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High prevalence of *Plasmodium falciparum* and soil-transmitted helminth co-infections in a periurban community in Kwara State, Nigeria

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ABSTRACT

Prevalence of malaria and soil-transmitted helminth infections, and the burden of disease are enormous in sub-Saharan Africa. Co-infections aggravate the clinical outcome, but are common due to an overlap of endemic areas. A cross-sectional survey was conducted to assess prevalence, intensity of infection and association between malaria and soil-transmitted helminth infections in a typical periurban community in Kwara State. Fresh blood and faecal samples were examined using thick blood film and Kato-Katz smear techniques.

A total of 383/471 study participants (81.3%) were infected with at least one parasite species, with the following prevalences and mean infection intensities: *Plasmodium falciparum* 63.7% (2313.6 parasites/μl); *Ascaris lumbricoides* 63.1% (3152.1 epg); *Trichuris trichiura* 53.3% (1043.5 epg); and hookworms 30.1% (981.7 epg). Sixty-three percent of the study population were co-infected with two or more parasite species. The prevalence of ascariasis was significantly higher in individuals infected with *P. falciparum* (adjusted OR: 5.87; 95% CI: 3.30–10.42). Heavy *A. lumbricoides* and *T. trichiura* infections were associated with high *P. falciparum* parasitaemia. Co-endemicity of malaria and soil transmitted helminth infections is an important public health problem in the study area. Multi-target integrated approaches focusing on disease intervention are essential to mitigate morbidity caused by multiple infections.

Introduction

Despite intensive control measures performed worldwide, malaria still causes a serious health burden in many tropical and subtropical countries, with the Democratic Republic of the Congo and Nigeria accounting for more than 35% of global malaria deaths [1]. Commonly, there is a geographical overlap of regions with high malaria endemicity, and the occurrence of Neglected Tropical Diseases (NTDs), such as soil-transmitted helminth infections. As a consequence, co-infections are expected to be a common phenomenon, rather than an exception, mainly in resource-poor communities [2–5].

While single malaria infections are often serious and even fatal especially in children, intestinal helminth infections may also result in serious clinical outcomes. Consequently, social and clinical consequences of multiple infections are heavily increased, as compared to single infections [5–8].

In Nigeria, soil-transmitted helminth infections and malaria are recognized major public health problems [3,9]. Endemic areas are mostly sustained by ecological, behavioral and socio-environmental conditions that favor parasite development and transmission, and include highly vulnerable populations [5,9,21].

Previous studies in schoolchildren revealed antagonistic effects in helminth-schistosome coinfection [5]. However, epidemiological surveillance and spatial congruence of both malaria and helminthiases remain poorly defined in Nigeria. This baseline information is necessary for cost-effective control measures that rather target multiple diseases than a single infections. The present study investigated malaria and soil-transmitted helminth infections in a community in north central Nigeria.

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Materials and methods

Study area and population

A community-based study was conducted in Ogele, a typical peri-urban area. Ogele is a small linear settlement, located along the old Ogbomosho road, about 13 km from Ilorin, the state capital of Kwara State. The climate is tropical, with well-defined wet (April–October) and dry (November–March) seasons (mean annual precipitation of >1.100 mm). The community is located in the transitional zone between rainforest and savannah grassland.

The inhabitants belong mainly to the Yoruba ethnic group, with a small proportion of Hausa, Nupe and Fulani ethnic groups. The vast majority (95%) are Muslims with a few Christians and members of traditional religions [10]. People are mainly peasant farmers, and grow crops such as cassava, maize, vegetables and yam.

Generally, sanitation status is poor. Most houses are devoid of toilets and adequate ventilation, with dumpsites located close to human habitations. The community is inadequately provided with essential amenities, such as electricity and portable water supply. There is one primary school, a secondary school and a primary health care centre.

Data collection and laboratory procedures

First, we performed a census in the community, consisting of a house-to-house survey. The population in Ogele was estimated to amount 619. Individuals with history of anthelminthic and antimalarial treatment (past three weeks) and those living for less than three months in the study area were excluded. History of treatment was confirmed by examination of drugs and/or medical prescriptions.

The recruitment of participants and data collection were conducted between January and May 2015 (end of dry season and beginning of rainy season).

During house visits, participants were instructed on how and when the samples (stool and blood) were to be taken. Pre-tested questionnaires were administered to obtain socio-demographic variables.

Thick and thin blood smears were prepared on a different slide from capillary blood obtained from the 3rd finger of left hand by finger prick using a sterile lancet. Blood smears were stained with Giemsa and examined under the oil immersion microscope objective. Thick smear was used to diagnose presence of malarial infection and parasitaemia load, and thin smear was used to identify the type of *Plasmodium* species. The number of parasites per microliter of blood was calculated as described in Cheesbrough [11]. At least one hundred fields were examined before a negative result was reported.

Stool samples were collected in labeled wide-mouth screwed-capped containers and processed for microscopic examination, using Kato-Katz thick smear method [12]. Kato-Katz slides were examined at the Parasitology Laboratory of University of Ilorin for the presence of helminth eggs, within a week after preparation. To estimate intensity of infection, egg counts per slide were converted to egg per gram of faeces (epg) by multiplying number of eggs on the slide by 24. The mean density of the epg of faeces was used to classify the pattern of infection as light, moderate and heavy infection, as defined by WHO [13]. All blood and stool slides were examined by two investigators who were blinded to the results, and where positive/negative discrepancy occurred, slides were counter-read by a third experienced parasitologist (USU), who was blinded regarding the two previous results.

Table 1
Demographic characteristics of the study population (n = 471).

Characteristic	No (%)
Gender	
Male	228 (48.4)
Female	243 (51.6)
Age (years): median (range)	23 (3–64)
Toilet facilities	
Cesspit/pit	114 (24.2)
None	357 (75.8)
Main source of water supply	
Borehole/well	233 (49.5)
Stream/pond	238 (50.5)
Education	
Primary education completed	208 (44.1)
Primary education not completed	263 (55.9)
Bed net (ITN) use	
Yes	140 (29.7)
No	331 (70.3)
Parasite infection pattern	
Single infection	118 (25.1)
Double infection	54 (11.5)
Multiple infection	211 (44.8)

Data analysis

Categorical variables are presented as ratios (%), and continuous variables with means and their standard deviations (SD). Differences in the prevalence and intensity of infection between ages and sexes were tested using the Chi squared (categorical variables) and one way ANOVA tests (continuous variables). As stratified analyses have shown a considerable influence of age and sex regarding and infection intensities were stratified by sex and age. Statistical analyses were performed using Excel (Windows Corporation, Redmond, WA, USA) and SPSS version 16 (SPSS Inc., Chicago, IL, USA). Prevalence, simple logistic regression analysis was applied to determine association between the parasites species adjusted with age and sex.

Results

A total of 508 people were eligible (70.6% of target population); 25 had a history of anthelminthic and antimalarial treatment in the past three weeks, and 12 had been living for less than three months in the study area and were excluded; resulting in a study population of 471 individuals. Of these 228 (48.4%) were males and 243 (51.6%) females, with a median age of 23 years. More than half of the population were illiterate; only about 1/4 had access to ITN bed nets, and the vast majority had not received any anthelminthic treatment within the last 3 weeks. Detailed demographic characteristics of the study population are summarized in Table 1.

Prevalence of *Plasmodium falciparum* infection was highest (64%), followed by ascariasis (63%), trichuriasis (53%) and hookworm infection (30%, Table 2). A low prevalence of *Plasmodium vivax* (0.03%) was recorded in the study area. A total of 383 (81.3%) were co-infected with one or more parasite species.

The prevalence and intensity of each of the four parasite species followed similar patterns, and varied significantly with age (Tables 2 and 3). With the exception of hookworm infection, which showed a significant steady increase with age, highest prevalences were observed in 11–20 year-olds.

Infection densities are detailed in Table 3. Soil-transmitted helminth infections were more prevalent and showed significantly higher infection intensity among males. Infection density of malaria reduced gradually with age (Table 3).