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Epidemiological Studies of Polyparasitism in Two Different Communities in Benue State, Nigeria

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Abstract. To advance knowledge on polyparasitism in Nigeria. This study examined parasitic infections and co-infections in two contrasting communities in Benue State, Nigeria. Urine specimens were evaluated for *Schistosoma haematobium* using the filtration technique, stool specimens were examined for intestinal parasites using the concentration technique, and blood specimens were examined using the thick and thin film technique for *Plasmodium* species. Results show high prevalence of infections in both populations, with 26.9% of participants carrying a single parasitic infection. Co-infection with two parasites was recorded in 9.1% while multiple infections with three parasites were recorded in 0.7% of participants. The prevalence rates in the two communities was significantly different ($df = 1$, $p < 0.05$). There were differences in infection rates between male and female participants. Of the 316 male examined, 26.6% and 8.9% had single and double infection rates, while the 375 female had 27.2% and 9.3% single and double infection rates. These gender differences are not statistically significant ($p > 0.05$). Six parasites were identified, with *Schistosoma haematobium*, *Plasmodium falciparum* and *Ascaris lumbricoides* accounting for the most frequent combination of parasite species. The synergistic impact of multiple parasitisms on the individual and community are discussed and the need to explore the consequences of these relationships stressed.

Keywords: Polyparasitism, Synergistic consequences, Naka, Kwasa, Nigeria

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Introduction

There has been a general renaissance in the epidemiological investigation of polyparasitism, with a particular focus on multiple helminth species[1-6] and more recently, on *Plasmodium* and helminth co-infection[7-11]. Interactions between parasites in humans can be synergistic or antagonistic[2]. Studies have demonstrated a positive association between intensity and concurrent infection of helminth species, suggesting that individuals harbouring multiple helminth species also harbour the most intense infections[2,12,13].

Morbidities are also likely to be compounded in people harbouring multiple parasites. For example, co-infections with helminthes and *Plasmodium* species have been shown to increase negative health effects, including organomegaly[12,14,15], low birth weight[16] and anemia[17,18] as compared to single infections. The morbidity associated with co-infection is also likely to depend on parasite load[19] as is seen in single-species *Plasmodium* infections[7] and *Schistosoma haematobium* (*S. haematobium*) infections[20]. Understanding the complexities of the pathogen-host landscape in settings of endemic situations for multiple human parasites is essential and deserves more attention for reducing morbidities.

This study was designed to examine the parasitic infections and co-infections in two different communities in Benue State, and to evaluate the circumstances of polyparasitism in Nigeria. The specific research objectives were to describe the prevalence and intensity of single and multiple species infections, and to identify epidemiological predictors of single and multiple infections.

Materials and Methods

Study Sites and Population

This study was conducted in 2009 in Naka, a rural community in Gwer-West Local Government Area and Kwasa, a sub-urban settlement near Makurdi (the Benue State capital), Nigeria. The two communities lie within longitude 8°00’ and 8°30’ E and latitude 7°30’ and 8°00’ N (Fig. 1).

Kwasa

The demographic characteristics of this settlement are typical of urban slums with buildings poorly ventilated and overcrowded. This study site is a sub-urban settlement and residents are predominantly subsistence farmers, low income earners working in the State capital and retired Air Force personnel. The settlement houses the Nigeria Air force Base and residents benefit from health services provided by the Nigerian Air Force.

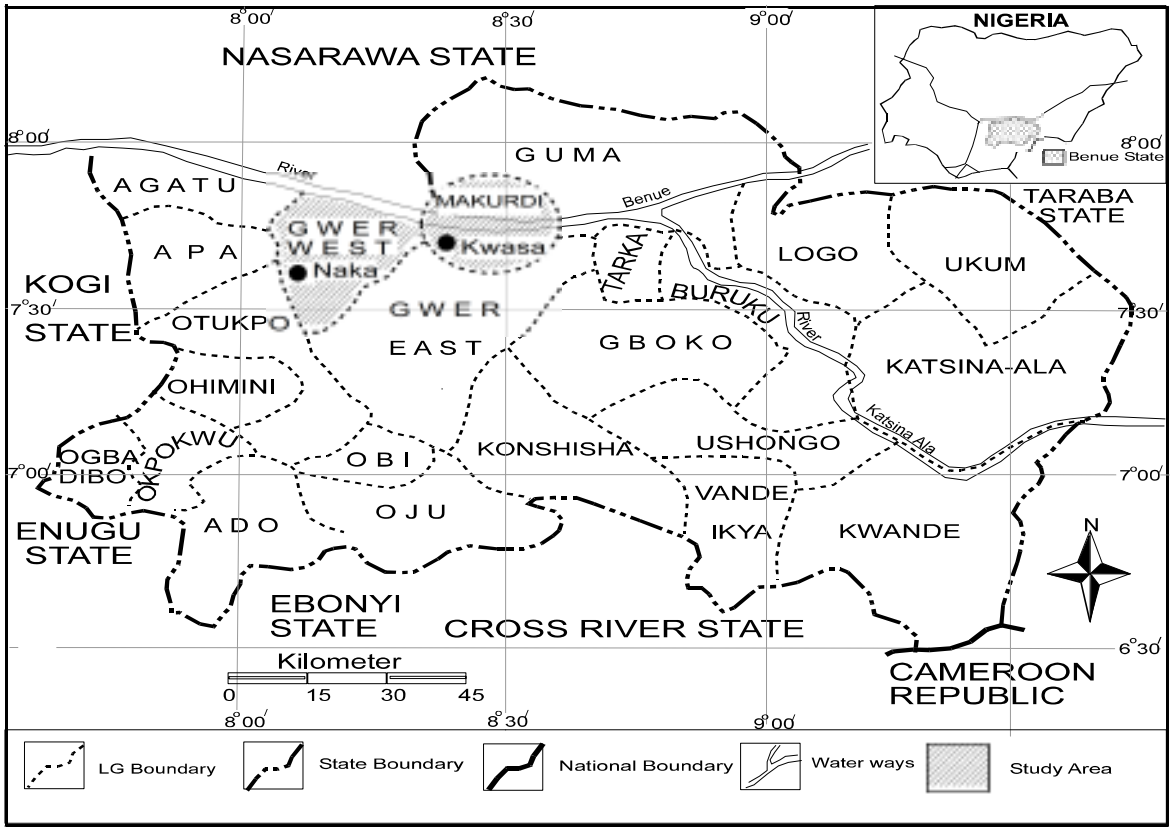

Fig. 1. Map of Benue State showing location of study sites; Kwasa and Naka.

Naka

Sparsely populated community with isolated settlement, access to pipe borne water is virtually non-existent and seasonal streams, hand dug wells and earth dam are the only source of water. The sanitary condition is poor with overwhelming evidence of open air defecation and only a few households using pit latrines. Residents are predominantly farmers and civil servants.

Household Demography

A complete demographical profile of these communities was compiled to identify participating households and household heads who responded to questionnaires. Every individual in the randomly selected household was invited to participate in the study. Ethical clearance for this study was granted by the Benue State University Institutional Review Board and Nigerian Air Force Medical Centre. Consent from participating individuals was sought through verbal persuasion highlighting the importance of medical examination. For infants and young children within the age group (1-10), parental consent was obtained before inclusion in the study. After consent was obtained, a questionnaire was administered to each participant to obtain information on sex, age, source of water, type of toilet and other demographic indices.

Parasitological Examination

The reason and procedure for stool, blood and urine examination was explained to all adults participating in the study at each study site. A member of the community who is a trained laboratory technician was identified and recruited to assist in sample collection to eliminate suspicion. Each participant was given two labeled specimen bottles, one for stool and the other for urine samples, on the day of submission, and their finger prick blood sample was taken. Urine specimens were examined for *S. haematobium* using the filtration technique. Stool specimens were examined for intestinal parasites using the concentration technique, and blood specimens were examined using the thick and thin film technique as described in Ukaga *et al.*[21]. Participants whose parasitological diagnosis was positive for any two or more parasites were considered to be co-infected.

Statistical Analysis

Data was analyzed using simple percentages and frequencies, and differences in proportion were evaluated using the Chi-square test. Statistical significance was achieved of $p < 0.05$.

Results

A total of 691 persons in both communities were parasitologically examined. Results show high prevalence of infections in both populations, with 26.9% of participants carrying single parasitic infection. Co-infection with two parasites was seen in 9.1%, while multiple infections with three parasites were recorded in 0.7% of participants (Tables 1 and 2). Analysis of the infection data in the two communities showed that the prevalence of infection in the Naka was higher than in the Kwasa, while 35.1% and 11.2% in Naka had single and dual infections. The rates were only 18.2% and 6.9%, respectively in Kwasa (Tables 1 and 2). The prevalence rates in the two communities was significantly in both communities, the age-group of 1-10 years recorded the highest infection rates for both single and multiple parasitism. When compared to other age groups, these differences were also significantly different ($p < 0.05$). In both communities, the pattern of infection between male and female participants showed no consistency. In Kwasa study site, single infection in female was 20.1% compared to 15.9% in male. The males however, had higher multiple infection rates of 7.9% compared to 5.8% in the female. On the other hand, the multiple infections in female in Naka were higher (12.5%) than in male (9.7%). Overall, these gender differences are not statistically significant ($p > 0.05$).different ($X^2 = 16.72$, $df = 1$, $p < 0.05$).

Six parasites were identified in the course of the study; these were *S. haematobium, Plasmodium falciparum (P. falciparum), Ascaris lumbricoides (A. lumbricoides), hookworm, Entamoeba histolytica (E. histolytica) and Trichuris trichiura (T. trichiura).* The parasite combination of *S. haematobium, P. falciparum and A. lumbricoides* accounted for the most frequent combination of parasite species (Figs. 2 and 3). Dual infection due to *S. haematobium* and *P. falciparum* was more common in the two communities, accounting for 46.5% and 21.7% in Naka and Kwasa, respectively. While no case of triple infection was encountered in Naka, Kwasa community recorded 5 cases of triple infection, and a case of an individual harbouring three different intestinal parasites and *P. falciparum*.

Table 1. Distribution of single and multiple parasitic infections in relation to age and sex in Kwasa settlement.

	Male				Female				Total			
Age Group	No. Examined	Single Infection	Double Infection	Triple Infection	No. Examined	Single Infection	Double Infection	Triple Infection	No. Examined	Single Infection	Double Infection	Triple Infection
1-10	20	4 (20.0)	5 (25.0)	1 (5.0)	13	4 (30.8)	1 (7.7)	1 (7.7)	33	8 (24.2)	6 (18.2)	2 (6.0)
11-20	100	17 (17.0)	6 (6.0)	1 (1.0)	107	20 (18.7)	9 (8.4)	2 (1.9)	207	37 (17.9)	15 (7.2)	3 (1.4)
21-30	19	-	-	-	33	5 (15.2)	1 (3.0)	-	52	5 (9.6)	1 (1.9)	-
31-40	6	-	-	-	24	7 (29.2)	-	-	30	7 (23.3)	-	-
41-50	5	3 (60.0)	1 (20.0)	-	5	-	-	-	10	3 (30.0)	1 (10.0)	-
51-60	1	-	-	-	2	1 (50.0)	-	-	3	1 (33.3)	-	-
Total	**151**	**24 (15.9)**	**12 (7.9)**	**2 (1.3)**	**184**	**37 (20.1)**	**11 (5.8)**	**3 (1.6)**	**335**	**61 (18.2)**	**23 (6.9)**	**5 (1.5)**

Figures in parentheses are percentages.

Table 2. Distribution of single and multiple parasitic infections in relation to age and sex in Naka.

	Male				Female				Total			
Age Group	No. Examined	Single Infection	Double Infection	Triple Infection	No. Examined	Single Infection	Double Infection	Triple Infection	No. Examined	Single Infection	Double Infection	Triple Infection
1-10	40	19 (47.5)	6 (15.0)	-	36	13 (36.1)	7 (19.4)	-	76	32 (42.1)	13 (17.1)	-
11-20	57	23 (40.3)	7 (12.3)	-	68	28 (41.2)	11 (16.2)	-	125	51 (40.8)	18 (14.4)	-
21-30	20	9 (45.0)	1 (5.0)	-	24	7 (29.1)	3 (12.5)	-	44	16 (36.4)	4 (9.1)	-
31-40	16	5 (31.3)	1 (6.3)	-	20	9 (45.0)	2 (10.0)	-	36	14 (38.9)	3 (8.3)	-
41-50	26	4 (15.4)	1 (3.8)	-	34	7 (20.6)	1 (2.9)	-	60	11 (18.3)	2 (3.3)	-
51-60	6	-	-	-	9	1 (11.1)	-	-	15	1 (6.7)	-	-
Total	**165**	**60 (36.3)**	**16 (9.7)**	-	**191**	**65 (34.0)**	**24 (12.5)**	-	**356**	**125 (35.1)**	**40 (11.2)**	-

Figures in parentheses are percentages.

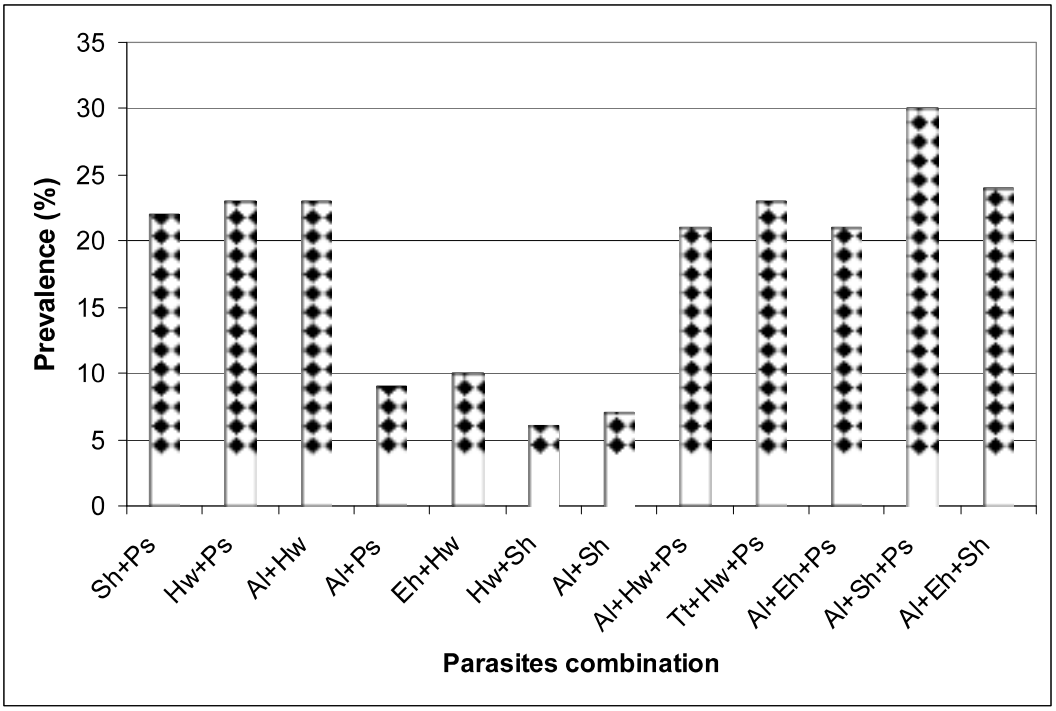

Fig. 2. Combination of parasites species in Kwasa settlement. Key: Sh = *S. haematobium*, Ps = *Plasmodium* species, Hw = Hookworm, Al = *A. lumbricoides*, Eh = *E. histolytica*. Tt = *T. trichiura*.

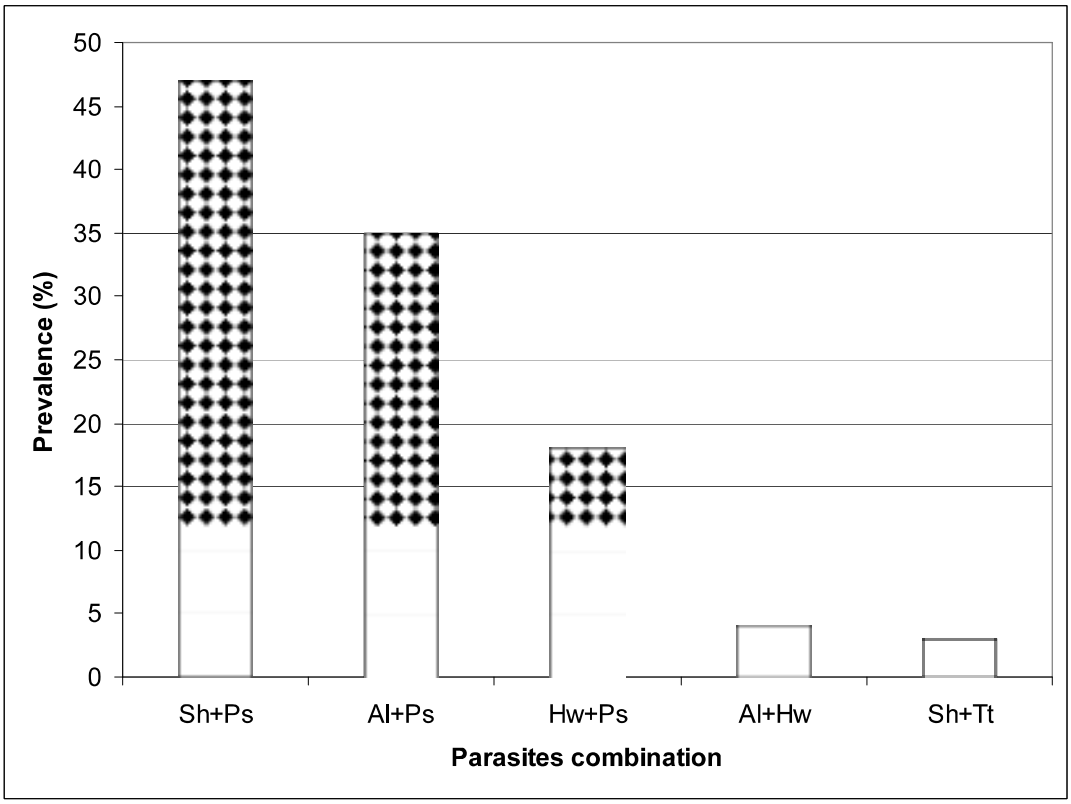

Fig. 3. Combination of parasites species in Naka. Key: Sh = *S. haematobium*, Ps = *Plasmodium* species, Hw = Hookworm, Al = *A. lumbricoides*, Eh = *E. histolytica*, Tt = *T. trichiura*.

Questionnaire analysis showed that the type of toilet and source of water did not significantly influence prevalence of polyparasitism. The rate of infection in respondents who use well as source of water had higher infection rates when compared with other sources of water (Fig. 4).

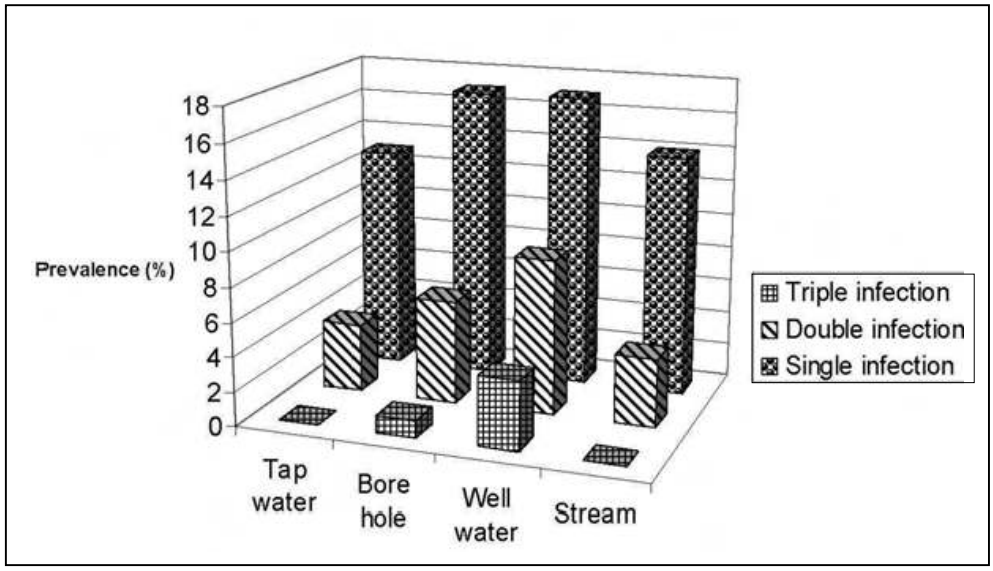

Fig. 4. Relationship between source of water and prevalence of infection.

Respondents who defecate in open field had higher infection rates than those who use pit latrines and water closets (Fig. 5). These differences in infection rates were, however not statistically significant ($p > 0.05$).

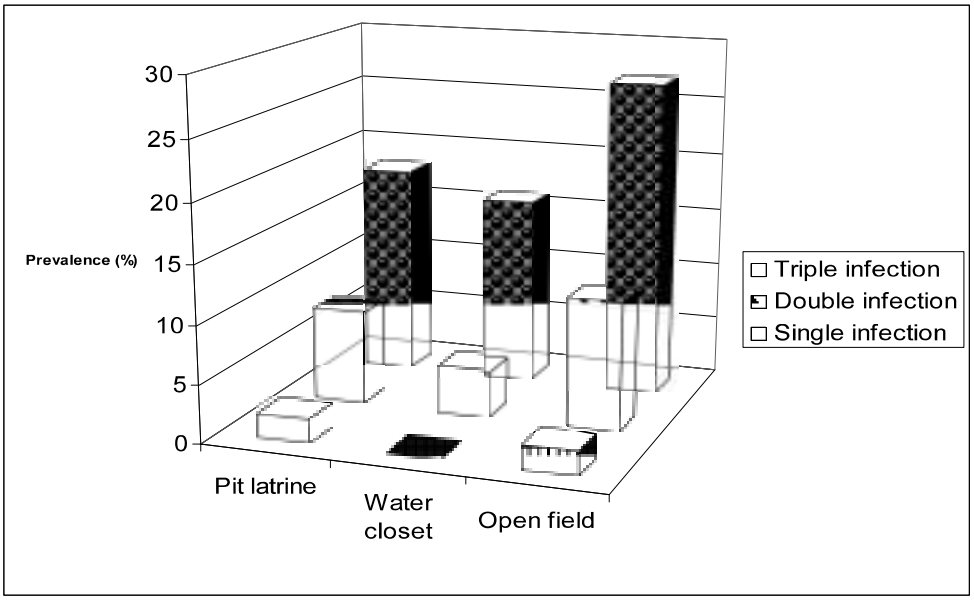

Fig. 5. Relationship between type of toilet and prevalence of infection.

Discussion

Polyparasitism is not a new phenomenon. Concomitant infection with multiple parasites has attracted research interests for a long time. There has, however been a general renaissance in the epidemiological investigation of polyparasitism, with particular focus on multiple helminth and protozoan species. The overall prevalence of polyparasitism encountered in these two communities was considerably low. Similar prevalence rates have also been reported from neighbouring Ebonyi State[6] and in communities along the Upper Regang River in Malaysia[22]. Higher prevalence rates of between 50% - 77% have been reported in parts of Africa[4,10]. Our observations confirm previous studies from different ecological and epidemiological settings in sub-Saharan Africa, highlighting that multiple parasite infections are the norm rather than the exception[12,23]. The main reasons for the high prevalence of multiple parasitisms have always been blamed on deplorable sanitary, social and environmental conditions, as well as inadequate or lack of basic amenities in both urban and rural communities. These conditions have in fact deteriorated in Nigeria within the past decade and will no doubt exacerbate disease transmission. Another reason for the observed high prevalence of soil-borne intestinal parasites is the practice of open-air defecation, which was common in both communities. The absence of household toilet facilities is epidemiologically significant as the environment continue to be seeded with parasite eggs.

The synergistic effect of concomitant parasitic infection in these individuals reveals that these infections interact biologically to influence morbidity and other human growth parameters within the communities[2]. Earlier studies in parts Benue State revealed that parasitic infections stunted growth in children[27]. Studies have demonstrated a positive association between intensity and concurrent infection of different parasite species, suggesting that individual's harbouring multiple helminth species also present with the most intense nutrient deficiency and growth impairment[2,12,10,24]. Polyparasitism may therefore have a greater impact on morbidity than single species infections, since morbidity is typically related to infection intensity for most parasites[12]. Multiple species infections is also believed to increase susceptibility to other serious life threatening infections, especially tuberculosis and HIV/AIDS[9,25,26].

Teenagers within the age bracket of 11-20 years were significantly more infected with both single and double parasite species. This may be as a result of higher level of exposure to the epidemiological factors that increase risk and enhance susceptibility. Studies elsewhere have also reported similar bias to this age group[4,6,22]. The particularly high prevalence of *S. haematobium* + *P. falciparum* and *S. haematobium* + *A. lumbricoides* combinations in Naka could be attributed to the earth dam constructed in the town which is the only source of water during the dry season. Kwasa settlement also recorded *S. haematobium* and *P. falciparum* as the most frequently encountered parasite combination. Despite the close proximity of the settlement to the state capital, residents resort to minor tributaries of the Benue River for water. The water contact behaviour in the two communities therefore increases the transmission potential and risk for dual infection. Studies in coastal Kenya have also reported significant association between *S. haematobium* and *P. falciparum* in school age children[10]. These observations re-enforce the view that there is a positive association between the intensities of the two parasites.

Clearly polyparasitism is widespread throughout the tropics, accurately estimating the magnitude of the problem remains a major epidemiological challenge. Further research on this topic is clearly warranted due to the importance of polyparasitism to public health, evidenced both by the high prevalence of parasitism and deteriorating sanitary conditions. Additional studies on polyparasitism in areas endemic for tuberculosis and HIV/AIDS may aspirer to investigate the synergistic consequences of these diseases in sub-Saharan Africa. This is necessary for both identification of species specific association that may be mediated by immune responses.

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دراسات وبائية التطفل المتعدد في مجتمعين بولاية بينو بنيجيريا

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المستخلص. لتحديث معرفة التطفل المتعدد بنيجيريا تم إجراء هذه الدراسة لفحص الإصابات الطفيلية والمتعددة بمجتمعين متفاوتين بولاية بينو بنيجيريا. تم فحص عينات من البول للكشف عن طفيلي البلهارسيا البولية باستخدام تقنية الفلترة، وعينات البراز تم فحصها للكشف عن الطفيليات المعوية باستخدام تقنية التركيز، وعينات الدم تم فحصها باستخدام تقنية شرائح الدم الرقيقة والسميكة للكشف عن طفيلي الملاريا. أظهرت النتائج ارتفاع معدل انتشار العدوى في السكان في كليهما، وكان ٢٦,٩٪ من المشاركين يحملون العدوى بطفيلٍ واحد. تم تسجيل الإصابة بطفيلين اثنين في٩,١٪ ، بينما كانت الإصابة بثلاثة طفيليات في ٠,٧٪ من المشاركين. كانت معدلات انتشار الطفيليات في المجتمعين مختلفتين بشكل ملحوظ ($df = 1, p < 0.05$). كانت هناك اختلافات في معدلات الإصابة بين المشاركين من الذكور والإناث. من ال ٣١٦ ذكور ، ٢٦,٦٪ . كانت لديهم إصابة مفردة و٨,٩٪ كانت لديهم إصابة مزدوجة، في حين كان من ال ٣٧٥ من الإناث، ٢,٪، ٢٧ كانت لديهم إصابة مفردة و ٩,٣٪ كانت لديهم إصابة مزدوجة. هذه الاختلافات بين الجنسين ليست ذات دلالة إحصائية ($p > 0.05$). تم تحديد ستة طفيليات، وكان أكثرها شيوعاً البلهارسيا الدموية، والملاريا المنجلية، والإسكارس الخراطيني. تم مناقشة التأثير المتآزر للتطفل المتعدد

على الفرد والمجتمع، وتم التشديد على الحاجة إلى استكشاف الآثار المترتبة على هذه العلاقات.