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Full Length Research

Prevalence and intensity of hookworm infection in relation to anaemia among primary school pupils in Lafia rural areas

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ABSTRACT: The study was carried out between March to September 2020 to determine the prevalence and intensity of hookworm infection in relation to anaemia among primary school children in Lafia rural areas of Nasarawa State namely Musha, Alawagana, Duglu and Azuba. Four primary schools were randomly selected from the locality and a total of 560 faecal and 69 blood samples were collected and analysed. Out of the 560 faecal samples analysed, 115(20.5%) were infected with hookworm with a Geometric Mean Intensity (GMI) of 436.2 eggs per gram of faeces (epgf). Meanwhile, the prevalence and GMI of hookworm infection were higher in females (21.5%, 76.3 epgf) than in males (19.6%, 71.1 epgf), though no significant difference (p>0.05) in the prevalence between males and females. Age group 10-12 years old had the highest prevalence rate of hookworm infection (26.3%), followed by 13-15 (22.9%), 7-9 (19.2%) and 4-6 (9.0%). There was a strong inverse correlation (r = -0.99) between the intensity of hookworm infection and haemoglobin value. Haemoglobin value decreased with an increase in the intensity of hookworm infection in terms of eggs per gram of faeces. Hookworm infection is therefore associated with anaemia in the study area.

Keywords: Aneamia, heamoglobin, hookworm, prevalence.

INTRODUCTION

The burden of disease associated with helminth infection is enormous (Albonico *et al*., 2002). Hookworm infection is a great public health concern and produces more serious diseases in humans by blood loss than other helminths (Mughees, 2006). Human hookworm infection is a common helminth infection that is mostly caused by the nematode parasites *Necator americanus* and *Ancylostoma duodenale* (David *et al.,* 2018). The infection is acquired by exposing skin to larvae in soil contaminated with human feaces **(**David *et al*., 2018*).* Infection by hookworm in particular is an important cause of aneamia, due to the gastrointestinal blood loss in addition to protein loss (CDC 2013) and decreased appetite (Hotez *et al*., 2004). An estimated 576 to 740 million people in the world are infected with hookworm (CDC, 2013). Anaemia is a condition in which the number of red blood cells or the haemoglobin concentration within them is lower than normal (Claveland Clinic Medical Professional, 2020). Anyone can develop aneamia, although Children, adolescent and Women have a higher risk of infection (Abah and Arene, 2016; Abah and Arene, 2015; Abah and Wokem 2016). Losing small amounts of blood over a long period of time makes the body loses more iron than it is able to replace with food (Claveland Clinic Medical Professional, 2020). The worm infection is rarely fatal, but anaemia can be significant in a heavily infected individual

(Brooker and Michael, 2000; Nguyen *et al*., 2006; Grimes *et al*., 2017). Anaemia is estimated to affect half the school-age children and adolescents in developing countries (Favour *et al*, 2011; Abah and Wokem, 2016; Kemajou *et al*., 2017) and low haemoglobin was associated with hookworm intensity in children aged and adolescent (Stoltzfus *et al*., 2000) and patients with underlying iron and protein nutritional deficiencies (Beaver *et al.,* 1984).

Public health concerns have focused mostly on children and women of child bearing age who are infected with hookworm because they are the group with high risk of infection identified by World Health Organization (Centre for Disease Control and Prevention (CDC), 2013). School-age children (0– 15 years of age) harbour heavy intestinal parasites and they are the group most responsible for contaminating the environment and transmitting these infections (Albonico *et al.,* 2002; Dada-Adegbola *et al.,* 2005). In endemic areas, the highest prevalences of hookworm infections are reported among school-aged children and adolescents (Wokem and Wokem, 2014). The Higher prevalent rate of hookworm infection among children than in other helminths is a result of most children who by chance eat soil (Uttah, 2007). Some human behavioural attitudes which may also promote the transmission of this worm include babies and toddlers crawling on the bare and contaminated soil and people walking and working barefoot on contaminated farmland (Uttah, 2007).

Once infected, children are more vulnerable to developing morbidity because dietary intake often fails to compensate for intestinal losses of iron and protein, especially in developing countries (Abah and Arene, 2016; Abah and Arene, 2015; Abah and Wokem, 2016). *Necator americanus* and *Ancylostoma duodenale*, the two major species of human hookworms are sympatric over much of their distribution and people are often simultaneously infected with both species in endemic areas (Chollom *et al*., 2012). This study was therefore aimed at investigating the prevalence and intensity of hookworm infection in relation to anaemia among primary school pupils in Lafia rural areas.

MATERIALS AND METHODS

Lafia the capital city of Nasarawa State is situated in the savannah region in North Central. The study was carried out in Musha, Duglu, Alawagana and Azuba, small towns and villages surrounding Lafia (Figure 1). One primary school was chosen in each of the villages and a stool sample and 2 ml of venous blood each were collected from 560 and 69 study subjects respectively. The study was conducted among primary school pupils, age 4 to 15 years. A simple questionnaire was distributed to the pupils to determine their, age, sex and sanitation situation in their schools and homes. The samples were analysed for hookworm infection and its intensity using methods by Arora and Arora (2010), Cheesbrough (2005).

Samples were collected using wide mouthed transparent sample bottles assigned with codes. Faecal samples were analysed at Parasitology Laboratories Units of Dalhatu Araf Specialist Hospital Lafia. Samples were examined using the direct smear and formol ether concentration technique as described by Arora and Arora (2010). Two grams (2 g) of faeces was picked using an applicator stick and smeared evenly on a drop of physiological saline on a clean glass slide and viewed under the microscope using x10 and x40 objective lenses. Using the concentration technique, 5 g of faeces from each sample was mixed thoroughly in 10 ml of water and strained through layers of gauze in a funnel and 3 ml each of ether and formalin were added to the filtrate and centrifuge at 2000 rpm for 2 minutes. After minutes of rest, the supernatant was discarded and a drop of sediments was viewed under the microscope with x10 and x40 lenses. The Intensity of infection was evaluated using Stoll's technique for counting helminth egg, expressed as eggs per gram of faeces (epgf) (Cheesbrough, 2005). Three grams (3 g) of faeces from each sample were mixed with 45 ml of water in a screw cap container and 0.15 ml of the suspension was transferred to a slide using a micropipette after the mixture, was covered completely and examined under the microscope. The number of eggs observed was multiplied by one hundred (100) to give the number of eggs per gram of faeces (epgf). The intensity of hookworm infection was classified according to WHO guidelines: zero (0) epgf classified as nil, one up to two thousand (1- 2,000) epgf classified as light, two thousand and one up to four thousand (2,001–4,000) epgf as moderate and greater than four thousand and one (> 4,001) epgf classified as heavy (Montresor *et al.,* 2002).

With the help of local health workers and a hired medical laboratory personnel, blood samples were taken a day after faecal sample collection under sterile technique. A needle and syringe were used each on a pupil. After disinfection of skin at the lower arm with methylated spirit, blood was collected through venipuncture and emptied into an Ethylene Diamine Tetra Acetic Acid (EDTA) bottles.

The uncompromising attitude of pupils on sighting the needle and syringe despite obtaining consent affects immensely the collection of blood samples as a result only the pupils that availed themselves (69 pupils) were sampled for blood across different areas.

Anaemia was determined by haemoglobin estimation using the cyanmethaemoglobin method (HICN) by Wittman and John (1983). Using Photoelectric Calorimeter (Sigma Diagnostics kit; Sigma, St Louis), blood samples were analysed at Haematology Laboratories Units of Dalhatu Araf Specialist Hospital Lafia. 0.2 ml of blood from the EDTA bottle was mixed thoroughly with 4 ml drabkins solution using a haemoglobin micropipette dispenser and

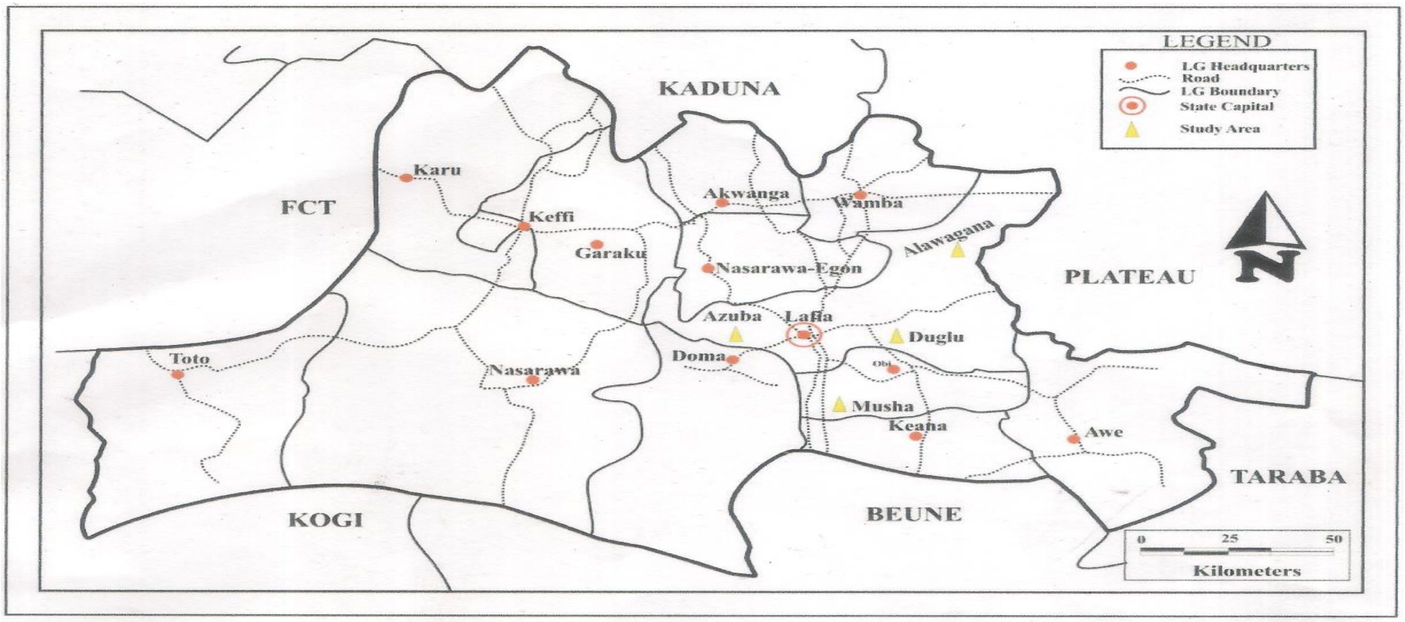

Figure 1. Map of Nasarawa State indicating the Local Governments and the study location.

left at room temperature away from sunlight for 5 minutes in a test tube. Haemoglobin less than 12 g/dl is regarded as anaemic (Kevin *et al*., 2008).

Data analysis

Differences in the prevalence of hookworm infection among school children by age were determined using ANOVA and X^2 tests for the association of infection between males and females. Relationship between the intensity of hookworm infection in terms of eggs per gram of faeces and haemoglobin was determined by the correlation coefficient method as described by Omalu *et al*. (2010).

RESULTS

Out of 560 samples examined for hookworm infection, 281 males and 279 females, 115 pupils were infected with hookworm with a prevalence rate of 20.5%. Out of 115 positive cases with hookworm, 55 were males and 60 were females. The females had a higher prevalence (21.5%), than males (19.6%), however, no significant difference ($p>0.05$) in the prevalence between males and females (Table 1).

The prevalence and geometric mean intensity of hookworm infection by age in the population of the school pupils studied showed that pupils between the ages of 10-12 years had the highest prevalence rate of 26.3%, followed by the age group 13-15 years with the prevalence of 22.9% then pupils of 7-9 years of age groups with the prevalence of 19.2%, while pupils of 4-6 age groups had the least prevalence rate of 9.0%. However, age group 7-9 years had the highest geometric mean intensity (45.5 epgf) followed by age group 4-6 (37.4 epgf) then 13-15 years old with a geometric mean intensity of 35.6 and 10-12 years with a geometric mean intensity of 29.5 epgf (Table 2).

Table 3 showed the relationship between the intensity (number of eggs per gram of faeces) of hookworm infection and haemoglobin value in grams per deciliter (g/dl). There is a linear inverse relationship between haemoglobin values and hookworm infection in terms of the number of eggs per gram of faeces. As the number of eggs per gram of faeces increased, the haemoglobin value decreased. The correlation coefficient by Karl Pearson (Omalu *et al*., 2010) showed a strong correlation ($r = -0.99$) between the intensity of hookworm infection and haemoglobin value.

DISCUSSION

The result of this investigation revealed 20.5% prevalence rate of hookworm infections from the study group in the study area. Similar observation was made by Adeyeba and Akinlabi (2002) among primary school pupils in rural community in Southwest Nigeria but the overall prevalence of 20.5% of hookworm infection recorded in this study is relatively high when compared to the report

Table 1. Prevalence and intensity of Hookworm infection by sex among pupils.

Sex	Number examined	Number positive	% Prevalence	GMI
Male	281	55	19.6	71.1
Female	279	60	21.5	76.3
Total	560	115	20.5	147.4

No. Exam. = Number Examined, No. tive = Number Positive, % Pre. = percentage prevalence and GMI = Geometric Mean Intensity.

Table 2. Prevalence and intensity of hookworm infection by age group among pupils.

Age group (Yrs)	Number examined	Number positive	% Prevalence	GMI
4-6	100	9	9	37.4
7-9	130	25	19.2	42.5
10-12	160	42	26.3	29.5
13-15	170	39	22.9	35.6

Age Grp= Age group, No. Exam. = Number Examined, GMI=Geometric mean intensity, No. +ve = Number positive and %= percentage prevalence.

Table 3. Relationship between intensity of Hookworm infection and Anaemia (haemoglobin g/dl).

Intensity	Number of subjects	Haemoglobin value (g/dl)
≤2000	27	13.7
2001-4000b	25	11.8
4001-6000c	4	10.4
6001-8000c	5	9.2
8001-10000c	5	8.5
10001-12000c	3	7.2

HB=haemoglobin, egpf=eggs per gram of faeces, a=light, b=moderate and c=heavy infections. r = - 0.99.

of Abah and Wokem (2016) in Aba Metropolis, Abia State, Adeyeba and Tijani (2002), Odebunmi et al., (2007) and Kemajou *et al.* (2017) in Igbo-ora in Oyo State, Vom, Plateau and Elele, Rivers-State Nigeria, respectively. The environment of these schools and the socio-cultural habits of the pupils could be responsible for the relatively high prevalence of hookworm infection in these areas. All the schools had no toilet facilities and the pupils defecate indiscriminately in the nearby bushes and around the school compound. A similar observation was made by Ezeaguna *et al.* (2010) who reported that the high prevalence of hookworm infections appeared to be a norm in many unhygienic rural communities. Though no significant association (p>0.05) between male and female pupils, the prevalent rate of hookworm infections in females was higher (21.4%) than in males (19.6%). This was in accordance with the reports of Chukwuma *et al.* (2009) and Ezeaguna *et al.* (2010) who reported a very high prevalence rate of hookworm infections among females than males school pupils in Ozobulu and Ebenebe town in Anambra State. So also, Kemajou *et al*. (2017) reported a high hookworm infection rate among female pupils in Elele, Rivers State, Nigeria. This finding is also consistent with the reports of Odebunmi *et al.* (2007), Abah and Arene (2016) and Wokem and Wokem (2014) who observed a higher infection rate of hookworm among females than males in Vom, Plateau State, the urban area of Rivers State and Port Harcourt respectively but statistically not significantly different. The high prevalence of worm infection among females is attributed to the variation in the frequency and intensity of occupational exposure to the contaminated environment in the areas. The females assist more in carrying out domestic chores in the houses, by removing and carrying waste materials to open refuse dumps sometimes barefoot and fetching water from streams, than the males. This finding however disagrees with that of Babamale *et al.* (2015) and some other researchers that reported otherwise. Their explanation suggested that immunological and hormonal factors play a role in the reduction of infection in females.

If however, other factors such as environmental and level of exposure are favourable, transmission and hence the prevalence of hookworm will be high.

The prevalence of hookworm infections increased with increase in age. The peak of infection with hookworm was highest between the age group 10-12 years. This suggested that this age group contribute more to the transmission of hookworm infection than other age groups. Dada-Adegbola *et al.* (2005), Ezeaguna *et al.* (2010) and Abah and Wokem (2016) supported this finding and reported the highest prevalence among children aged 12-17 years, than other age groups. These corroborate Crompton (2000) who suggested that teenagers and pregnant women were more at risk of hookworm and hookworm diseases such as iron deficiency anaemia than any other age group. The relationship between the intensity of hookworm infections and haemoglobin showed a strong correlation (r = - 0.99). The higher the number of eggs per gram of faeces, the lower the haemoglobin counts and consequently increased in the severity of anaemia. Similar relationships were reported by Mughees **(**2006) and Grimes *et al.* (2017). Nguyen *et al.* (2006) reported that hookworm infection was the strongest factor associated with anaemia and its intensity was significantly associated with haemoglobin level; for each 1000 egg increase, haemoglobin was reduced by 1.3 g/dl. Light infection with hookworm led to compensated anaemia while moderate and heavy infection led to hypochromic anaemia. Beaver *et al. (*1984) reported that moderate and heavy hookworm infection especially in patients with underlying iron and nutritional deficiencies resulted in anaemia.

Conclusion

There was a relatively high prevalence of hookworm infection in the study area. Though no statistically significant associations were found between male and female pupils for hookworm infection, there was a higher prevalence of hookworm infections among females than males. Also, the correlation between anaemia and intensity of hookworm infection was strong. Moderate and high intensity of hookworm infection was responsible for anaemia in the study area, the higher the number of eggs per gram of faeces, the lower the haemoglobin counts. Any public health intervention aimed at reducing anaemia prevalence, to be effective, must include the control of hookworm.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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