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Research Article

Malaria, Soil-transmitted Helminth Infections and Malnutrition among Orphaned and Vulnerable Children in Orphanages in Osun State, Nigeria

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ABSTRACT

Orphans and Vulnerable Children (OVC) often face malnutrition and health risks, including malaria and soil-transmitted helminth (STH) infections. This investigation in Osun State aimed to examine the nutritional status and the prevalence of malaria and STH infections among OVC residing in orphanages in Osun State, Nigeria, from June to November 2021. Blood and stool samples from 161 children aged 5 to 18 across three orphanages were collected and examined for *Plasmodium* spp and helminth ova using microscopy and the Kato-Katz method, respectively. Anthropometric measurements were analyzed based on WHO growth charts. Results showed an overall prevalence of 39.1% for malaria and 16.8% for soil-transmitted helminthiasis. Females (48.2%) had a higher malaria prevalence than males (34.3%). The prevalence of STH was also slightly higher in females (17.9%) compared to males (16.2%). However, no significant association between gender and disease prevalence was observed ($p>0.05$). Additionally, 13 (8.8%) children were severely stunted and 6 (10.2%) were severely underweight. Among severely stunted children, 24 (41.4%) tested positive for malaria and 11 (19.0%) for STH. There were no significant correlations between stunting and malaria infection ($p=0.808$) or stunting and STH ($p=0.450$). This study reveals a high prevalence of malaria, STH, and malnutrition among OVCs, underscoring the urgent need for interventions supported by the government such as the distribution of insecticide-treated bed nets, regular deworming programs, improved water, sanitation, and hygiene (WASH) services to reduce the burden of helminthic infections, and the provision of nutritious diets to improve the health and well-being of children in orphanages.

Keywords: Malaria; Malnutrition; Orphaned and vulnerable children (OVC); Osun State; Soil-transmitted helminths

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INTRODUCTION

Malnutrition, malaria, and Soil-Transmitted Helminth (STH) infections remain significant contributors to morbidity and death in low-income and resource-limited countries worldwide. In 2019, 8.9% of the global population was undernourished, while approximately 241 million malaria cases were recorded globally (Gebreegziabher *et al.*, 2023). Soil-transmitted helminths disproportionately affect an estimated 1.5 billion persons globally (WHO, 2023). The African region bears a disproportionate burden of child malnutrition, accounting for 45% of child deaths (Akombi *et al.*, 2017) and nearly 95% of global malaria cases (WHO, 2022).

Malnutrition heightens the risk of infections, illnesses, and child mortality by compromising immune defenses (Morales *et al.*, 2023). In contrast, infections can contribute to undernutrition by diminishing appetite, elevating metabolic demands, impairing nutrient transport to body tissues, and disrupting gut function, thereby hindering nutrient absorption (Katona & Katona-Apte., 2008; Gebreegziabher *et al.*, 2023). Studies have been done to establish relationship between malaria and malnutrition with conflicting findings. Some studies have shown that malnutrition has no impact on the risk of malaria infection (Oldenburg *et al.*, 2018), whereas others found that malnutrition increased (Shikur *et al.*, 2016) or decreased the risk of malaria (Fillol *et al.*, 2009; Alexandre *et al.*, 2015).

There are about 140 million orphans globally, with available data highlighting that the most concerning situations are predominantly observed in countries across sub-Saharan Africa and South Asia (Cansu, 2020). Based on the 2008 Situation Analysis report by the Federal Ministry of Women Affairs and Social Development (FMWASD, 2008), Nigeria is estimated to have approximately 17.5 million OVC, among them 7.3 million are orphans and this accounts for roughly one-third of Africa's total orphan population (FMWASD, 2008). Childhood malnutrition stands as a significant contributor to childhood morbidity and mortality in Nigeria. According to Tagurum *et al.* (2015), over a quarter of the OVC examined exhibited mild to moderate malnutrition symptoms. Furthermore, nearly 70 percent of them faced household food insecurity, elevating their vulnerability to malnutrition (Tagurum *et al.*, 2015). Assessment of nutrition has a cornerstone importance in children because growth retardation is mainly caused by undernutrition in childhood (Yeganeh *et al*., 2018). Dietary deficits in children during their early years of life are primarily caused by undernutrition (Ferdoushi *et al.* 2014). The question of whether OVC experience higher rates of undernutrition compared to their non-vulnerable counterparts has been a persistent area of investigation for researchers with several conflicting outcomes. Research conducted in several African nations, such as Tanzania, Zimbabwe and Kenya revealed that OVC experience higher levels of undernutrition compared to non-orphaned and vulnerable children (Berr *et al.*, 2021). Specifically, rates of undernutrition were significantly elevated among OVC, who also exhibited generally poorer health indicators (Watts *et al.*, 2007; Braitstein *et al.*, 2013). However, a comprehensive analysis of national data from 40 Sub-Saharan African countries found no significant variations in nutritional status between vulnerable and non-vulnerable children under five years (Monash *et al.*, 2004). In Nigeria, it is unclear whether OVC face higher levels of undernutrition compared to non-OVC or how malnutrition impacts the risk of malaria and STH infections. Hence, this study aims to assess the nutritional status and the impact of malnutrition on the risk of malaria and STH among orphans and vulnerable children in Osun State, Nigeria.

MATERIALS AND METHODS

Study Area

This cross-sectional study was conducted between March and November 2021 at three randomly selected registered orphanages in Osun State, southwest Nigeria. Two orphanages were located in Osogbo, the state capital, while the third was in Ilesha, Ilesha East Local Government Area. A total of 161 children between the ages of 5 to 15 years comprising of 105 male and 56 females were selected to participate in the study across the three orphanages.

Ethical Approval

Approval for the study was granted by the Ethics Review Committee of the Osun State Ministry of Health (OSHREC/PRS/560T/192). Also, approval and access to institutional homes were given by the Ministry of Women, Children and Social Affairs, Osun State. Written consent and approval were also obtained from the head of the institutionalized homes for each child examined. In the presence of the orphanage representatives, the children's assent was verbally gained and a thumbprint on the assent form.

Nutritional and Anthropometric Assessment

A structured form was deployed to collect demographic information, including the children's names, age, and gender. Anthropometric measurements, such as weight and height, were also obtained. Weight was measured in kilograms (kg) using a manual weighing scale, and height was recorded in centimeters (cm) using a stadiometer while the children were barefoot. Two observers took the measurements independently and compared them for accuracy before entering the data into the participants' forms.

Nutritional status was assessed following the World Health Organization's Growth Standards for Children and Adolescents (WHO, 2009). Various indicators were used, including height-for-age (HAZ), weight-for-age (WAZ), and body mass index-for-height (BAZ). Children whose scores fell below -2 standard deviations (SD) were categorized as underweight, and those below -3 SD were classified as severely underweight. HAZ identified stunted children, with a z-score below -2 SD indicating stunting and below -3 SD indicating severe stunting. BAZ was used to assess children who were underweight or obese, with scores above +2 SD and +3 SD pointing to high weight-for-height, and wasting was

identified with scores below -2 SD for wasting and below -3 SD for severe wasting (WHO 2008, 2009).

Parasitological examination

Soil-transmitted helminths

Each consenting child was provided with a sterile, labeled plastic universal container. Fresh stool samples from the children were collected during the visit to the institutionalized home. The specimens were then transported to the laboratory within two hours. The Kato-Katz technique was used to analyze the samples, following the manufacturer's protocol (Kato-Katz kit, Sterlitech Corporation, Kent, WA, USA).

Malaria test

A finger prick was performed using a sterile lancet to collect 5 microliters of blood from each child with a capillary tube. Thick and thin blood smear slides to detect the presence of malaria parasites were then prepared. The smears were fixed with methanol and stained with 10% Giemsa stain and examined under a microscope at 100x magnification to check for the presence of malaria parasites. This was done according to methods described by (Cheesbrough, 2006).

Data Analysis

To assess nutritional outcomes and compare them with reference standards, data were first input into the WHO AnthroPlus software (WHO, 2009). Descriptive statistics were used to analyze the nutritional outcomes alongside other demographic details. Univariate chi-square tests were then applied to assess the relationships between explanatory variables and the outcome categories. Statistical analysis was conducted using SPSS version 21, with frequencies and percentages calculated for categorical variables. Significant associations were identified when $p \leq 0.05$

RESULTS

Sex and age information of study participants

A total of 161 children from the three different orphanages were enrolled in the study. Each orphanage represented a distinct cluster, with differences in both the age and gender of the participants. There was no significant difference in age and gender across the three homes (p.0.05) (Table 1).

Malnutrition Status of study population using WHO child growth standards

Table 2 presents the nutritional status of the children. Among the total number of children samples, 6 (10.2%) were classified as severely underweight, 58 (44.6%) as severely stunted, and 13 (8.8%) as severely wasted. Additionally, 9 (15.3%) were categorized as severely overweight and 31 (20.9%) as severely obese. Significant deviations in HAZ, WAZ, and BAZ scores were observed relative to WHO child growth standards (Figures 1–3).

Prevalence of undernutrition among OVC

The prevalence of undernutrition observed in this study is high, with overall rates of underweight, stunting, and wasting recorded at 15.3%, 59.2%, and 11.5%, respectively (Table 3).

Table 1: Sex and age characteristics of study population

		Gender			Age (in months)			
Clusters	N (%)	Male (%)	Female (%)	p-value	Mean ±SD	Min	Max	p-value
1	50 (31.1)	36(72.0)	14(28.0)	0.468	138.3±25.4	72	168	0.192
2	78 (48.4)	48(61.5)	30(38.5)		130.8±33.1	60	168	
3	33(20.5)	21(63.6)	12(36.4)		123.6±33.6	60	180	
Total	161(100)	105 (65.2)	56(34.8)		131.03±31.2	60	180	

Table 2: Malnutrition Status of the study population using WHO child growth standards

	Malnutrition Indicators		
Status	**Weight for Age WAZ [a] (%)**	**Height for Age HAZ[b] (%)**	**Body Mass Index for Age BAZ [c] (%)**
<-3SD	6(10.2)	58(44.6)	13(8.8)
<-2SD	3(5.1)	19(14.6)	4(2.7)
<-1 SD to +1SD	33(55.9)	48(36.9)	33(22.3)
>+1SD	6(10.2)	4(3.1)	28(18.9)
>+2SD	2(3.4)	1(0.8)	39(26.4)
>+3SD	9(15.3)	0(0)	31(20.9)
Total	59[d]	130[e]	148[f]

[a]WAZ: used to identify children with low weight relative to their age, categorized as underweight (<-2SD) or severely underweight (<-3SD); [b]HAZ: identifies children with low height for their age, indicating stunting (<-2SD) or severe stunting (<-3SD) due to prolonged malnutrition or frequent illness; [c]BMI for Age: assesses children with low weight for height, indicating wasting (<-2SD), severe wasting (<-3SD), or those with high weight for height, indicating

overweight (>+2SD) or obesity (>+3SD); [d]102 records (88 beyond age limits and 14 with implausible z-scores) were excluded from the analysis; [e]31 implausible z-scores were excluded; [f]13 implausible z-scores were excluded.

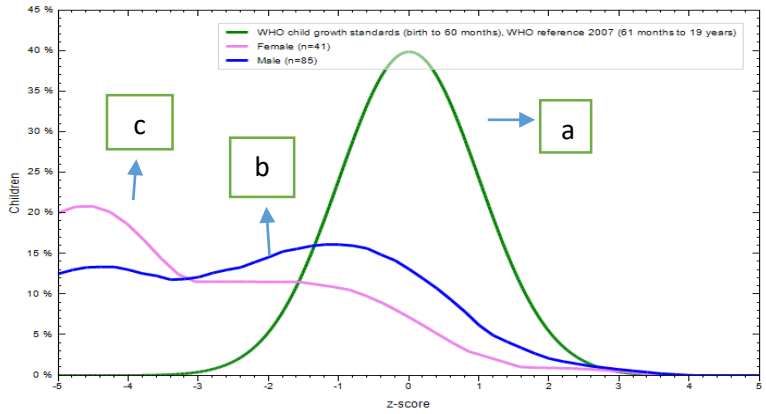

Figure 1: Gender based curves for Height for Age (HAZ) z-scores

This figure illustrates deviations in growth patterns between female (c) and male (b) distributions compared to the WHO growth standard (a). A higher proportion of female children exhibit lower Z-scores than their male counterparts. This implies a greater prevalence of stunting among females.

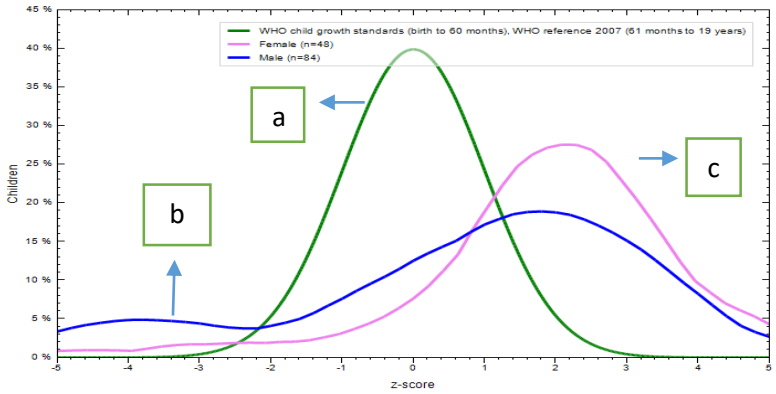

Figure 2: Gender based curves for Body Mass Index for Age (BAZ) z-scores

The figure shows deviations in male (b) and female (c) growth distributions from the WHO standard (a). Female children tend to have higher Z-scores than males, indicating variations in growth patterns. This implies females having a higher BMI Z-scores than males, suggesting that they may have relatively better body mass for their age compared to males.

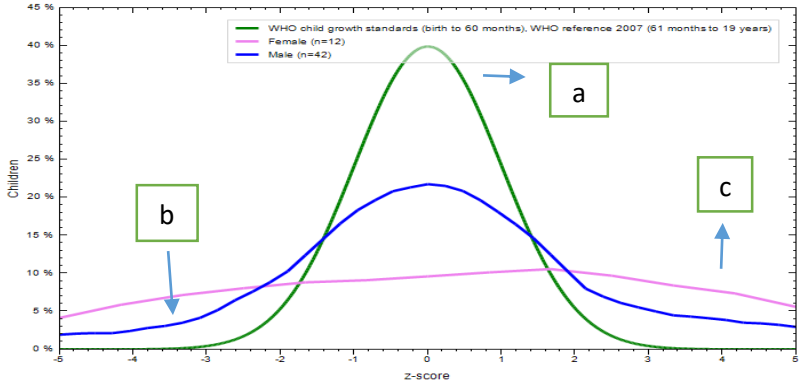

Fig 3. Gender based curves for Weight for Age (WAZ) z-scores

This figure suggests that male children (b) showed to be more underweight compared to the WHO standard (a), while female (c) weight distribution is more varied.

Table 3. Prevalence of undernutrition among OVC

Category	Type	Frequency (%)
Underweight	Mild	3 (5.1)
	Severe underweight	6 (10.2)
	Total	9 (15.3)
Stunting	Mild	19 (14.6)
	Severe stunting	58 (44.6)
	Total	77 (59.2)
Wasting	Mild	4 (2.7)
	Severe	13 (8.8)
	Total	17 (11.5)

Prevalence of malaria and STH among study participants

The overall prevalence rates were 63 (39.1%) for malaria and 27 (16.8%) for STH infections. In malaria cases, females exhibited a higher prevalence of 27 (48.2%) compared to males 36 (34.3%). Similarly, for STH infections, females had a slightly higher prevalence of 10 (17.9%) compared to 17 (16.2%) in males. Although females showed a higher prevalence of both malaria and STH infections than males, the differences were not statistically significant ($p > 0.05$) for either disease (Table 4).

The occurrence of malaria and intestinal helminth infections in relation to the nutritional status of the study participants

Based on the WAZ index, malaria was detected in 33.3% of underweight children, while 66.7% of overweight children tested positive. None of the underweight or severely underweight children tested positive for soil-transmitted helminths (STH), whereas 4 (44.4%) of the overweight children tested positive for STH. For stunted children, 24 (41.4%) of the severely stunted tested positive for malaria, and 11 (19.0%) were positive for STH. In contrast, children with a high height-for-age score were negative for both malaria and STH. For BAZ scores, 2 (15.4%) and 1 (7.7%) of the severely wasted children were positive for malaria and STH, respectively. Among the children with a high BAZ score, 14 (45.2%) tested positive for malaria, and 7 (22.6%) were positive for STH. BAZ index was significantly associated with malaria prevalence ($p = 0.046$), but no significant association was observed with STH infection rates ($p = 0.811$) (Table 5).

Table 4: Prevalence of malaria and STH among study participants

Gender	Prevalence of malaria (%)	Prevalence of STH (%)
Male	36 (34.3%)	17 (16.2%)
Female	27(48.2%),	10 (17.9%)
Total	63 (39.1%)	27 (16.8%)
	P value = 1.00	*P* value = 0.10

Table 5: The occurrence of malaria and intestinal helminth infections to the nutritional status of the study participants

Malnutrition indicators	Weight for Age (WAZ)			Height for Age (HAZ)			Body Mass Index for Age (BAZ)		
	n	Malaria positives (%)	STH Positives (%)	n	Malaria positives (%)	STH Positives (%)	n	Malaria positives (%)	STH Positives (%)
<-3SD	6	0(0)	0(0)	58	24(41.4)	11(19.0)	13	2(15.4)	1(7.7)
<-2SD	3	1(33.3)	0(0)	19	8(42.1)	2(10.5)	4	1(25.0)	1(25.0)
<-1 SD to +1SD	33	17(51.5)	4(12.1)	48	19(39.6)	10(20.8)	33	9(27.3)	4(12.1)
>+1SD	6	2(33.3)	0(0)	4	2(50)	2(50)	28	17(60.7)	5(17.9)
>+2SD	2	1(50.0)	0(0)	1	1(100)	0(0)	39	16(41.0)	7(17.9)
>+3SD	9	6(66.7)	4(44.4)	0	0 (0)	0 (0)	31	14(45.2)	7(22.6)
Total	59	27(45.7) p=0.175	8(13.5) p=0.07	130	54(41.5) p=0.808	25(46.3) p=0.450	148	59(39.9) p=0.046	25(16.8) p=0.811

*Overall Malaria positives: 39.1% (63/161); Overall STH positives: 16.8% (27/161)

DISCUSSION

This study highlights the prevalence of malnutrition among vulnerable children living in orphanage homes in Osun State, Nigeria. A significant number of the children were found to be stunted and overweight, demonstrating clear deviations from the World Health Organization's child growth standards (WHO, 2008). According to WHO (2021), malnutrition is a significant global health challenge, particularly in regions burdened by poverty, limited healthcare access, and inadequate infrastructure. The findings of this study indicate a significant prevalence of undernutrition among children, with rates of underweight, stunting, and wasting at 15.3%, 59.2%, and 11.5%, respectively. These figures align closely with data from Ethiopia, where studies among OVC reported underweight, stunting, and wasting prevalences of 12.0%, 35.1%, and 4.7% (Berr *et al.*, 2021). Similarly, another Ethiopian study on orphans under five years of age recorded prevalences of 12.2%, 37.8%, and 21.7% for stunting, wasting, and underweight, respectively (Feleke *et al.*, 2021). The prevalence of overweight and obesity reported in this study is higher than the 7.9% and 1.1% reported by Foko et al. (2021). Obesity is an emerging public health issue in Africa and Asia, driven by shifts in dietary patterns and lifestyle changes (Foko et al., 2021). The high prevalence of overweight and obesity among OVC in this study raises concerns, as it substantially increases the risk of chronic diseases such as type 2 diabetes, cardiovascular disorders, depression, certain cancers, disability, and premature mortality (Hruby & Hu, 2015).These findings underscore the persistent global challenge of undernutrition and obesity among vulnerable children, warranting urgent interventions. In Nigeria, undernutrition prevalence has remained consistently high over the years. For instance, Olanipekun *et al.* (2012) reported 44% stunting and 40% underweight in Ibadan, while Hassan *et al.* (2012) recorded stunting and underweight prevalences of 41.2% and 48.7% in Kaduna. The observed stunting prevalence of 59.2% in this study is exceptionally high. Bisrat & Kulkarni (2017) and Wete *et al.* (2019) in Ethiopia demonstrated that children without parents face a higher likelihood of stunting. Similarly, earlier findings from Zimbabwe highlighted that orphanhood significantly increases the risk of stunting (Watts *et al.*, 2007). Wasting was the least prevalent (11.5%) among the three nutritional outcomes. Wasting, or acute malnutrition, reflects a significant reduction in food intake and/or the impact of illness, leading to pronounced depletion of muscle and fat reserves. Factors such as poor maternal nutrition, delayed breastfeeding initiation beyond six months, insufficient or low-quality complementary feeding, and nutrient malabsorption due to infections are recognized contributors to nutritional deficiencies in children (Kramer & Allen, 2015).

The findings of this study revealed a notably high malaria prevalence rate. This prevalence is higher than the 23.3% previously reported among children in orphanages in Anambra (Oluboyo *et al.*, 2017). Environmental differences such as proximity to mosquito breeding sites and behavioural differences among children could be responsible for the differences in prevalence. Observation at the orphanages indicated that some sleeping areas for children lacked windows and protective window nets, which are essential barriers against mosquito entry. Additionally, the noticeable lack of insecticide-treated bed nets further increases their exposure to mosquito bites. Some studies have established a link between household size and malaria risk, households having six or more children are particularly vulnerable to malaria infection (Kabaria *et al.*, 2017). The strain on basic infrastructure, common in settings like orphanages as observed in this study, can lead to environmental neglect, which favors the breeding of mosquitoes and increases the risk of malaria transmission (Isiko *et al.*, 2024).

The prevalence of malaria was higher among females compared to males, though the difference was not significant. Similar findings of higher malaria prevalence in females have been documented in Uganda (Okiring *et al.*, 2022). In contrast, several studies in Nigeria (Noland *et al.*, 2014; Dawaki *et al.*, 2016; Gebretsadik *et al.*, 2018), Mozambique (Temu *et al.*, 2012), and Kenya (Brooker *et al.*, 2004) have reported a insignificantly higher prevalence among males than females, underscoring the heterogeneity of malaria transmission risk across genders. The lower prevalence observed in males in this study may be linked to their frequent engagement in outdoor activities, which increases their exposure to mosquito bite. This repeated exposure could contribute to the development of partial immunity, making them less susceptible compared to females (Dawaki *et al.*, 2016).

This study identified a 16.7% prevalence of STH, which is notably lower than figures reported in previous research across Nigeria, such as 69.9% by Idowu *et al.* (2022), 78% by Taiwo *et al.* (2017) and 39.3% by Omitola *et al.* (2016). The reduced prevalence observed in this study may be attributed to the availability of water, sanitation, and hygiene (WASH)

facilities in the orphanages, which reduced the risk of STH infections. However, the presence of STH infections could be linked to behaviors such as children consuming food picked from the ground and walking barefoot, which increases exposure to STH. Furthermore, large number of children in such settings can undermine efforts to control infections, as individuals with high parasite loads may serve as sources of reinfection within the orphanages (Kattula *et al.*, 2014).

Females also had a higher prevalence of STH (17.9%) compared to males (16.2%), although the difference was not significant ($p > 0.05$). Conversely, studies by Omitola *et al.* (2016) and Idowu *et al.* (2022) reported a greater prevalence of STH in males than females, but these differences were also insignificant.

In this study, children with relatively better nutritional indices generally showed a higher prevalence of malaria compared to those who were underweight or wasted, except in the case of stunting, where stunted children exhibited a higher malaria prevalence. However, these differences were not statistically significant. This indicates that malaria prevalence in this study is more likely driven by behavioral factors, such as outdoor activities, and environmental conditions, including the presence of breeding sites, rather than nutritional status. The lack of a significant relationship between malaria infection and weight-for-age (WAZ) reported in this study aligns with the findings of Ayana *et al.* (2015) in Ethiopia and Kateera *et al.* (2015) in Rwanda. Additionally, the relationship between stunting and malaria has been widely studied, with conflicting findings. Das *et al.* (2018), in a systematic review, reported that 15 studies linked stunting to an increased risk of malaria, while 11 studies found no association. This variability underscores the complexity of the interaction between nutritional status and malaria infection. The same trend observed with malaria prevalence was also observed with STH, where children with better nutritional indices had higher prevalence of STH than malnourished children. Severe malnourished children showed a low prevalence of both malaria and STH infections. This may be due to reduced exposure, as severely malnourished children often experience mobility or social restrictions that limit their interaction with environments conducive to infection transmission.

This study offers important insights into the prevalence and distribution of malaria and STH infections among orphaned and vulnerable children, as well as their association with nutritional status. The combined burden of malaria, intestinal helminths, and malnutrition among OVC is particularly concerning because it creates a vicious cycle of terrible health outcomes and heightened vulnerability for these vulnerable populations. These results highlight the need for integrated control programs to address both infectious diseases and malnutrition in orphanages.

However, it is important to note that this study had some limitations due to its small sample size and cross-sectional design, which may have limited our ability to establish causality between observed associations. Future research with larger sample sizes and longitudinal designs may offer a better insight into how malaria, STH, and nutrition interact in OVC's.

CONCLUSION

This study reveals a high prevalence of malaria, soil-transmitted helminth infections, and malnutrition among OVCs, underscoring the urgent need for interventions supported by the government such as the distribution of insecticide-treated bed nets, regular deworming programs, improved water, sanitation, and hygiene (WASH) services to reduce the burden of helminth infections, and the provision of nutritious diets to improve the health and well-being of children in orphanages.

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Author Contributions

O.A.S., O.G.D. and K.I.T. contributed to the initial conceptualization of this research. O.A.S. and M.R. were charged with the project management, while N.K. and M.A.A. provided supervision throughout its duration. Data collection was carried out by K.I.T. and G.B.J., with H.M. leading the data analysis and interpretation of the results, as well as actively participating in drafting all versions of the manuscript. All authors contributed to the review and editing process, and each author has read and approved the final manuscript.

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Data availability: All data generated and/or analysed during this study will be made available by the corresponding author, Dr. Olabanji A. Surakat upon reasonable request.

Code Availability: Not applicable.

Declarations

Competing interests: The authors declare no competing interests.

REFERENCES

Akombi, B. J., Agho, K. E., Merom, D., Renzaho, A. M., & Hall, J. J. (2017). Child malnutrition in sub-Saharan Africa: A meta-analysis of demographic and health surveys (2006–2016). PLoS ONE, 12*(5), e0177338.

Alexandre, M. A., Benzecry, S. G., Siqueira, A. M., Vitor-Silva, S., Melo, G. C., Monteiro, W. M., Leite, H. P., Lacerda, M. V., & Alecrim, M. G. (2015). The association between nutritional status and malaria in children from a rural community in the Amazonian region: A longitudinal study. PLoS Neglected Tropical Diseases, 9(4), e0003743. https://doi.org/10.1371/journal.pntd.0003743

Ayana, T. G., Solomon, T., Atsbeha, H., Shumbulo, E. L., Amente, W. D., & Lindtjorn, B. (2015). Malnutrition and malaria infection in children 6–59 months: A cohort study in Adami Tulu District, Ethiopia. Tropical Medicine & International Health, 20(Suppl 1), 294.

Berr, N., Nigatu, Y., & Dereje, N. (2021). Nutritional status among orphans and vulnerable children aged 6 to 59 months in Addis Ababa, Ethiopia: A community-based cross-sectional study. BMC Nutrition, 7(1), 24.

Bisrat, G., & Kulkarni, U. (2017). Assessment of the nutritional status and associated factors of orphans and vulnerable preschool children on care and support from non-governmental organizations in Hawassa town, southern Ethiopia. Global Journal of Medical Research, 16(2), 1–41.

Braitstein, P., Ayaya, S., Nyandiko, W. M., Kamanda, A., Koech, J., Gisore, P., et al. (2013). Nutritional status of orphaned and separated children and adolescents living in community and institutional environments in Uasin Gishu County, Kenya. PLoS ONE, 8(7), e70054. https://doi.org/10.1371/journal.pone.0070054

Brooker, S., Clarke, S., Njagi, J. K., Polack, S., Mugo, B., Estambale, B., Muchiri, E., Magnussen, P., & Cox, J. (2004). Spatial clustering of malaria and associated risk factors during an epidemic in a highland area of western Kenya. Tropical medicine & international health, 9(7), 757–766.

Cansu. (2020). Orphan report research. INSAMER.

Cheesbrough, M. (2006). District laboratory practice in tropical countries, Part 2 (2nd ed.). Cambridge University Press.

Das, D., Grais, R. F., Okiro, E. A., Stepniewska, K., Mansoor, R., van der Kam, S., Terlouw, D. J., Tarning, J., Barnes, K. I., & Guerin, P. J. (2018). Complex interactions between malaria and malnutrition: A systematic literature review. BMC Medicine, 16(1), 186.

Dawaki, S., Al-Mekhlafi, H., Ithoi, I., Ibrahim, J., Atroosh, W., Abdulsalam, A., Sady, H., Elyana, F. N., Adamu, A., Yelwa, S., Ahmed, A., Al-Areeqi, M., Subramaniam, L., Nasr, N., & Lau, Y. L. (2016). Is Nigeria winning the battle against malaria? Prevalence, risk factors and KAP assessment among Hausa communities in Kano State. Malaria Journal, 15(1), 351.

Federal Ministry of Women Affairs and Social Development. (2008). Situation assessment and analysis on OVC in Nigeria. ISBN: 9789780889975, 9780889973

Feleke, S., Egata, G., Mesfin, F., Yilak, G., & Molla, A. (2021). Undernutrition and associated factors in orphan children aged 6–59 months in Gambella Southwest, Ethiopia: A community-based cross-sectional study. BMJ Open, 11(7), e045892.

Ferdoushi, A., Rana, M., Mahmud, M. S., Datta, D., & Akter, F. (2014). Health and nutritional status of selected orphanage children in Tangail City. Journal of Food Science and Technology, 3(1), 11–15.

Fillol, F., Cournil, A., Boulanger, D., Cissé, B., Sokhna, C., Targett, G., Trape, J. F., Simondon, F., Greenwood, B., & Simondon, K. B. (2009). Influence of wasting and stunting at the onset of the rainy season on subsequent malaria morbidity among rural preschool children in Senegal. American Journal of Tropical Medicine and Hygiene. 80, 202–208.

Foko, L. P., Nolla, N. P., Nyabeyeu, H., Tonga, C., & Lehman, L. G. (2021). Prevalence, patterns, and determinants of malaria and malnutrition in Douala, Cameroon: A cross-sectional community-based study. *BioMed Research International, 2021*, 5553344.

Gebreegziabher, E., Dah, C., Coulibaly, B., Sie, A., Bountogo, M., Ouattara, M., Compaoré, A., Nikiema, M., Tiansi, J., Dembélé, N., Lebas, E., Roh, M., Glidden, D. V., Arnold, B. F., Lietman, T. M., & Oldenburg, C. E. (2023). The association between malnutrition and malaria infection in children under 5 years in Burkina Faso: A longitudinal study. The American Journal of Tropical Medicine and Hygiene, 108(3), 561–568. https://doi.org/10.4269/ajtmh.22-0573

Gebretsadik, D., Feleke, D. G., & Fiseha, M. (2018). Eight-year trend analysis of malaria prevalence in Kombolcha, South Wollo, north-central Ethiopia: A retrospective study. Parasites & Vectors, 11(1), 55.

Hassan, A., Onabanjo, O. O., & Oguntona, C. R. B. (2012). Nutritional assessment of school-aged children attending conventional primary and

integrated Qur'anic schools in Kaduna. Research Journal of Medical Sciences, 6(4), 187–192.

Hruby, A., & Hu, F. B. (2015). The epidemiology of obesity: A big picture. Pharmacoeconomics, 33(7), 673–689.

Idowu, O. A., Babalola, A. S., & Olapegba, T. (2022). Prevalence of soil-transmitted helminth infection among children under 2 years from urban and rural settings in Ogun State, Nigeria: Implication for control strategy. Egyptian Pediatric Association Gazette, 70(1), 1–14. https://doi.org/10.1186/s43054-021-00096-6

Isiko, I., Nyegenye, S., Bett, D. K., Asingwire, J. M., Okoro, L. N., Emeribe, N. A., Koech, C. C., Ahgu, O., Bulus, N. G., Taremwa, K., & Mwesigwa, A. (2024). Factors associated with the risk of malaria among children: analysis of 2021 Nigeria Malaria Indicator Survey. Malaria journal, 23(1), 109.

Kabaria, C. W., Gilbert, M., Noor, A. M., Snow, R. W., & Linard, C. (2017). The impact of urbanization and population density on childhood Plasmodium falciparum parasite prevalence rates in Africa. Malaria Journal, 16(1), 49.

Kateera, F., Ingabire, C. M., Hakizimana, E., Kalinda, P., Mens, P. F., Grobusch, M. P., Mutesa, L., & van Vugt, M. (2015). Malaria, anaemia and under-nutrition: Three frequently co-existing conditions among preschool children in rural Rwanda. Malaria Journal, 14(1), 440.

Katona, P., & Katona-Apte, J. (2008). The interaction between nutrition and infection. Clinical infectious diseases: an official publication of the Infectious Diseases Society of America, 46(10), 1582–1588.

Kattula, D., Sarkar, R., Rao Ajjampur, S. S., Minz, S., Levecke, B., Muliyil, J., & Kang, G. (2014). Prevalence & risk factors for soil-transmitted helminth infection among school children in south India. The Indian Journal of Medical Research, 139(1), 76–82.

Kramer, C. V., & Allen, S. (2015). Malnutrition in developing countries. Paediatrics and Child Health, 25(9), 422–427.

Monasch, R., & Boerma, J. T. (2004). Orphanhood and childcare patterns in sub-Saharan Africa: An analysis of national surveys from 40 countries. AIDS, 18(Suppl 2), S55–S65. https://doi.org/10.1097/00002030-200406002-00007

Morales, F., Montserrat-de la Paz, S., Leon, M. J., & Rivero-Pino, F. (2023). Effects of Malnutrition on the Immune System and Infection and the Role of Nutritional Strategies Regarding Improvements in Children's Health Status: A Literature Review. Nutrients. 16(1):1. doi:10.3390/nu16010001.

Noland, G. S., Graves, P. M., Sallau, A., Eigege, A., Emukah, E., Patterson, A. E., Ajiji, J., Okorofor, I., Oji, O. U., Umar, M., Alphonsus, K., Damen, J., Ngondi, J., Ozaki, M., Cromwell, E., Obiezu, J., Eneiramo, S., Okoro, C., McClintic-Doyle, R., Oresanya, O., & Richards, F. O., Jr (2014). Malaria prevalence, anemia and baseline intervention coverage prior to mass net distributions in Abia and Plateau States, Nigeria. BMC infectious diseases, 14, 168.

Okiring, J., Epstein, A., Namuganga, J. F., Kamya, E. V., Nabende, I., Nassali, M., Sserwanga, A., Gonahasa, S., Muwema, M., Kiwuwa, S. M., Staedke, S. G., Kamya, M. R., Nankabirwa, J. I., Briggs, J., Jagannathan, P., & Dorsey, G. (2022). Gender difference in the incidence of malaria diagnosed at public health facilities in Uganda. Malaria journal, *21*(1), 22.

Olanipekun, T. O., Obatolu, V. A., Fasoyiro, S. B., et al. (2012). Assessment of nutritional status of primary school children in Ibadan, South-West Nigeria. Food Science & Nutrition, 42(6), 390–396.

Oldenburg, C. E., Guerin, P. J., Berthé, F., Grais, R. F., & Isanaka, S. (2018). Malaria and nutritional status among children with severe acute malnutrition in Niger: A prospective cohort study. Clinical Infectious Disease 67(1), 1027–1034.

Oluboyo, B. O., Enweani, I. B., Ekejindu, I., & Oluboyo, A. O. (2017). Prevalence of malaria parasitaemia among children resident in orphanages in Anambra State, Nigeria. African Journal of Biomedical Research, 20, 245–247.

Omitola, O. O., Mogaji, H. O., Oluwole, A. S., Adeniran, A. A., Alabi, O., & Ekpo, U. F. (2016). Geohelminth infections and nutritional status of preschool-aged children in a periurban settlement of Ogun State. Scientifica, 2016.

Shikur, B., Deressa, W., & Lindtjørn, B. (2016). Association between malaria and malnutrition among children aged under-five years in Adami Tulu District, south-central Ethiopia: a case-control study. BMC Public Health. 16(1), 174.

Tagurum, Y. O., Chirdan, O. O., Bello, D. A., Afolaranmi, T. O., Hassan, Z. I., Iyaji, A. U., & Idoko, L. (2015). Situational analysis of orphans and vulnerable children in urban and rural communities of Plateau State. Annals of African Medicine, 14(1), 18–24.

Taiwo, T. O., Sam-Wobo, S. O., Idowu, O., Talabi, A., & Taiwo, A. (2017). Comparative assessment of intestinal helminths prevalence in water, sanitation and hygiene (WASH) intervention and non-intervention communities in Abeokuta, Nigeria. Asian Pacific Journal of Tropical Biomedicine, 7. https://doi.org/10.1016/j.apjtb.2017.05.006

Temu, E. A., Coleman, M., Abilio, A. P., & Kleinschmidt, I. (2012). High prevalence of malaria in Zambezia, Mozambique: The protective effect of IRS versus increased risks due to pig-keeping and house construction. PLoS ONE, 7(2), e31409.

Watts, H., Gregson, S., Saito, S., Lopman, B., Beasley, M., & Monasch, R. (2007). Poorer health and nutritional outcomes in orphans and vulnerable young children not explained by greater exposure to extreme poverty in Zimbabwe. Tropical Medicine & International Health, 12(5), 584–593.

Wete, A. T., Zerfu, T. A., & Anbese, A. T. (2019). Magnitude and associated factors of wasting among under-five orphans in Dilla town, southern Ethiopia: 2018: A cross-sectional study. BMC Nutrition, 5(1), 33. https://doi.org/10.1186/s40795-019-0295-6

World Health Organization (2023). Soil-transmitted helminths. Available at: https://www.who.int/news-room/fact-sheets/detail/soil-transmitted-helminth-infections (Assessed 18 January 2023).

World Health Organization (2022). Malaria. Available at: https://www.who.int/news-room/fact-sheets/detail/malaria. Accessed June 10, 2022.

World Health Organization. (2008). Training course on child growth assessment. Retrieved from https://www.who.int/tools/child-growth-standards

World Health Organization. (2009). AnthroPlus for personal computers manual: Software for assessing growth of the world's children and adolescents. Retrieved from https://www.who.int/tools/growth-reference-data-for-5to19-years

World Health Organization. (2021). Malnutrition. Retrieved March 1, 2024, from https://www.who.int/news-room/fact-sheets/detail/malnutrition

Yeganeh, S., Motamed, N., NajafpourBoushehri, S., & Ravanipour, M. (2018). Assessment of the knowledge and attitude of infants' mothers from Bushehr (Iran) on food security using anthropometric indicators in 2016: a cross-sectional study. *BMC Public Health, 18*.