OPEN ACCESS International Journal of Applied Biology

ISSN : 2580-2410
eISSN : 2580-2119

Intestinal Parasites and Risk Factors Among Inmates in Umuahia Abia State, Nigeria.

Queen Ozioma Lawrence [1*], Anthonia Nnenna Chuks Amadi [1], Chinenye Okosa [1], Eberejah Juliet John [2], Nsikakabasi Charles Ukpong [3], Prisca Chimerebere Aririguzo [4]

[1] Department of Zoology and Environmental Biology, College Of Natural Sciences, Michael Okpara University of Agriculture Umudike, Nigeria
[2] Department of Microbiology, Faculty of Biological Sciences, Abia State University Uturu, Nigeria
[3] Department of Animal and Environmental Biology, Faculty of Sciences, University of Uyo, Nigeria
[4] Department of Public Health, School of Health Technology, Federal University of Technology Owerri, Nigeria

Abstract

Human intestinal parasites are among the most common infectious diseases worldwide. This study was conducted to determine intestinal parasites prevalence and risk factors in the study area. A total of 350 consented inmates aged 18->60 years participated in the study. Stool samples were screened using wet preparation and formol ether concentration method. An overall prevalence of 48.8% was recorded for intestinal parasite, which was significantly ($p< 0.05$) high among females. Five species of intestinal parasite were identified. The most common identified was hookworm (95, 33.5%), while the least was *Trichuris trichiuria* (33, 11.6%). Age group 51-60 years recorded the highest infection (63.33%) among the males, while age group 18-20 years had the least (25.0%). Age groups 51-60 and >60 years recorded 100% infections among the females. Of the 171 infections recorded, 97(56.7%) had single infection, while 74(43.3%) had multiple infections. Questionnaire analysis showed that inmates who have been in the prison for years were more parasitized. Inmates who deworm monthly, yearly and not at all accounted for 64.2%, 78.7% and 39.2% infections respectively which was significant ($p< 0.05$). The study revealed the prevalence of intestinal parasitic infections in the inmates. Improved healthcare and awareness is highly recommended inside the facility.

Article History
Received June 25, 2022
Accepted December 14, 2022

Keyword
parasites;
hookworm;
infection;
factors;
inmates

Introduction

The parasitic worms found in the intestine of man or animals are known as intestinal parasites (Arora, and Arora, 2006) Intestinal parasite infections are among the most persistent public health problems and are of public health importance (Brookers *et al*., 1999). Either protozoa or helminthes can cause intestinal parasite infection. Protozoan parasites are one-celled microscopic organisms belonging to the kingdom protista (Arora,

CONTACT : QUEEN OZIOMA LAWRENCE queenlawrence8@gmail.com

and Arora, 2006). They can take over the intestinal tract of their host and then migrate to other organs and tissues (Arora, and Arora, 2006), while helminthes are worms usually with elongated, flat, or round bodies (Castro, 1996). Among these helminthes are soil-transmitted helminthes; the roundworms, whipworm and hookworm, classified as neglected tropical diseases. Neglected tropical diseases (NTDs are diverse group of 20 health conditions that are mainly prevalent in tropical areas, where they mostly affect the impoverished communities and disproportionately affects women and children (WHO, 2002; WHO, 2022). They are widely distributed in tropical and subtropical areas, with the most significant numbers occurring in sub-Saharan Africa, the Americas, China, and East Asia (WHO, 2002). Theses disease causes devastating health, social and economic consequences to more than 1 billion people (Al Amin and Wadhwa, 2022). Its study has received less than 1% of the global research budget (Al Amin and Wadhwa, 2022). Approximately more than 2 billion people are infected by soil-transmithiasis (Samuel *et al*., 2017) The majority of the people in the general population are affected by intestinal parasites to which the main species are *Entamoeba histolytica*, *Ascaris lumbricoides* (roundworm), *Trichiuris trichiuria* (whipworm) and hookworms species (Lorainne *et al*., 2015). Intestinal parasite infections can be contracted through faecal-oral rout (eg; eggs or larvae *T. trichiuria* and *A. lumbricoides*) transdermal (e.g; larval of hookworm) and vector-borne transmission (eggs of the flukes) (Schabussova, 2014; Kiani *et al*., 2016; Kumie and Ali, 2005).

These parasitic intestinal infections are promoted by several factors such as poor personal and community hygiene, poor environmental sanitation, ignorance, and climatic condition (Al Amin and Wadhwa, 2022). Other factors tied to the prevalence of the infection are; untreated water supply, poverty, low level of education (Kiani *et al*., 2016). Amuta *et al.* (2010) reported that improperly cooked meat exacerbates intestinal parasite infection. His The study further noted that sources of drinking water like the river, well, water bought from vendors and patronizing food vendors were observed as risk factors for the transmission of intestinal parasite infections in the study area. Kiani *et al.* (2016) observed that educational status, contact with domestic animals and soil, age and seasons were significantly related to intestinal parasite infections. Signs and symptoms of intestinal parasitic infections can often be unclear and misleading or even asymptomatic. However, some of the symptoms include some common ones like abdominal pain, bloating, nausea, and vomiting. Diarrhoea is also a common infection symptom usually observed in the chronic state. Intestinal parasites lead to the development of mild diarrhoea, which may last for several days or even months. *E. histolytica* occasionally may invade the brain, lungs, liver, and other organs forming cysts and giving rise to a disease called amoebic dysentery. Other symptoms include abdominal cramps and severe colitis, along with the development of an ulcer. In addition, blood and pus may be seen occasionally in the stool (WHO, 2022; Al Amin and Wadhwa, 2022). Intestinal parasitic infestations do not let the intestines absorb minerals and vitamins, resulting in pale skin and fatigue (Arora, and Arora, 2006).

Transmission of parasitic infection can be prevented by employing good hygienic practices, avoiding soil consumption, discriminate defecation, and washing vegetables and fruits with clean water before intake is highly recommended (Al Amin and Wadhwa, 2022; Khan *et al*., 2022). The constant wearing of shoes or slippers (to prevent hookworm infection) should be instill on the population. Campaign programs should be employed to educate the population on the need for proper personal and environmental hygiene, i.e. washing hands after going to the toilet, playing outside, and preparing or eating food (Al Amin and Wadhwa, 2022; WHO, 2022). Safe single-dose drugs, such as albendazole, are

highly effective for treating intestinal parasites, available through healthcare services, school health programs, and community interventions directed at vulnerable groups (WHO,2022; Ughava and Okon, 2016).

The study is aimed at determining the presence and prevalence of intestinal parasites and their risk factors among inmates in a Correctional Facility (Prison) in Umuahia, Abia State, Nigeria.

Materials and Methods

A cross sectional study was adopted for the purpose of this study which lasted between February and May 2017. The study was carried out in Umuahia Prison located at Aba road in Afara, in Umuahia the capital of Abia state, South-Eastern Nigeria (Fig 1). It is located on latitude 5°31'12.0"N and longitude 7°29'16.8"E in Nigeria. The average annual rainfall is 133.7mm and temperature 74°c. The study area is within the tropical rainforest of eastern Nigerian states (within the ecological zones of Enugu, Akwa Ibom, Cross River, Ebonyi, Imo, and Rivers States). Samples were examined in Zoology and Environmental Biology (ZEB) postgraduate laboratory, Michael Okpara University of Agriculture Umudike (MOUAU).

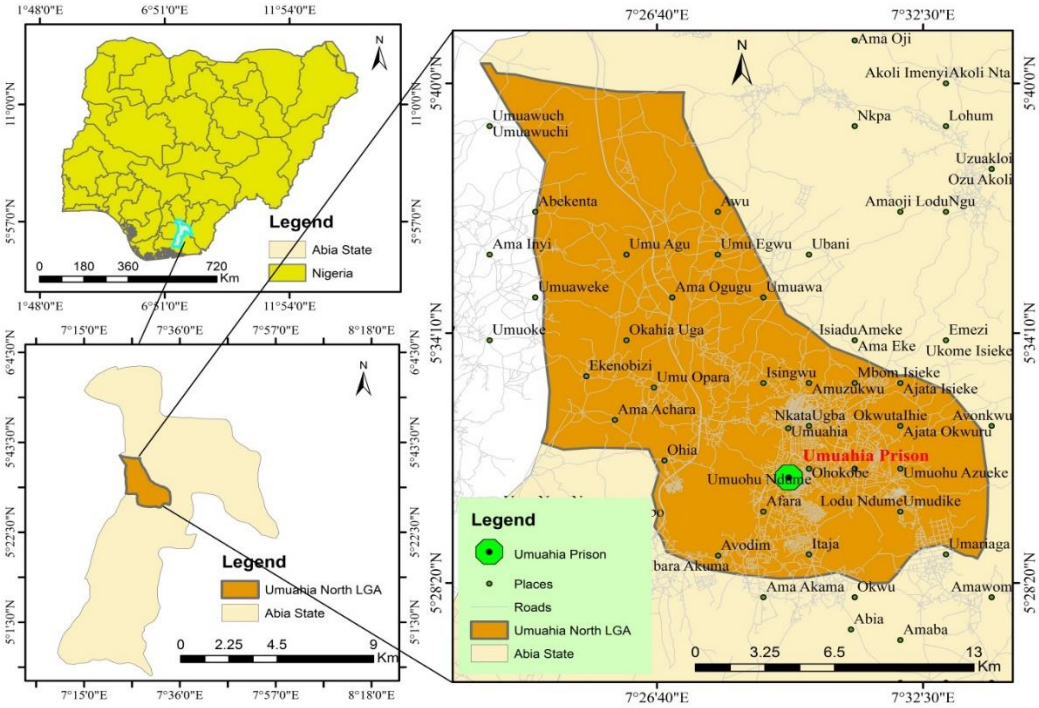

Figure 1. Map of Umuahia North showing the location of the Prison, Aba Road, Umuahia

Sample collection

Ethical clearance was sought and obtained from the ethical board of authorities of Nigerian Correctional Services, Umuahia, Abia State (Ref No: ABS/ SHQ/C.37/VOL.111/907), Ministry of Health Ethical Research Committee, Abia State (Ref No: AB/MH/E&HR/1/17/04) and Ethical Research Committee, College of Natural Sciences Ethical Research Committee, Michael Okpara University of Agriculture Umudike (Ref No: CREEC/004/18). Consent was sought from the inmates by educating them on the need and relevance of the study. A fresh stool sample was collected using a sterile labeled screwed capped bottle from 350 inmates (280 males and 70 females) aged 18->60 years and was transported to Zoology and

Environmental Biology Postgraduate laboratory, Michael Okpara University of Agriculture Umudike, Nigeria. Samples were assessed macroscopically and reported before laboratory analysis (Cheesbrough, 2005). Saline wet preparation and formol ether concentration methods were used for laboratory examinations.

Saline wet preparation technique

A drop of normal saline was placed on a clean grease free glass slide, and 2g of faeces was placed and gently mixed with the drop of normal saline. They were gently covered with cover slip to avoid air bubbles. The smear was examined under Binocular microscopy with x10 and then x40 objectives (Arora and Arora, 2006).

Formol ether concentration technique

Formol ether concentration techniques were used to demonstrate the presence of eggs and cysts of the parasites. About 2g of stool sample was emulsified using a rod in approximately 3ml of 10% formol saline contained in a tube. 3-4ml of 10% formol saline was further added, mixed well, and then sieved. About 7ml was transferred into a test tube, and 3ml of formol ether was added to make it 10ml. Covered and shake very well for proper mixing. Samples were centrifuged immediately at 1500rpm for five minutes. With a stick, the faecal debris layer was loosed from the side of the tube and then inverted to discard the formol saline and faecal debris. The sediment was transferred to a slide, covered with a cover slide and examined microscopically using x10 and x40 objective to examine the small cyst and eggs of the parasites (Zongo *et al*., 2020).

Statistical Analysis

The PART statistical package (version 3.1) was used for data analysis to test the association between demographics, behavioral factors, and intestinal parasite infection. Results were analyzed using chi-square. The relationship was considered significant when the p-value was <0.05 (Hammer, 2001).

Results and Discussion

Results

A total of 171 inmates were infected with at least one intestinal parasite; giving an overall prevalence rate of 48.8% (Table 1). The prevalence rate of intestinal parasites was highest among the females (72.8%) compared to the males (42.8%). There was a significance difference ($P < 0.05$) in the prevalence of the intestinal parasites among the female and male inmates.

Table 1. Gender related prevalence of intestinal parasites infection among inmates in Umuahia Correctional Facility, Abia State

Gender	Total No Examined	Total No Infected	Percentage (%)	P – Value
Male	280	120	42.8	0.015572
Female	70	51	72.8	
Total	350	171	48.8	

df= 1, Chi^2=61846, p-value=0.015572

Age group prevalence among the males showed that age group (51-60) had the highest (63.33%) followed by 31-40 (44.87%), 41-50 (42.18%), 21-30 (36.7%), 60> (33.33%) and 18-20 was the least (25.0%). Those in the age groups 51-60 and >60 recorded 100% prevalence among the female inmates, and those in age groups 31-40 and 41-50 recorded 75.00% prevalence, while those in the 18-20 age group were the least (33.33%) (Table 2). However, chi-square analysis showed no association between the prevalence of intestinal parasites and the age of both male and female inmates (P>0.05).

Table 2. Prevalence of intestinal parasites among the inmates by sex and age group the study area

	Male			Female			Total No infected (%)
Age group	Number examined	Number infected	%	Number examined	Number infected	%	
10-20	4	1	25.00	9	3	33.33	4 (1.4)
21-30	98	36	36.7	10	6	60.00	42 (12.0)
31-40	78	35	44.87	20	15	75.00	50 (14.28)
41-50	64	27	42.18	16	12	75.00	39 (11.14)
51-60	30	19	63.33	10	10	100.00	29 (8.22)
>60	6	2	33.33	5	5	100.00	7 (2.0)
Total	**280**	**120**	**42.85**	**70**	**51**	**72.85**	**171(48.84)**

Male: df = 5, Chi^2=2.8128, P-value=0.72882 Female: df=5 Chi^2=2.3604, P-value=0.79735

Five species of intestinal parasites was identified in the study which occurred 248 times as a single or multiple infections (polyparasitism) (Table 3). Hookworm was the most common parasite identified (95, 33.5%), followed by *Ascaris lumbricoides* (57, 20.1%), *Entamoeba histolytica* (56, 19.7%). *Giardia lamblia* (43, 15.1%) and *Trichuris trichiuria* was the least (33, 11.6%).

Table 3. Prevalence of intestinal parasites species identified in Umuahia Correctional Facility, Abia State (N=284)**.**

Parasites species Identified	No of parasite seen	%
Hookworm	95	33.5
Ascaris lumbricoides	57	20.1
Trichuris trichiuria	33	11.6
Giardia lamblia	43	15.1
Entamoeba.histolytica	56	19.7
Total	**284**	**100**

Table four highlighted Single and mixed infections recorded in the study area. Of the171 inmates that had intestinal parasite infections, 56.7% had a single infection, while 43.27% had mixed infection. Hookworm was the most (28.9%) frequent single parasites

recorded while *T. trichiuria* (9.3%) was the least (Table 4). Mixed infections with the combinations of hookworm (HW) and *E. histolytica* (Eh) was highest (36.5%) while other mixed infection were combinations of more than two parasites (Table 4).

Table 4. Prevalence of single and mixed (multiple) infections among inmates in Umuahia Correctional Facility, Abia State

Parasite seen	Male		Female		Total (N=171)	
	No infected	%	No infected	%	No infected	%
Single infection						
Protozoal						
G. lamblia	14	20.3	8	28.6	22	22.6
E.histolytica	14	20.3	6	21.4	20	20.6
Helminths						
Hookworm	20	28.9	8	28.6	28	28.9
A.lumbricoides	16	23.2	5	17.9	21	21.6
T.trichiuria	5	7.2	1	3.6	6	9.3
Total	**69**	**100**	**28**	**100**	**97**	**56.7**
Mixed infection						
Hw+Al	17	33.3	3	13.0	20	27.0
Hw+Tt	5	9.8	6	26.0	11	14.9
Hw+Gl	8	15.6	0	0	8	10.8
Hw+Eh	15	29.4	12	52.1	27	36.5
Eh+Tt	0	0	1	4.3	1	1.4
A.l+Tt	1	1.9	0	0	1	1.4
G.L+Eh	1	1.9	0	0	1	1.4
Hw+Al+Tt	1	1.9	0	0	1	1.4
Hw+Eh+Gl	1	1.9	0	0	1	1.4
Hw+Al+Eh	1	1.9	0	0	1	1.4
Hw+Al+Tt+Eh	1	1.9	1	4.3	2	2.7
Total	**51**	**100**	**23**	**100**	**74**	**43.27**

KEY=Hw=hookworm, Al= *Ascaris lumbricoides*, Eh=*Entamoeba histolytica*, Gl= *Giardia lamblia*, Tt= *Trichiuris trichiuria.*

Out of the 350 questionnaire distributed among the participants, only 220 filled and returned to us. All the respondents agreed that they use borehole water for drinking and other usages. The infected inmates that have been in the correctional facility for years, months, and weeks accounted for varying prevalence rates - 74.6%, 40.5%, and 22.2% respectively that was significantly different ($p< 0.05$) see Table 5. Those that reported washing their hand after eating only were highly infected (90.0%), followed by those who said 'always' (69.6%), 'sometimes' (57.3%), and those that wash their hands before eating alone were the least infected (33.3%). There was no significant difference ($p> 0.05$) in this aspect (Table 5). Inmates who wash their hands sometimes after defecation had the highest

infection (70.0%) while those who wash their hand always recorded the least infection 59.3%. There was also no significant difference (p> 0.05) in this aspect (Table 5). Inmates that deworm monthly, yearly and not all accounted for 64.2%, 78.7%, and 39.2% of infections respectively. There was a significant difference (p< 0.05) in this aspect.

Table 5. Risk factors of intestinal parasites among the participating inmates in Umuahia Correctional Facility, Abia State

Variables	No of Respondents (n=220)	No infected (%)	P-value
How long have you been In the prison			
Years	142	106 (74.6)	0.022216
Months	69	28 (40.5)	
Weeks	9	2 (22.2)	
Total	**220**	**136 (61.9)**	
How often do you wash hands			
Before eating only	30	10 (33.3)	0.21929
After eating only	10	9 (90.0)	
Sometimes	68	39 (57.3)	
Always	112	78 (69.6)	
Total	**220**	**136 (61.9)**	
How often do you wash hands after defecation			
Sometimes	50	35(70.0)	0.8109
Always	150	89 (59.3)	
Not at All	20	12 (60.0)	
Total	**220**	**136 (61.9)**	
How often do you wash your fruits before intake			
Sometimes	52	26 (50.0)	0.32256
Always	128	90 (70.3)	
Not at All	40	20 (50.0)	
Total	**220**	**136 (61.9)**	
How often do you deworm yourself			
Monthly	28	18 (64.2)	0.020679
Yearly	108	85 (78.7)	
Not at All	84	33 (39.2)	
Total	**220**	**136 (61.9)**	

The inmates reported various symptoms associated with intestinal parasite infection: watery stool (50, 29.2%), stool accompanied by blood (11, 6.4%) and abdominal cramps (20, 11.7%), although a greater number 90 (52.6%) of people were asymptomatic. There was no significant difference (p> 0.05) in this aspect (Table 6).

Table 6. Symptoms associated with intestinal parasite infection among the inmates in Umuahia Correctional Facility, Abia State

NO Examined	Total No infected (%)	Total No without symptoms (%)	Characteristic symptoms		
			Watery stool No infected (%)	Stool accompanied with blood No infected (%)	Abdominal cramps (%)
350	171 (48.9)	90 (52.6)	50 (29.2)	11(6.4)	20 (11.7)

df=1, Chi^2=0.32589, P-value= 0.57409

Discussion

Intestinal parasites such as soil transmitted helminthes (STH) remains a public health concern and part of Neglected tropical diseases (NTDs). Among the six 2030 global targets for STH by the World Health Organization is to achieve and maintain elimination of STH and is part of WHO global target 2030 (WHO, 2022). Microscopic examination using wet mount and formol ether concentration methods is still the most appropriate techniques widely used for the detection of intestinal parasites despite the advances in intestinal parasites diagnosis (Zongo *et al*., 2020). Our study employed the two above mentioned technique to determine the presence and prevalence of intestinal parasites among inmates in Umuahia correctional facility using stool samples. The study recorded an overall prevalence of 48.8% for intestinal parasitic infections, accounting for almost half of the population harboring at least one intestinal parasite species. The overall prevalence rate of 48.8% was high and agreed with Rasha *et al.* (2011) value that recorded a prevalence rate of 49% in Omduruma prison in Sudan. The high prevalence of intestinal parasite infection recorded could be linked to poor environmental and personal hygiene (Khan *et al*., 2022), common among prison inmates. These are among the major contributing factors to intestinal parasite transmission (Arora, and Arora, 2006). However, the prevalence was lower than the 72.7% recorded by Mamo (2014) in North central Ethiopian prison, 74.85% by Amuga (2006) in Keffi prison, Nasarawa State and 77.0% by Okolie (2008) in Owerri prison but higher than 33.5% reported by Kadio *et al*. (2021) in central prison of Conakry, Guinea, 32.84% reported by Colman *et al*. (2013) among inmates of Maiduguri prison, 26.6% reported by Loraine *et al*. (2015) in Kajang prison in Malaysia and 20.2% reported by Curval *et al*. (2017) in Brazil. It is expected that prevalence rates should be on the decline in Nigeria due to some significant improvements in the level of awareness and personal and environmental hygiene values (Amuga *et al*. 2006; Okolie, 2008).

Female inmates recorded a higher prevalence of intestinal parasite than the males. This may be associated with the different exposure rates and unhygienic environment often exposed during household chores (as seen in normal population), general unhygienic nature of the facility and females' physiology. Studies have shown that latrines and unsanitary toilets disposes one to intestinal parasite infection. This is contrary to the findings of Colman *et al*. (2013) in Maiduguri, Borno State and Ughavah *et al*., (2016) in Jos, plateau State,

which reported higher prevalence among male inmates with a zero infection among female inmates.

Males in the age group 51-60 years were more infected while age group 31-40 in females recorded 100% infection. On other hand, 18-20 years age group recorded the minor infection in both male and females. This finding did not agree with related studies. The highest infection recorded in Owerri prisons, Imo State was among those under 35 years of age group (Okolie, 2008), 15-20 years in Keffi prison, Nasarawa State (Amuga *et al*., 2006), 21-30 years in Omdurman prison, Sudan (Colman *et al*., 2013), <20 years in Jos prison, Plateau State (Ughava and Okn, 2016) and 15-24 years in North central Ethiopia (Mamo, 2014). As seen in the present study, the highly infected age group may be because these groups lack proper personal hygiene. The male inmates from this age group are known for lackadaisical attitude of and frustration leading to less care about their health beings which may increase parasite transmission. Previous studies revealed that high intensity of helminthic parasites, especially hookworm, occurs in adults resulting from farming as an occupation (Kadio *et al*., 2022; Amuga *et al*., 2006; Brooker et al., 2006). However, there was no association between the prevalence of intestinal parasites and age group in both male and female inmates ($p > 0.05$).

The most frequent parasite recorded was hookworm followed by *A. lumbricoides* (20.1%) as observed by Okolie (2008) in Owerri prisons but differ from *A. lumbricoides* reported as the most common parasite by Amuga *et al*. (2016) in Keffi prison, Nassarawa State. The high occurrence of hookworm infection could be due to a simple mode/mechanism of parasite transmission (WHO, 2022).

Inmates that have spent years in prison were more parasitized than inmates who have been in the correctional facility for only months or weeks. This finding did not agree with Amuga *et al*. (2006) in Keffi prison, Nassarawa State that recorded 100% prevalence among inmates that had been in the correctional facility for less than one month. This current observation may be linked to the fact that the immune systems of the newly confined inmates are still strong enough to resist parasitic infections of the intestine than those who have spent years in the correctional facility (Kadio *et al*., 2021). Besides, they have not been subjected to the prevailing conditions in the facility.

Those that wash their hands after eating were more parasitized compared with those that wash their hands sometimes and those that wash their hands before eating. A significant difference was recorded between inmates that wash hands before meals and those that do not in Kissi prison, Kenya (Dickson *et al*., 2016). Maintaining a good routine of hand washing, especially before eating, can reduce intestinal parasite transmission (Al Amin and Wadhwa, 2022). No significant difference was recorded between the inmates that regularly washed their hands and those that do not wash their hands always after defecation ($p>0.05$). This also differs from the findings of Dickson *et al*. (2016) in Kissi prison, Kenya. Improper washing of hands before eating and after defecation is associated with intestinal parasite infection and can explain the high prevalence recorded among those that wash their hands sometimes after defecation (Al Amin and Wadhwa, 2022). The effects of proper washing of fruits before intake on the transmission of intestinal parasite infections were accessed. Those that deworm yearly were found more infected than those that deworm monthly. The high prevalence recorded may be linked to an inconsistent deworming at least to a considerable interval; leading to increase parasite multiplication and transmission. Deworming practice and intestinal parasite burden were significantly related.

Since all the respondents agreed on using the same source of water supply and toilet facility type, we could not investigate or compare the effects of water source and toilet facility on the transmission of intestinal parasites. Studies have shown that inmates using boreholes are more prone to intestinal parasite infection (Kadio *et al*., 2021). However, related studies have demonstrated a strong relationship between the prevalence and transmission of intestinal parasitic infection to toilet facility and water source used (Amuga *et al*., 2006; Amuta *et al*., 2010; Dickson *et al*., 2016). A water closet facility assumed to be the best can amplify parasitic infection transmission, especially when the faeces accumulate for a long time or if the toilet is not adequately washed regularly. Studies have also opined that the transmission of intestinal parasites is related to the water closet type of toilet used by many household (either at public or private level) a result of splashing of water during defecation (Afolabi *et al*., 2016).

Related studies revealed various factors responsible for high prevalence of intestinal parasite infection and incidence [Brooker *et al*., 2006; Kumie and Ali, 2005) These factors include inadequate and untreated water supply (to which borehole belong to, age, poor sanitation, low level of income, low level of education, consumption of unwashed vegetables and fruits, and low personal hygiene practice (Al Amin and Wadhwa, 2022; Khan *et al*., 2021). They are considered significant risk factors for intestinal parasite infections (Al Amin and Wadhwa, 2022).

Symptoms of intestinal parasites reported by the inmates were watery stool, stool accompanied with blood and abdominal cramps, though a significant number of the inmates were asymptomatic. The presence of blood in the stool suggests amoebic dysentery, usually caused by *E. histolytica*. Diarrhoea is one of the most reported symptoms of the intestinal parasite to which *G. lamblia* is responsible (WHO, 2022)

Conclusion

The presence and prevalence of intestinal parasitic infections has been established among inmates of the Correctional Facility (prison), Umuahia, Abia State. Females were more infected than males. The most common intestinal parasites were soil transmitted helminthes, especially hookworm. Mixed infections of intestinal parasite species were confirmed. Variables like inconsistent deworming and duration spent in the prison were considered significant risk factors. The spread of parasitic infection could be controlled, reduced or even eliminated by proper hygiene, and deworming therapy latest every three months. We recommend that inmates should be checked and treated adequately (dewormed), especially before being released into the general population. Inmates should be educated on the dangers of dangerous behavior that could lead to the spread of this parasite infection. We recommend further research investigating the handling of food pre- and post-cooking inside the correctional facility as a risk factor for intestinal parasites.

Acknowledgement

The authors are grateful to all the inmates and staff of Umuahia Prison, Anyawu. E. D., Mr. Pipi Okechukwu and the Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture, Umudike, Nigeria for providing the necessary facilities used in this study.

References

Arora, D. R. and Arora, B. 2006. Medical parasitology textbook. 2nd edition. CBS Publishers and Distributors, New Delhi, India; p. 38-43.

Afolabi, O. J., Simon-Oke, I, A. and Bakare, P. T. 2016. The Prevalence of Intestinal Parasites among Students in Federal University of Technology Akure, Nigeria. *International Journal of Tropical Disease and Health. 14(2): 1-9* DOI: 10.9734/IJTDH/2016/23886

Al Amin A. S. M. and Wadhwa, R. 2022. Helminthiasis. In: StatPearls [Internet], Treasure Island (FL): StatPearls Publishing.

Amuga, G., Usmand, D. and Onwuliri, C. O. E. 2006. Human intestinal parasites among inmates of Keffi prison, Nasarawa State. *International Journal of Natural and Applied Sciences.* 2: 7–10.

Amuta, E.U., Houmsou, R.S. and Mker, S.D. 2010. Knowledge and Risk factors of intestinal parasitic infections among women in Makudi, Benue State. *Asian Pasific Journal of Tropical Medicine.* 3(12): 993-996.

Brookers, S., Peshu, N., Warn, P. A. and Mosobo, M. 1999. The epidemiology of hookworm infection and its contribution to anaemia among pre-school children in Kenyan coast; *Tropical Medical Hygiene.* 93 (3): 240 – 246.

Brooker, S., Clements, A. C. and Bundy, D. A. 2006. Global epidemiology, ecology and control of soil- transmitted helminth infections. *Advance Parasitology*. 62: 221–261.

Castro, G. A. 1996. Helminths: Structure, Classification, Growth, and Development. In: Baron S, editor. Medical Microbiology. 4th edition. Galveston (TX): University of Texas Medical Branch at Galveston. Chapter 86.

Cheesbrough, M. 2005. Medical laboratory manual for tropical countries. 2nd edition, Cambridge University Press. p. 192–198

Colman, S., Mangoro, Z. M. and Isa, L. 2013. Incidence of intestinal and urinary parasites among prison inmates. *Academia Journal of Microbiology. Resource.* 1(1): 11-15.

Curval, L.G., Franca, A., Fernandes, H. J., Mendes, R. P., de Carvalho, L. R., Higa, M.G., Ferreira, C. E. and Dorval, M. E.C. 2017. Prevalence of intestinal parasites among inmates in Midwest Brazil. *PloS ONE.* 12 (9): 182248

Dickson, C. R., Benson, O. N., Johnson, N. and Vincent O. O. 20116. Risk factors associated with intestinal parasitic infections among inmates of Kisii prison, Kisii County, Kenya. *BioMed Central.* 9:384.

Hammer, Ø., Harper, D.A.T. and Paul, .D. R. 2001. PART: Paleontological Statistics Software Package for Education and Data Analysis. *Paleontologia Electronica*. 4 (1), article 4: p. 9

Kiani, H., Haghighi, A., Rostami, A., Azargashb, E., Javad, S., Tabaei, S., Solgi, A. and Zebardast, N. 2016. Prevalence, risk factors and symptoms associated to intestinal parasite infections among patients with gastrointestinal disorders in Nahavand, Western Iran. *Journal of Institution of medicine and tropical science*. 58 (42): 1678-9946.

Kumie, A. and Ali, A. 2005. An overview of environmental health status in Ethiopia with particular emphasis to its organization, drinking water, and sanitation: a literature survey. *Ethiopian Journal of Health Development.* 19:89–103.

Khan, W., Rahman, H., Rafiq, N., Kabir, M., Ahmed, S. M. and Escalante, P. L. R. 2022. Risk factors associated with intestinal pathogenic parasites in School children. *Saudi Journal of Biological Sciences.* 29, 2782–2786.

Kadio, J. O. K., Diao Cissé, Awo, L. A., Adrien, F. T., Sékou, K., Soua, G., Maladho, D., Niouma, N. L., Alpha, S., Sidikiba, S., Alioune. C, Alexandre, D. and Abdoulaye, T. 2021. Factors associated with intestinal parasites in the central prison of Conakry, Guinea. *PAMJ - One Health*. 6(10). 10.11604/pamj-oh.2021.6.10.31165

Khan,W., Arshad, S., Khatoon, N., Khan, I., Ahmad, N., Kamal, M., UlHassan, K., Khan, N., Haq, A.U., Ilyas, M., Ullah, S., Ullah, I., Mahmoud, A. H. and Mohammed, O. B. 2021. Food handlers: an important reservoir of protozoans and helminth parasites of public health importance. *Brazilian Journal of Biology*. 82, 10.1590/1519-6984.238891

Lorainne, A., Rohela, M., Sajideh, S., Nan-Jiun, Y., Romano, N., Amirah, A., Init I., Adeeba, K. and Yvonne, A. L. 2015. Determining intestinal parasitic infections (IPIs) in inmates from Kajang Prison, Selangor, Malaysia for improved prison Management. *BoiMed Central Infectious Diseases.* 15: 467.

Mamo, H. 2014. Intestinal Parasitic Infections among Prison Inmates and Tobacco Farm Workers in Sewa Robit, North-Central Ethiopia. *PLoS ONE.* 9(6): 99559.

Okolie, N. 2008. Intestinal Parasites Distribution among Inmates of Owerri Prison. *The Internet Journal of Parasitic Diseases.* 4 (1): 1-5.

Rasha, R. G., Asha, A.A., and Saad, M.B. (2011). Gastrointestinal parasites among inmates in Omdurman prison. *Sudan Medical Laboratory Journal.* 1(2): 26-33.

Samuel, F., Demsew, A., Alem, Y. and Hailesilassie, Y. 2017. Soil transmitted Helminthiasis and associated Risk factors among elementary school children in ambo town, western Ethiopia. *BMC Public Health*. 17(1):791

Schabussova, I. 2014. Helminths and Helminthiasis. Center for Disease Control and Prevention. (accessed 2 June 2022)

Ughava, J. R. and Okon P. E. 2016. Prevalence of intestinal helminthiasis among prison inmates in Jos, Nigeria. *African journal of Biology*. 3(6): 238-242.

World Health Organisation. http:www.who.int/news-room/fact-sheets/detail/soli-transmitted-helminth-infections 2022; (accessed 6 May 2022)

World Health Organization. 2002. Prevention and control of Schistosomiasis and soil-transmitted helminthiasis; report of a WHO expert committee. *Geneva.* 912: 63.

Zongo, A. W., Ouattara, A.K., Yonli, A. T., Sorgho, P. A., Sombié, H.K, Lallogo, T., Bado1, P., Compaoré, T. R., Djigma1, F. W., Ouermi, D., Millogo, H. and Simporé, J. 2020. Real-time multiplex PCR Diagnosis of common diarrhea causing parasites in children under five years in Ouagadougou, Burkina Faso. *Infectious Disease and Tropical Medicine.* 6: e641