procedures as described by Jelliffe [29]. The instruments used include: portable wall measuring rod (stadiometre), calibrated in centimeters for measurement of height; HANA bathroom weighing scale with readings taken to the nearest 0.5kg. To validate the instrument and ensure reliability, a pilot study was carried out in one of the public primary schools not selected for the main study using the same instruments and procedures that were later used during the main data collection exercise.

## 2.9 Data Analysis

Out of a total of 748 instruments retrieved, 745 were assessed and found to be complete and usable. Data analysis was done using IBM Statistical Package for Social Sciences (SPSS) version 21 (SPSS Inc. Chicago, IL, USA). Both descriptive and inferential statistics were used to summarize and make inferences on the data. Chi square ( $\chi^2$ ) and odd ratio (OR) were computed and used to compare proportions and estimate risks of malaria infection among the subjects. Findings were considered significant at P-values less than 0.05. Data were presented in tables and charts. The indicators of children's nutritional status that were used for this study included stunting, underweight, and wasting which were obtained from anthropometric measurements (height and weight) and their corresponding ages from oral interview. Height for age z-score (HAZ), weight for age z-score (WAZ) and weight for height z-score (WHZ) were calculated using WHO AnthroPlus software [30,31].

## 3. RESULTS AND DISCUSSION

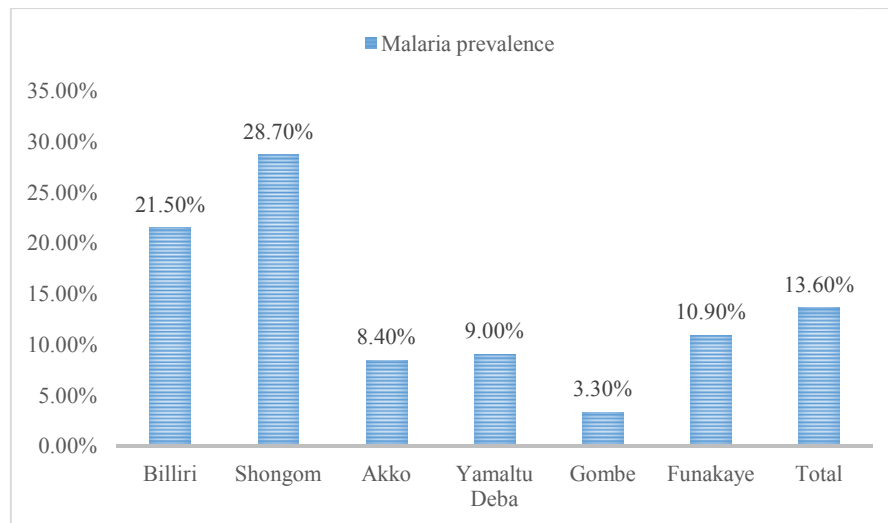
### 3.1 Results

The overall simple prevalence rate of malaria infection among the study subjects was 13.60%, but when segregated according to the six selected LGAs there were different rates (Fig. 2). The highest prevalence was recorded in Shongom LGA (28.70%) followed by Billiri LGA (21.50%), all in the southern senatorial districts of the state. The next was Funakaye LGA (10.90%) in the far northern part of the state, while

Yamaltu Deba LGA (9.00%) and Akko LGA (8.40%) in the central zone of the state followed. From behind Gombe LGA (3.30%) had the lowest malaria prevalence.

Based on weight-for-age z-scores (WAZ) the overall (20.9%, 18.1 - 23.9), moderate (18.8%, 16.2 - 21.8) and severe (2.0%, 1.2 - 3.3) prevalence rates of underweight were obtained, with higher rates recorded among the school boys [overall (26.3%, 22.1 - 30.9), moderate (23.6%, 19.6 - 28.1) and severe (2.7%, 1.4 - 4.8) prevalence rates at 95% confidence intervals] (Table 1). Stunting rates were computed based on height-for-age z-scores (HAZ) yielding overall (22.5%, 19.6 - 25.6), moderate (17.1%, 14.6 - 20.0) and severe (5.4%, 4.0 - 7.2) rates among the subjects (Table 2). Again, boys exhibited slightly higher rates of overall (23.1%, 19.1 - 27.6) and severe (6.6%, 4.5 - 9.6) stunting; while moderate stunting was higher (17.8%, 14.2 - 22.0) among girls. The prevalence rates of acute malnutrition (wasting) based on weight-for-height z-scores (WHZ) were; overall (16.8%, 13.7 - 20.4), moderate (12.7%, 10.0 - 16.1) and severe (4.0%, 2.6 - 6.2). Boys showed slightly higher overall (16.8%, 12.7 - 21.9) and severe (4.7%, 2.7 - 8.0) wasting rates, while moderate figures were slightly higher (13.5%, 9.6 - 18.7) among girls.

From the results (Table 4 and Table 5) testing positive or negative for malaria infection may not be associated with underweight ( $\chi^2 = 0.000$ ,  $df = 1$ ,  $P = 0.997$ ,  $OR = 0.999$ ,  $CI = 0.596-1.675$ ) and wasting ( $\chi^2 = 2.259$ ,  $df = 1$ ,  $P = 0.133$ ,  $OR = 0.514$ ,  $CI = 0.213-1.241$ ,  $F\text{-Exact} = 0.193$ ) forms of malnutrition. On the other hand stunting was found to be associated with malaria infection (Table 6) - there was a higher prevalence of stunting (31.7%) among children that tested positive for malaria and about 2 times risk than those that tested negative ( $\chi^2 = 5.770$ ,  $df = 1$ ,  $P = 0.016$ ,  $OR = 1.749$ ,  $CI = 1.104-2.770$ ). Comparatively age group and sex were significantly ( $p < 0.05$ ) associated with malnutrition (underweight or stunting or both) but they weren't with malaria (Table 7). On the other hand, while place of residence and level of education were significantly ( $p < 0.05$ ) associated with malaria, they were not associated with malnutrition. On the whole, both malnutrition and malaria were found to be significantly associated with type of school, senatorial district, tribe, and religion. Both conditions were also associated with occupation of father, occupation of mother and level of education of mother.



**Fig. 2. Prevalence of malaria infection among school children in six selected LGAs of Gombe state**

**Table 1. Prevalence of underweight based on weight-for-age z-scores by sex**

	All n = 743 (%) at 95% CI	Boys n = 377 (%) at 95% CI	Girls n = 366 (%) at 95% CI
Prevalence of underweight (<-2 z-score)	155 (20.9 %) (18.1 - 23.9)	99 (26.3 %) (22.1 - 30.9)	56 (15.3 %) (12.0 - 19.3)
Prevalence of moderate underweight (<-2 z-score and >=-3 z-score)	140 (18.8 %) (16.2 - 21.8)	89 (23.6 %) (19.6 - 28.1)	51 (13.9 %) (10.8 - 17.9)
Prevalence of severe underweight (<-3 z-score)	15 (2.0 %) (1.2 - 3.3)	10 (2.7 %) (1.4 - 4.8)	5 (1.4 %) (0.6 - 3.2)

**Table 2. Prevalence of stunting based on height-for-age z-scores and by sex**

	All n = 743 (%) at 95% CI	Boys n = 377 (%) at 95% CI	Girls n = 366 (%) at 95% CI
Prevalence of stunting (<-2 z-score)	167 (22.5 %) (19.6 - 25.6)	87 (23.1 %) (19.1 - 27.6)	80 (21.9 %) (17.9 - 26.4)
Prevalence of moderate stunting (<-2 z-score and >=-3 z-score)	127 (17.1 %) (14.6 - 20.0)	62 (16.4 %) (13.0 - 20.5)	65 (17.8 %) (14.2 - 22.0)
Prevalence of severe stunting (<-3 z-score)	40 (5.4 %) (4.0 - 7.2)	25 (6.6 %) (4.5 - 9.6)	15 (4.1 %) (2.5 - 6.7)

**Table 3. Prevalence of acute malnutrition based on weight-for-height (wasting) z-scores and by sex (n=471)**

	All n = 471 (%) at 95% CI	Boys n = 256 (%) at 95% CI	Girls n = 215 (%) at 95% CI
Prevalence of global malnutrition (<-2 z-score)	79 (16.8 %) (13.7 - 20.4)	43 (16.8 %) (12.7 - 21.9)	36 (16.7 %) (12.3 - 22.3)
Prevalence of moderate malnutrition (<-2 z-score and >=-3 z-score)	60 (12.7 %) (10.0 - 16.1)	31 (12.1 %) (8.7 - 16.7)	29 (13.5 %) (9.6 - 18.7)
Prevalence of severe malnutrition (<-3 z-score)	19 (4.0 %) (2.6 - 6.2)	12 (4.7 %) (2.7 - 8.0)	7 (3.3 %) (1.6 - 6.6)

**Table 4. Association between malaria and Underweight (n=745)**

Malaria (RDT result)	Malnutrition (using WAZ score)		Total
	Underweight (WAZ score <-2)	Normal (WAZ score -2+)	
Positive	21 (20.8%)	80 (79.2%)	101 (100.0%)
Negative	134 (20.8%)	510 (79.2%)	644 (100.0%)
Total	155 (20.8%)	590 (79.2%)	745 (100.0%)

$\chi^2 = 0.000$ ;  $df = 1$ ;  $P\text{-value} = 0.997$ ;  $OR = 0.999$  ( $CI: 0.596\text{-}1.675$ ) Fisher's Exact = 1.000

**Table 5. Association between malaria and wasting (n=471)**

Malaria (RDT result)	Malnutrition (using WHZ score)		Total
	Wasted	Normal	
Positive	6 (7.6)	73 (92.4)	79 (100.0)
Negative	54 (13.8)	338 (86.2)	392 (100.0)
Total	60 (12.7)	411 (87.3)	471 (100.0)

$\chi^2 = 2.259$ ;  $df = 1$ ;  $P = 0.133$ ;  $OR = 0.514$ ;  $CI = (0.213\text{-}1.241)$ ;  $F\text{-Exact} = 0.193$

**Table 6. Association between stunting and malaria by mRDT (n=745)**

RDT result/MP	Malnutrition (using HAZ score)		Total
	Stunted	Normal	
Positive	32 (31.7%)	69 (68.3%)	101 (100.0%)
Negative	135 (21.0%)	509 (79.0%)	644 (100.0%)
Total	167 (22.4%)	578 (77.6%)	745 (100.0%)

$\chi^2 = 5.770$ ;  $df = 1$ ;  $P = 0.016$ ;  $OR = 1.749$ ;  $CI = (1.104\text{-}2.770)$ ;  $F\text{-Exact} = 0.021$

### 3.2 Discussion

The findings of this study showed relatively lower rates of malaria infection among the school children compared to findings from other parts of Nigeria and the sub-Saharan African (SSA) region [32-35]. This might be partly due to the fact that most part of the months of March-May/June within which the survey was conducted was dry season which coincides with the low malaria transmission period when the climatic conditions do not favour the sustenance of the malaria vector (female anopheles mosquito) breeding sites. The differential pattern of malaria infection prevalence among the subjects from different LGAs and ecological zones of the state, reflects the rainfall pattern which increases with decrease in latitude [22,36].

Based on the three indicators of nutritional status the rates of stunting, underweight and wasting among the school children were 22.5%, 20.9% and 16.8% respectively. These rates are slightly higher than those of a nationwide survey of the health of schoolchildren (aged 6-15 years) in Chad which revealed stunting, underweight and wasting rates of 18.7%, 16.5% and 4.6% respectively [37]. Contrariwise, the findings of this study is much lower were than the findings of

Simeon et al. [38] who reported overall prevalence of underweight, stunting and overweight among school age children from Anambra state, South East Nigeria; as 10.7%, 1.9% and 4.1% respectively. When compared with an earlier work among primary school children aged 5-15 in Gombe metropolis [39], this study reports higher stunting rates (22.5% vs. 18.4%), lower underweight (20.9% vs. 26.6%) and slightly lower wasting (16.8% vs. 17.7%). Similarly male children exhibited more stunting and underweight, while girls were more wasted. This gender bias in the burden of malnutrition could possibly be a reflection of the culture of girl child's intimacy with the mother and assumption of more domestic roles including cooking and hence more access to food than the male child who would normally assume outdoor masculine duties likes assistance of the father with farm and field chores. However, the scenario is quite worrying as about eight years later the situation got worse for stunting and slightly lower for underweight and wasting. The United Nation Standing Committee on Nutrition (UNSCN) had posited that prevalence of acute malnutrition between 5-8% indicates a worrying nutritional situation, and prevalence greater than 10% corresponds to a serious situation [40].

**Table 7. A Comparison of malnutrition (Underweight and Stunting) and Malaria (n=745)**

SN	Variable/ Category	Malnutrition				Malaria	
		Underweight		Stunting		mRDT	
		-2 SD	$\chi^2$ /p-Value	-2 SD	$\chi^2$ /p-Value	Positive	$\chi^2$ /p-Value
1	Age group						
	<= 9	36 (11.7%)		40 (13.0%)		34 (11.1%)	
	10 - 12	73 (21.9%)		86 (25.8%)		54 (16.2%)	
	13+	46 (43.8%)		41 (39.0%)		13 (12.4%)	
	Total	155 (20.8%)	49.334/ 0.000*	167 (22.4%)	34.48/0.000*	101 (13.6%)	3.747/0.154
2	Sex (female/male)						
	Male	99 (26.1%)		87 (23.0%)		57 (15.0%)	
	Female	56 (15.3%)		80 (21.9%)		44 (12.0%)	
	Total	155 (20.8%)	13.232/ 0.000*	167 (22.4%)	0.129/0.0720	101 (13.6%)	1.447/0.229
3	Place of residence						
	Rural	66 (22.8%)		72 (24.8%)		65 (22.4%)	
	Urban	89 (19.6%)		95 (20.9%)		36 (7.9%)	
	Total	155 (20.8%)	1.099/ 0.294	167 (22.4%)	1.588/0.208	101 (13.6%)	31.783/ 0.000*
4	Type of school						
	Public	123 (24.6%)		136 (27.3%)		91 (18.2%)	
	Private	32 (13.0%)		31 (12.6%)		10 (4.1%)	
	Total	155 (20.8%)	13.552/0.000*	167 (22.4%)	20.342/0.000*	101 (13.6%)	28.237/0.000*
5	Senatorial district						
	South	31 (12.8%)		60 (24.7%)		61 (25.1%)	
	Central	54 (21.3%)		44 (17.4%)		22 (8.7%)	
	North	70 (28.1%)		63 (25.3%)		18 (7.2%)	
	Total	155 (20.8%)	17.666/0.000*	167 (22.4%)	5.588/0.061	101 (13.6%)	41.252/0.000*
6	Tribe						
	Hausa/Fulani	100 (30.8%)		86 (26.5%)		34 (10.5%)	
	Tangale/Waja/ etc	15 (8.7%)		36 (20.8%)		28 (16.2%)	
	Tera/Kanuri/Bolewa	11 (10.8%)		8 (7.8%)		5 (4.9%)	
	Others-Yoruba/Igbo etc	29 (20.0%)		37 (25.5%)		34 (23.4%)	
	Total	155 (20.8%)	41.317/0.000*	167 (22.4%)	16.573/0.001*	101 (13.6%)	22.302/0.000*



SN	Variable/ Category	Malnutrition				Malaria	
		Underweight		Stunting		mRDT	
		-2 SD	$\chi^2$ /p-Value	-2 SD	$\chi^2$ /p-Value	Positive	$\chi^2$ /p-Value
7	Religion						
	Christianity	33 (9.9%)		61 (18.2%)		57 (17.0%)	
	Islam	122 (29.8%)		106 (25.9%)		44 (10.7%)	
	Total	155 (20.8%)	44.334/0.000*	167 (22.4%)	6.195/0.013*	101 (13.6%)	6.211/0.013*
8	Occupation of father						
	Farmer/artisan/Trader	71 (21.3%)		91 (27.2%)		64 (19.2%)	
	Civil Servant/Banke etc	54 (19.0%)		48 (16.9%)		23 (8.1%)	
	Top Business man etc	26 (21.8%)		27 (22.7%)		12 (10.1%)	
	Total	151 (20.5%)	0.635/0.728	166 (22.5%)	9.414/0.009*	99 (13.4%)	17.524/0.000*
9	Occupation of mother						
	Farmer/Artisan	16 (13.8%)		26 (22.4%)		19 (16.4%)	
	Civil servant/Banker etc	13 (9.0%)		16 (12.6%)		6 (4.2%)	
	House wife	125 (25.9%)		3 (17.6%)		76 (15.8%)	
	Total	154 (20.8%)	23.319/0.000*	122 (25.3%)	9.553/0.023*	101 (13.6%)	13.585/0.001*
10	Level of Education of father						
	Primary School or none	43 (25.3%)		41 (24.1%)		39 (22.9%)	
	Secondary School	51 (17.6%)		74 (25.5%)		46 (15.9%)	
	Tertiary Institution	59 (21.3%)		51 (18.4%)		15 (5.4%)	
	Total	153 (20.8%)	3.949/0.139	166 (22.5%)	4.321/0.110	100 (13.6%)	29.737/0.000*
11	Level of Education of mother						
	Primary School or none	86 (28.0%)		94 (30.6%)		62 (20.2%)	
	Secondary School	54 (19.8%)		56 (20.5%)		29 (10.6%)	
	Tertiary Institution	14 (8.7%)		17 (10.6%)		10 (6.2%)	
	Total	154 (20.8%)	24.202/0.000*	167 (22.5%)	25.358/0.000*	101 (13.6%)	20.865/0.000*

In regard to relationship between malaria and malnutrition, this study has shown that testing positive or negative for malaria infection may not be associated with underweight ( $P = 0.997$ ) and wasting ( $P = 0.133$ ) forms of malnutrition. This agrees with some findings in Cameroun, Kenya and Gambia which reported no association between malaria and malnutrition [12,14,15]. On the other hand stunting which is an indicator of chronic malnutrition was found to be associated with malaria infection with higher prevalence of stunting (31.7%) recorded among children that tested positive for malaria and about 2 times odds of infection than those that tested negative ( $OR = 1.749$ ,  $CI = 1.104-2.770$ ). This finding is in agreement with those of Deen et al. [41] who demonstrated increased risk for malaria in chronically malnourished (stunted) children under 5 years of age in rural Gambia; and that of Friedman et al [42] who asserted that stunted children are more likely to have malaria infection and illness than non-stunted. However, it contradicts the finding of Charchuk *et al* [16] in southern Sudan where no association was observed between malnutrition and malaria. Filol et al. [43] in Senegal also observed no association between stunting and underweight forms of malnutrition and malaria attacks while at the same time observing lower risk of attacks among wasted children.

This study showed significant ( $p < 0.05$ ) association between malnutrition (underweight or stunting or both) and age group and sex but malaria was not associated with any of them (Table 7). The former is in line with the findings of Sumbele et al. [44] who in the Mount Cameroon area demonstrated sex ( $P = 0.006$ ) and age group ( $P = 0.03$ ) as significant predictors of malnutrition. Regarding relationship of malaria with age group and sex. Kimbi et al. [45] reported a significant inverse association with age group, but non-significant with sex which is consistent with the findings of Swana et al. [46] who, in DRC Congo, averred that malaria prevalence was independent of age and gender. But contrariwise, even to the findings of this study, Onyido et al. [33] in Anambara Southern Nigeria established a statistically significant association between malaria prevalence and age as well as gender. On the other hand, while place of residence and level of education were significantly ( $p < 0.05$ ) associated with malaria, congruent to the finding of Umeanaeto et al. [47] in Enugu State, southern Nigeria; they were not associated with malnutrition. These apparent inconsistencies of findings may not be

unconnected with differences in study settings, study designs, sample sizes, procedures etc. On the whole, both malnutrition and malaria were found to be significantly associated with type of school, senatorial district, tribe, and religion. And also associated with both conditions were occupation of father, occupation of mother and level of education of mother. In view of this convergence of socio-demographic factors on the twin issues of malnutrition and malaria, the possibility of common precursors and predisposing factors may not be ruled out.

#### 4. CONCLUSION

This comparative study on the prevalence of malnutrition and malaria infection among school children in the study area may as well be among pioneer works that would point to the need for more rigorous studies on the subject matter in future. This study concludes that malaria is significantly associated with stunting but not with underweight and wasting forms of malnutrition. The differences observed in the types of independent variables associated with each of the two problems (malnutrition and malaria) are quite instructive. In other words, the notable tendencies with age group and sex that were found to be significantly ( $p < 0.05$ ) associated with malnutrition, but not with malaria; should be further investigated. More so, place of residence and level of education that were significantly ( $p < 0.05$ ) associated with malaria, but not with malnutrition would require studies. Overall, the significant association of both conditions with type of school, senatorial district, tribe, and religion as well as with occupation of father, occupation of mother and level of education of mother should inform more focused integrated public health intervention programmes.

#### ETHICAL APPROVAL

An ethical approval and clearance for this study was obtained from the Gombe State Ministry of Health Research and Ethics Committee (GSMoHREC) – Ref: MoH/ADM/S/658. Additionally, consents of the heads of the 18 schools that participated in the study, the parents and the volunteering pupils were all secured before conducting the study on the children. The study was conducted in tandem with the Helsinki Declaration.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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