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Original Article

PREVALENCE OF ASYMPTOMATIC MALARIA AND ANEMIA AMONG PRIMARY SCHOOL CHILDREN IN ENUGU STATE, NIGERIA

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ABSTRACT

Objective: The objective of the study was to determine the prevalence of asymptomatic malaria and anaemia among primary school children in Enugu State, Nigeria.

Methods: This research was a quantitative cross-sectional survey conducted among children in 8 primary schools in Nsukka, Enugu State, Nigeria. Asymptomatic children aged 5 to 13 were randomly selected and screened for malaria parasitemia and anaemia. The presence of malaria parasites in the blood sample was detected using the rapid diagnostic test (RDT) kit. At the same time, haemoglobin concentration was measured using a portable Mission® Plus Hemoglobin (Hb) Testing kit. The clinical status of the children was obtained from a self-administered questionnaire completed by their parents or guardians. Descriptive statistics and the Chi-square test were used for data analysis.

Results: The prevalence of asymptomatic malaria and anaemia was 24.1% and 45.8%, respectively. The school-age children with both asymptomatic malaria and anaemia were 13.7%. The prevalence of asymptomatic malaria was significantly associated with asymptomatic anaemia ($p = 0.013$). Sleeping under insecticide-treated nets was significantly associated with a lower prevalence of asymptomatic malaria ($p = 0.024$) and anaemia ($p = 0.015$).

Conclusion: The study revealed a high burden of asymptomatic malaria and anaemia among primary school children in Nsukka. This study, thus, underscores the need for robust implementation of malaria and anaemia screening, prevention, and treatment programmes in this population.

Keywords: Asymptomatic malaria, Anaemia, School-age children, Nsukka, Nigeria

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INTRODUCTION

Malaria and anaemia are two significant public health problems affecting children, particularly in sub-Saharan Africa [1]. Malaria is a life-threatening disease that constitutes Nigeria's major public health problem. Malaria and its accompanying anaemia account for a significant proportion of morbidity and mortality among children under five [2]. According to the World Health Organisation (WHO), Nigeria has the highest number of malaria cases globally, with approximately 61% of its population at risk of contracting the disease [3]. Several factors contribute to the high prevalence of malaria and anaemia among primary school children in Nigeria. These contributing factors include poor sanitation and hygiene practices, lack of access to safe drinking water, and poverty. Also, inadequate healthcare services, including a lack of access to malaria diagnostic tools and effective treatment, contribute significantly to the high prevalence of malaria and anaemia [4].

Malaria is a parasitic disease caused by the Plasmodium parasite and transmitted to humans through the bite of infected female Anopheles mosquitoes [5]. On the other hand, anaemia is a condition characterized by a reduction in red blood cells or haemoglobin concentration in the blood [6]. Malaria and anaemia are intricately linked, with malaria being a significant cause of anaemia in endemic areas. Children are particularly vulnerable to these diseases due to their underdeveloped immune systems and increased exposure to the malaria parasite [7]. Asymptomatic malaria ocurs when individuals have malaria parasites in their blood without showing any clinical symptoms [8]. Asymptomatic malaria can negatively affect children's health, including an increased risk of anaemia and impaired cognitive development [8]. Children with asymptomatic malaria may also act as a reservoir for transmitting malaria to others in the community [9]. Hence asymptomatic malaria is now recognized as an essential obstacle to malaria elimination [10].

Asymptomatic anaemia occurs when a person has anaemia but does not experience any noticeable symptoms. While asymptomatic anaemia may not cause noticeable symptoms, it is still essential to address the underlying cause. In primary school children, anaemia is most commonly caused by an iron deficiency [11]. Iron is vital for the production of red blood cells and haemoglobin, and a lack of iron can lead to anaemia. Common causes of iron deficiency in children include malaria infection, consumption of iron deficient foods, rapid growth and development, and blood loss from injuries or illnesses [12]. Iron deficiency anaemia can lead to developmental delays, behavioural problems, and decreased academic performance in children [13]. In addition, asymptomatic malaria can result in chronic, low-grade hemolysis, with consequent intermittent anaemia and high-density symptomatic recurrence [14]. Asymptomatic malaria and anaemia in children can easily be overlooked and untreated, although they have subtle consequences and should be regarded as potentially harmful. It is crucial to detect and treat both asymptomatic malaria and anaemia in order to prevent serious health complications down the line. This can involve regular screening for malaria and anaemia and providing appropriate treatment and follow-up care for those who are affected. Therefore, this study aimed to determine the prevalence of asymptomatic malaria and anaemia among primary school children in Enugu State, Nigeria.

MATERIALS AND METHODS

Study design and setting

This study employed a quantitative cross-sectional design. It was conducted in eight public primary schools in Nsukka, Enugu State, Nigeria, from September 2022 to February 2023. These schools were: (1) Community Primary School, (2) Central Primary School, (3) Model Primary School I, (4) Model Primary School II, (5) Model Primary School III, (6) Model Primary School IV, and (7) Union Primary School I and (8) Union Primary School II. Nsukka is a local government area in Enugu State, located in the southeastern part of Nigeria. Enugu State has a population estimate of over 3.3 million people. It is known for its fertile land and high rainfall, which provide favourable conditions for breeding mosquitoes that transmit malaria. Its exact coordinates are 6.8550 °N latitude and 7.3956 °E longitude. The weather of the study location is best categorized as a tropical savanna climate. It has two different seasons: a wet season and a dry season. The dry season typically lasts from November to March, whereas the wet season usually lasts from April to October. The annual rainfall pattern in Nsukka is bimodal, with the wettest months being June and September and the driest being January and February. Around 1,500 millimetres of rainfall on average each year in Nsukka. Nsukka experiences year-round high temperatures, with a daily average of 27 °C. The months with the highest average temperatures are often March and April at 29 °C, while December typically has the lowest average temperature of 24 °C. The study location experiences high relative humidity levels throughout the year, averaging 85%.

Study participants

The study population was primary school children aged 5–13 in Nsukka, Enugu State, Nigeria. A multistage sampling technique was used for the purpose of selecting the study participants. In the first stage, eight public primary schools were selected in the Nsukka local government area of Enugu State using a simple random sampling technique. In the second stage, simple random sampling was also used in selecting study participants from the eight public primary schools.

Sample size calculation

The sample size was calculated using the formula for estimating a single population proportion for a cross-sectional study design. The formula was given as $n = Z^2P(1-P)/d^2$, where 'n' represents the sample size, 'Z' is the statistics corresponding to the level of confidence, 'P' is the expected prevalence based on previous studies, and d stands for effect size or precision. Based on previous studies, the researchers assumed a prevalence of 20% for asymptomatic malaria and 50% for anaemia among primary school children. Therefore, with a 5% level of significance and a 95% confidence interval, the minimum sample size required was 323. To account for non-response, the sample size was increased by 10% to 355 participants.

Eligibility criteria

The study participants were recruited based on the following inclusion criteria: (1) School-aged children less than 14 y old; (2) children without any symptom of malaria or anaemia at the time of sampling; (3) those whose parents or guardians granted consent to participate in the research; and (4) sick children who presented with symptoms of malaria or anaemia were excluded from the study. Children between the ages of 5 and 13 and those who consented to participate in the study were included in this study, while children below the age of 5 and above the age of 13 were excluded from this study.

Data collection

A written, informed consent was obtained from the parents or guardians of the schoolchildren. Thereafter, the participants were given a paper-based, self-administered questionnaire to be completed by their parents or guardians. The questionnaire contained information on the participants' sociodemographic and clinical status. The participants returned the completed questionnaires the next day at school. Upon submission of the completed questionnaire, blood samples were obtained from the study participants through finger pricking for malaria and anaemia testing by a medical officer. Prior to drawing a blood sample, the index finger was cleaned with a swab and gently pricked by the side using a sterile lancet. The first drop of blood was wiped off, and light pressure was applied to obtain a second drop, which was used to run tests for the presence of malaria parasites and the level of haemoglobin. The rapid diagnostic test (RDT) kit was used to test for malaria. On the other hand, the haemoglobin level was measured using the Mission Plus Hemoglobin (Hb) Testing System. Asymptomatic malaria was defined as a positive malaria RDT result in the absence of any clinical signs or symptoms of malaria in the past two weeks. However, the level of haemoglobin was determined by mixing the blood sample with a reagent that contains a chemical that reacts with haemoglobin to produce a colour change. The intensity of the colour change is proportional to the amount of haemoglobin present in the blood sample.

Data analysis

The data collected were analyzed using IBM SPSS for Windows, version 21.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics (frequency, per cent, mean, standard deviation) were used to summarise the participants' demographic information and the prevalence of asymptomatic malaria and anaemia. For the asymptomatic malaria, the participants were grouped as either negative or positive based on the outcome of the RDT. On the other hand, using the haemoglobin level, asymptomatic anaemia was classified based on the WHO standard. Hence, the participants were classified as normal (11.5 g/dl), mild anaemia (11.0–11.4 g/dl), moderate anaemia (8.0–10.9 g/dl), and severe anaemia (8.0 g/dl). [6] The chi-square test was used to determine independent variables associated with asymptomatic malaria and anaemia. The level of significance was set at p-values less than 0.05.

Ethical considerations

Ethical approval for the study was obtained from the National Health Research Ethics Committee (NHREC) of the University of Nigeria Teaching Hospital, Ituku-Ozalla, Enugu, Enugu State. The reference number for the ethical approval was NHREC/05/01/2008B-FWA0000245B-1RB00002323. The researchers also obtained written permission from the school authorities to proceed with the study. The pupils eligible for the study were given a written informed consent form to hand over to their parents or guardians to complete on their behalf and to return the duly completed consent form the next day in school. Measures to protect the confidentiality and anonymity of participants were strictly adhered to. This implied that the participant's identity was not disclosed and that their responses were not associated with their identity. Also, the data collected was stored securely and accessed only by authorized persons. Participation in the survey was voluntary, and participants were informed that they could withdraw from the study at any time without penalty or consequence. Overall, this research adhered to the principles of the Helsinki Declaration, as modified in 2013, for medical research involving human subjects.

RESULTS

A total of 487 eligible schoolchildren were invited to participate in the study. However, the parents or guardians of 402 children provided informed consent on their behalf to participate in the research and also completed the self-administered questionnaire on the clinical status of the children. Other parents or guardians whose children were invited to take part in the study declined consent, largely because of a lack of interest in the research and the involvement of an invasive procedure. Therefore, the participation rate in this research was 82.5%. More than half of the participants were female (53.0%) and aged 8 to 10 y (53.7%). The participants included children in grade levels 2 to 6, with the majority in primary 5 (31.3%). More than a quarter of the children (30.0%) reportedly sleep under an insecticide-treated net (table 1).

Table 2 contained the study participants' prevalence of asymptomatic malaria and anaemia. The results revealed that the prevalence of asymptomatic malaria and anaemia in schoolchildren was 24.1% and 45.8%, respectively. Nearly a quarter (23.4%) of the participants had moderate anaemia based on the standard WHO classification of anaemia. The mean haemoglobin level was 11.24±1.61.

Table 3 illustrates the association between the demographic characteristics of the study participants and the prevalence of asymptomatic malaria and anaemia. The prevalence of asymptomatic malaria ($p = 0.024$) and anaemia ($p = 0.015$) were significantly related to whether the participants slept under an insecticide-treated net. However, the findings demonstrated that school ($p = 0.426$), age ($p = 0.387$), gender ($p = 0.576$), and grade level ($p = 0.622$) were not associated with the prevalence of asymptomatic malaria. Similarly, school ($p = 0.610$), age ($p = 0.247$), gender ($p = 0.615$), and grade level ($p = 0.957$) had no relationship with the prevalence of asymptomatic anaemia.

Table 1: Participants' demographic data (n = 402)

Variables	Frequency (%)
Schools	
Community primary school	93(23.1)
Central primary school	52 (12.9)
Union primary school I	51 (12.7)
Union primary school II	51 (12.7)
Model primary school I	43 (10.7)
Model primary school II	34 (8.5)
Model primary school III	41 (10.2)
Model primary school IV	37 (9.2)
Age (years)	
6-7	37 (9.2)
8-10	216 (53.7)
11-13	149 (37.1)
Gender	
Male	189 (47.0)
Female	213 (53.0)
Grade Level	
Primary 2	11 (2.7)
Primary 3	46 (11.4)
Primary 4	110 (27.4)
Primary 5	126 (31.3)
Primary 6	109 (27.1)
Sleeps under an insecticide-treated net	
No	108 (30.0)
Yes	252 (70.0)

Table 2: Prevalence of asymptomatic malaria and anaemia among school children

Variable	Frequency (%)
Malaria status	
Negative	305 (75.9)
Positive	97 (24.1)
Haemoglobin	
Non-anaemic	218 (54.2)
Anaemic	184 (45.8)
Classification of haemoglobin according to WHO	
Normal	218 (54.2)
Mild anaemia	89 (22.2)
Moderate anaemia	94 (23.4)
Severe anaemia	1 (0.2)
Hematocrit	
Normal	179 (44.5)
Low	220 (54.7)
High	3 (0.7)

Mean hemoglobin level = 11.24±1.61; Mean hematocrit = 33.29±5.56; Children with both asymptomatic malaria and anemia = 55 (13.7%)

Table 3: Association of demographic variables with the prevalence of asymptomatic malaria and anaemia

Variables	Presence of malaria parasite (%)		P value	The severity of anaemia (%)		P value
	Negative	Positive		Anaemic	Non-anaemic	
School						
Community primary school	21.6	27.8	0.426	25.5	21.1	0.610
Central primary school	14.8	7.2		14.1	11.9	
Model primary school I	11.8	7.2		10.9	10.6	
Model primary school II	8.5	8.2		7.1	9.6	
Model primary school III	9.8	11.3		10.3	10.1	
Model primary school IV	8.9	11.3		9.2	9.2	
Union primary school I	12.8	12.4		13.6	11.9	
Union primary school II	11.8	15.5		9.2	15.6	
Age (years)						
6-7	10.2	6.2	0.387	9.2	9.2	0.247
8-10	54.1	52.5		49.5	57.3	
11-13	35.7	41.3		41.3	33.5	
Gender						
Male	46.2	49.5	0.576	45.7	48.2	0.615
Female	53.8	50.5		54.3	51.8	
Grade Level						
Primary 2	3.3	1.0	0.622	2.7	2.8	0.957

Variables	Presence of malaria parasite (%)		P value	The severity of anaemia (%)		P value
	Negative	Positive		Anaemic	Non-anaemic	
Primary 3	10.5	14.4		10.3	12.4	
Primary 4	26.9	28.9		26.6	28.0	
Primary 5	31.8	29.9		32.6	30.3	
Primary 6	27.8	25.8		27.7	26.6	
Sleeps under mosquito-treated net						
No	26.2	7.5	0.024*	10.4	21.8	0.015*
Yes	73.8	92.5		89.6	78.2	

*Chi-square test was Significant at p<0.05; the prevalence of asymptomatic malaria was significantly associated with asymptomatic anaemia (p = 0.013)

DISCUSSION

This study aimed to assess the prevalence of asymptomatic malaria and anaemia and their associated factors among school-age children in Nsukka, Enugu State, Nigeria. The finding demonstrated a high prevalence of asymptomatic malaria and anaemia among the study group. The findings were consistent with similar studies among school-age children in Ghana, which reported a high prevalence of asymptomatic malaria ranging from 17.5% to 23.1% in school-age children living in forest and coastal regions of the country [15]. In addition, a Cameroonian study reported a similar prevalence of asymptomatic anaemia (44.7%) but a much higher prevalence of asymptomatic malaria (72.4%). The higher prevalence of asymptomatic malaria in the study in Cameroon was possible because the researchers utilized a more sensitive microscopy test for the detection of malaria parasitemia, unlike the present study that used an RDT, which appears less sensitive, especially in areas with low parasite density [16]. Furthermore, in contrast to the current study findings, Nzobo and colleagues reported a lower prevalence of asymptomatic malaria (5.4%) and anaemia (10.1%) among school-age children (6–13 y) in Morogoro municipality, Tanzania. An Ethiopian study reported a lower prevalence of asymptomatic malaria (1.62%) and anaemia (22.0%) in children aged 7–14 [17]. This study's high prevalence of asymptomatic malaria and anaemia underscores the need for robust implementation of preventive measures against the spread of the malaria parasite and adequate nutrition, particularly for school-age children. However, efforts to address malaria and anaemia in Nigeria need to consider the high prevalence of asymptomatic infections, which can contribute to the ongoing transmission of the diseases and the development of complications. Targeted interventions, such as regular screening and treatment, improved access to health care, and vector control measures, may be necessary to reduce the burden of these diseases among children in Nigeria.

This study found that sleeping under insecticide-treated nets was significantly associated with the prevalence of asymptomatic malaria and anaemia. This finding agrees with some previously published studies. These studies established that using insecticide-treated nets was an effective intervention in reducing the prevalence of malaria and anaemia. A study conducted in Kenya found that using insecticide-treated nets was associated with a lower prevalence of malaria and anaemia in children [18]. Another study conducted in Burkina Faso found that using insecticide-treated nets was associated with a lower risk of anaemia [19]. In like manner, higher odds of developing asymptomatic malaria were observed in people who do not use insecticide-treated nets while sleeping compared to those who use them [20]. One of the best methods for preventing malaria is using insecticide-treated nets, especially in regions where the disease is endemic [21]. Insecticide-treated nets deter or kill insects that come into contact with them. The bite of infected mosquitoes spreads malaria. Thus, since insecticide-treated nets create a physical barrier between people and the insects that transmit the disease, they help prevent the development of asymptomatic malaria. In this study, barely 30% of participants slept under insecticide-treated nets. Hence, the coverage and use of insecticide-treated nets should be promoted among school-age children in the study location.

The prevalence of asymptomatic malaria and anaemia was not associated with age, gender, or grade level. This finding is consistent with a study conducted in Cameroon, which found that the prevalence of anaemia during asymptomatic malaria parasitemia was not associated with age, sex, or socioeconomic status [22]. In contrast, other studies found that age and gender were related to the prevalence of asymptomatic malaria [15]. A higher prevalence of malaria and anaemia was reported in children between the ages of 9 and 11 compared to children under the age of 5 and above the age of 11 [15]. The lack of an association between asymptomatic malaria and anaemia and age, gender, and grade level suggests that screening and early detection programmes for asymptomatic malaria and anaemia should be carried out across various demographic groups equally rather than focusing on children with particular demographics. This would make it easier to identify and quickly treat children who could be at risk of anaemia or malaria.

The high prevalence of asymptomatic malaria among primary school students suggests that state efforts must be made to prevent and manage the disease. This could involve giving out bed nets sprayed with an insecticide, treating malaria effectively, managing the environment to eliminate mosquito breeding grounds, and providing appropriate case management. The study's findings also emphasize the necessity of routinely diagnosing and treating anaemia among the state's elementary school students. Children's health and cognitive development can be significantly impacted by anaemia, which can result in subpar academic performance and decreased productivity in later life. In order to lower the prevalence of anaemia among primary school students in Nsukka, Enugu State, measures such as regular iron and folic acid supplementation, deworming programs, and nutritional interventions might be put into place.

This study had a few limitations. First, the authors assessed the presence of malaria using RDT, which is both easy to use and convenient. However, the sensitivity of RDT decreases as the parasite density reduces below 200 parasites per microliter. Thus, a confirmatory microscopy test would likely have ensured that all children with malaria were detected. Secondly, the sample size appears small, although the study sampled participants from eight randomly selected public primary schools in Nsukka local government area.

CONCLUSION

The study revealed a high asymptomatic malaria and anaemia burden among primary school children in Nsukka, Nigeria. Using insecticide-treated nets was associated with a lower prevalence of asymptomatic malaria and anaemia. Therefore, the findings of this study emphasize the need for routine screening, prevention, and treatment programs in school-age children at risk of malaria and anaemia. These interventions to curb malaria and anaemia, including the regular use of insecticide-treated nets, should be strongly encouraged for use among school-aged children across various age groups, genders, and grade levels.

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AUTHORS CONTRIBUTIONS

Ebere E. Ayogu (EEA) contributed immensely to developing the research concept and design, data collection, analysis, and interpretation, research funding, critically reviewing the drafted manuscript, and approving the final copy for publication.

Chibueze Anosike (CA) contributed to data acquisition and cleaning, data analysis and interpretation, the drafting of the manuscript, the critical review of the drafted manuscript, and the approval of the final copy for publication.

Stephen Ikechukwu Azumara (SIA) contributed to the data collection, the research funding, the critical review of the drafted manuscript, and the approval of the final manuscript for publication.

Desmond Nnia Ani (DNA) contributed to data collection, drafting the manuscript, critical review of the final manuscript, and approval of the final copy for publication.

CONFLICT OF INTERESTS

The authors have no conflict of interest to declare

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