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Detection and Quantification of Gastrointestinal Parasites among Inmates of Social Welfare Homes and Low Socio-economic Areas in Metropolitan Port Harcourt

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Detection and quantification of gastrointestinal parasitic infections (GIPIs) causing public health problems among poorer layers of the society are still one of the Neglected Tropical Diseases (NTDs) in developing countries.
Objective: The aim of the study was to detect gastrointestinal parasites among inmates of Social Welfare Homes and Low Socioeconomic Areas in Metropolitan Port Harcourt.
Methods: A cross-sectional survey was carried out for the evaluation of all the 1500 participants for GIPs among residents of social welfare homes and low socioeconomic areas in Rivers State, Nigeria for a period of one year (July 2019- June 2020). Stool samples were collected from each participant for isolation of GIPs in stool sample. Formol-ether concentration methods and Modified Ziehl-Neelson Staining techniques was used for the isolation and identification of gastrointestinal parasites. Descriptive and Chi square statistical analysis was applied.
Results: Out of 1500, 1,381 (92.1%) participants showed negative report, while 119(7.9%)

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participants were positive for GIPs. Females account for 839 (55.9%) while males were 661 (44.1%). Positivity in males accounted for 9.8% (65/661) and the females had 6.4% (54/839). Age group with high prevalence occurred among 11-15yrs (13.5%)/340. Both variables were statistically significant (*p*<0.05). Seasonal distribution of GIPs was high during the wet season (p<0.05). Overall, *A. lumbricoides* was the most predominant gastrointestinal parasites, accounting for 35.3% of the total identified. Others were as follows; *T. Trichiura* 26.1%, hookworm 21.9%, *C. sinensis* and *S. mansoni* 2.5%, tapeworm 1.7%, while *H. nana* and *H. diminuta* had 0.8% each. Co-infection of *A. lumbricoides* + hookworm and hookworm + *T. Trichiura* recorded 4.2% each. Protozoa species were not identified. Risk factor of the use of toilet papers was found to be statistically significant (*p*<0.05) among others.

Conclusion: We recommend that knowledge of epidemiology and transmission routes of *C. sinensis* and *H. diminuta* needs to be improved and effective health education on personal hygiene and mass treatment should be sustainable to control the spread of gastrointestinal parasites.

Keywords: Gastrointestinal parasitic infections; social welfare homes; low socioeconomic areas; Port Harcourt.

1. INTRODUCTION

Parasitic infections cause a tremendous burden of disease in both the tropics and subtropics as well as in more temperate climates. Of all parasitic diseases, malaria causes most deaths globally. Malaria kills more than 400,000 people each year, most of them young children in sub-Saharan Africa [1]. The Neglected Tropical Diseases (NTDs), which have suffered from a lack of attention to the public health community, include parasitic diseases such as lymphatic filariasis, onchocerciasis, and Guinea worm disease. The NTDs affect more than 1 billion people worldwide, largely in rural areas of low-income countries. These diseases extract a large toll on endemic populations, including lost ability to attend school or work, stunting of growth in children, impairment of cognitive skills and development in young children, and the serious economic burden placed on entire countries. However, parasitic infections also affect persons living in developed countries, including the United States [1]. Globally, gastrointestinal parasitic infections (GIPIs) are one of the main causes of human morbidity and mortality especially in developing countries where public health standards are poor [2]. These are common in developing countries in tropical and sub-tropical areas, particularly in Sub-Saharan Africa, Asia, Latin America, and the Caribbean, where high prevalence rates have been recorded [3]. These infections are associated with poor sanitation, poverty, outdoor defaecation, cultural practices and other environmental condition that are prevalent in such area [4-6].

In most cases, gastrointestinal infections are asymptomatic, hence many infected persons serve as vehicle for the transmission of the parasites. For instance, the food handlers are considered common vehicle for the spread of disease and is a persistent problem worldwide [7], probably causing faecal contamination of foods with their hands during food preparation, and may be implicated in the transmission of many infections to the public in the local community [8]. Orphanage in Pathum Thani province was examined for gastrointestinal parasites using using simple smear, formalin-ether concentration, Boeck and Drbohlav's Locke-Egg-Serum (LES) medium culture and special staining (modified acid-fast and modified trichrome) techniques. Protozoa were the most identified where *Blastocystis hominis* was found at the highest prevalence (45.2%) [9]. This study was aimed at detecting gastrointestinal parasites among inmates of social welfare homes and low socio-economic areas of metropolitan Port Harcourt. The objectives were to: determine, characterize the overall prevalence and distribution of gastrointestinal parasites among inmates of social welfare homes and low socio-economic areas in metropolitan Port Harcourt in relation to age, gender, seasonal variation and risk factors.

2. MATERIALS AND METHODS

2.1 Study Area

This cross-sectional study was conducted in Port Harcourt metropolis which is made up of two Local Government Areas: Port Harcourt City LGA and Obi-Akpor LGA. The low socio-economic areas and social welfare homes for this study comprising of: Waterfront (latitude- 4^{o} 45'54.378" N longitude-7^{o} 1'53.6268" E), Life Care

Orphanage (latitude- 4° 49'21.4788" N longitude-7° 3'13.6944" E), Abuja Waterfront (4° 45'42.4872" N longitude-7° 1'25.2444" E), Port Harcourt Children Home (latitude- 4° 44'34.6524" N longitude-7° 2'27.3264" E), Port Harcourt Remand Home (latitude- 4° 44'34.6524" N longitude-7° 2'27.3264" E), Blesam Orphanage, (latitude- 4° 53.1470" N longitude-6° 54.1200" E), Goodnews Orphanage (latitude- 4° 48.5580" N longitude-6° 56.9220"E), David Bassey (latitude-4° 47.0360" N longitude-6° 58.7540" E), Susan Brown (latitude- 4° 46.9710" N longitude-6° 58.5580" E), Nembe Waterfront (latitude- 4 °45.28.2996" N longitude-7° 1.29.046" E), Gambia Diobu (latitude-4° 47.7490" longitude-6° 59.6720" E) and Yam Zone Waterfront **(**latitude- 4° 45.4920" N longitude-7° 1.6660" E) (Fig 1).

2.2 Experimental Design

The study was conducted between July 2019-June 2020 during wet (March-November) and dry (December-February) season with the cooperation of the Association of Orphanage and Vulnerable of Nigeria and the local community of the low socio-economic areas in Port Harcourt and Obi-Akpor in Rivers State where participants were randomly selected. The age group for this study was from 1 year and above. The age grouping was generated from information given on participant's questionnaire of both social welfare homes and low socio-economic areas. The age was grouped into: 1-5yrs, 6-10yrs, 11-15yrs, 16-20yrs, 21-25yrs, 26-30yrs, 31-35yrs, 36-40yrs and 41yrs and above.

The fieldwork involved home-to-home visits, encouraging participation from each individual for the social welfare homes while the low socio-economic area was carried out by the means of Town cryer. Verbal informed consent was obtained from each individual before the study. Name, sex, age, education, sociodemographic factor, and personal hygiene details were collected.

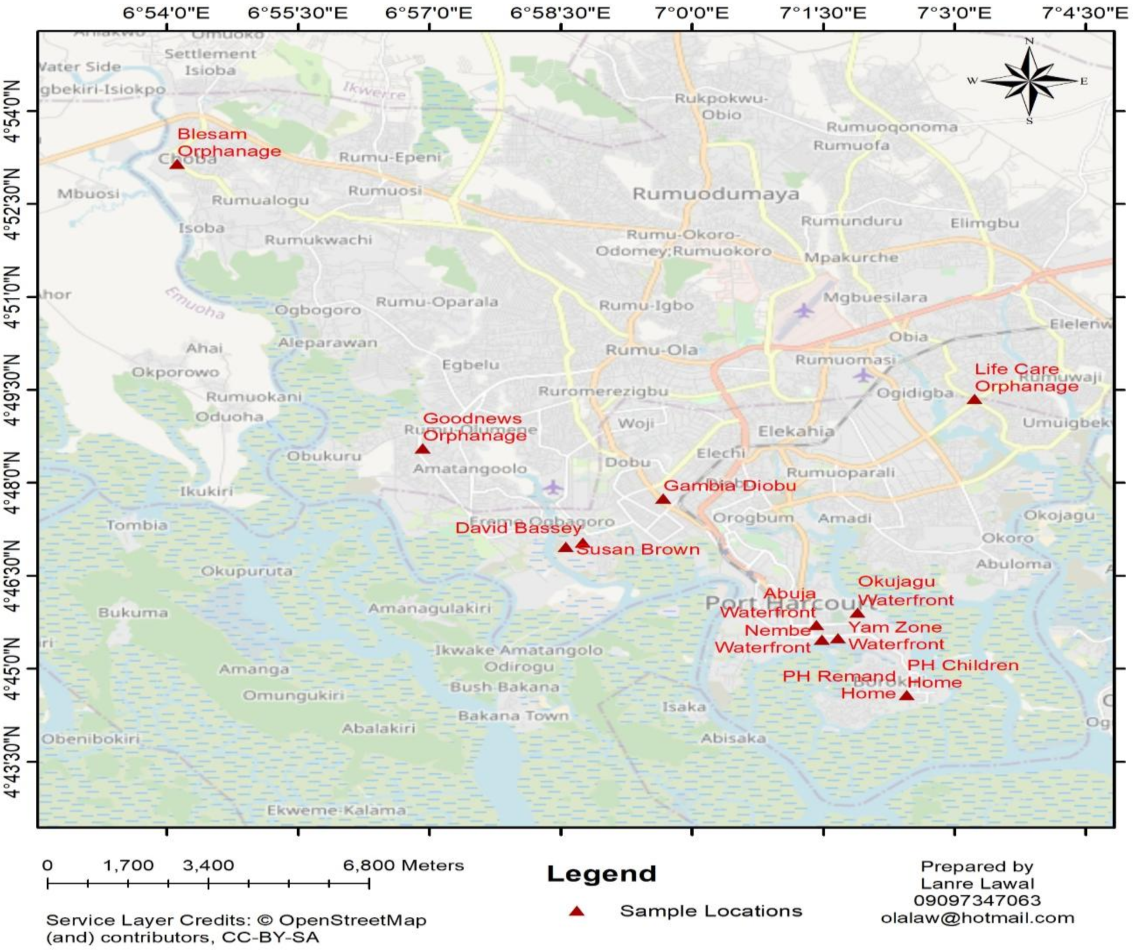

Fig. 1. Sampling Points in Obio-Akpor and Port Harcourt LGAs

Sample size of this study was determined using this formula: $n = Z^{2*} p(1-p)/ M^2$ [10].

2.3 Sample Collection

Sample collection was carried out for a period of one year (wet and dry seasons). A small screw capped plastic bottle with plastic scoop was provided to each participant after enrollment. They were advised to fill half the bottle. The next day samples were collected and brought to the location and was immediately transported to the laboratory for processing. All the containers along with specimen were properly labelled with the respective sample number, date, and area. Where there was delay, the specimen was preserved with 10% formalin. Preservation of fecal specimens is essential to maintain protozoal morphology and also to prevent further development of helminthic eggs and larvae.

2.4 Laboratory Investigation

2.4.1 Formol-ether concentration methods

Although, this formol ether technique cannot detect trophozoites, it is considered as the best concentration technique used in diagnostic parasitology laboratories for detection of cysts, ova, and larvae [11,12]. About 2g of stool in 10-15mL of 10% formol saline. The suspension was allowed to stand for 10 minutes, and then strained through two layers of gauze into a 15mL conical centrifuge tube. A total of 3mL of diethyl ether was added, and then the tube was shaken vigorously for 30 seconds and centrifuged at 2000rpm for 5 minutes. The fecal debris layer was loosened by wooden stick and the tube rapidly inverted to discard the top three layers while the sediment remained at the bottom. The debris was then placed on a clean microscopic glass slide for examination under microscope using x10 and x40 objective lenses.

2.4.2 Modified Ziehl-Neelsen Stain (Acid-Fast Staining) Techniques

The smear on slide was allowed to air-dry and then fixed with methanol for 10 minutes. Five-seven (5-7) drops of Carbol fuchsin were flooded for 2-3 minutes. Then, it was decolourized with 5% Sulphuric acid for 30 seconds. Then, the smear was counter-stained with methylene blue for a minute. Finally, the smear was rinsed, drained, air-dried and examined under x10, x40 and oil immersion (x100) objective lenses.

2.5 Data Analysis

The data collected from the study area were entered in Microsoft office excel 2016 before being imported to SPSS version 23. Descriptive analysis was evaluated. Logistic regression analysis was employed to determine the association between various independent risk factors and the occurrence of gastrointestinal parasites. *P*-values were set to be less than 0.05 were considered statistically significant using Chi square.

3. RESULTS AND DISCUSSIONS

Gastrointestinal parasitic infections (GIPIs) caused by helminths and protozoans remain a major burden causing morbidity and mortality in many developing countries including Nigeria. A total of 2500 questionnaires were sent out, but only 1500 returned stool samples and analyzed. Of these population in terms of gender, 663 respondents were males. Of the male population, 65(9.8%) respondents were positive for gastrointestinal parasites while 596 (90.2%) were negative for gastrointestinal parasites. Female participants accounted for 839. Of the total female respondents, 54(6.2%) were positive and 785 (93.6%) were negative. However, *p*-value was found to be statistically significant ($p<0.05$) (Table 1).

The prevalence rates in the study areas, shows that people are less concerned about the health status of their children under the care-giver especially in the social welfare homes in relation to the number of participants of the study [13]. Other studies elsewhere had different prevalence which could be due to personal/environmental hygiene, study participants and geographical locations. Moura et al. [14] observed higher prevalence rates of 62.9% in Brazil. Lower prevalence rates of 20.7% and15.8% were recorded in Nigeria and Ghana respectively [15,16]. Among the low socio-economic areas, lower prevalence rates of 21.5% and 25.4% and compared to our findings were reported by Bahrami et al. (2018) and Gizaw et al. (2019) in Iran and Ethiopia [17,18]. da Silva et al. [19] study associated with GIPIs among young population in Northeast Brazil, had 68% prevalence rate while 75.7% was recorded in a comparative study of the prevalence of gastrointestinal parasites in low socio-economic areas from South Chennai, India [20]. The different prevalence rates from various studies are not in agreement with our findings. These differences could due to age, geographic difference, socio-economic status, awareness to control GIPs, transmission route as well as seasonal differences.

In this study, a total prevalence of 7.9%(119/1500) of GIPs was observed which were mainly gastrointestinal helminths. This overall prevalence rate reported was lower compared to other studies elsewhere. Michael et al. [21] had prevalence rate of 24.8% of gastrointestinal parasitic infections among school children in Port Harcourt City Local Government Area. Similarly, in the South-South region of Nigeria, Sapele Local Government Area, Wokem and Onosakponome in 2014 recorded a prevalence of 19.1% among school children in Delta state [22]. On the other hand, the overall prevalence of GIPs found in this study is slightly higher than findings from Haftkel County, Southwest of Iran which reported of prevalence of 3.9% in study by Akinbo et al. (2011) and Saki et al. (2017) recorded 4.8% in Benin state and Delta Nigeria [23,24]. The significantly low prevalence of gastrointestinal parasitic infections observed in this study might be due to abovementioned factors.

Based on the infected study population, *Ascaris lumbricoides* was recorded to be 42(35.3)/119. Okujagu Waterfront was observed to have most prevalent gastrointestinal parasites 26(9.2%)/284 participants with *A. lumbricoides* 13(50.0%)/26 as the most prevalent. This was followed by Port Harcourt Remand Home 15(44.4%)/35 inmates, Nembe Waterfront had 13(5.1%/275 participants as shown in Table 2. This predominance of *A. lumbricoides* than any other GIPs agreed with some other reports [23,15]. On the other hand, da Silva et al. [19], Khanal et al. [2] and Herna´ndez et al. [25] found *T. trichiura* predominant (55.1%: 32.0%: 12.3%) in Kathmandu, Nepal and Colombia. The high prevalence of *A. lumbricoides* may be due to the high resistance of the infective ova to desiccation and the direct mode of infection that enhances longevity and promotes infectivity [26].

Trichuris trichiura was relatively the second most common GIPs identified in this study. The prevalence value was 31(26.1%)/119. This prevalence rate is low though is in agreement with the report of Manz et al. [27] 26.6% in Tanzania among their population-based study. In contrast, studies elsewhere with very low prevalence ranges in Uganda (0.4%) and Nigeria (2.9%) [28,29]. *T. trichiura* infections are transmitted by ingesting eggs, which develop in the soil [30]. Infections usually occur through ingestion of infective ova from contaminated hands, food or drinks. Flood and copraphagous animals play some part in the transportation of the ova to locations other than the defecation site [31].

The prevalence of 26(21.9%)/119 was recorded for hookworm *Ancylostoma duodenale/Necator americanus*) infections in this survey. This prevalence of hookworm infections was lower compared to 45% and 29.4% in earlier reports in Ghana and Ibadan [32,33]. However, da Silva et al. (2016) agreed with the findings of our report [19]. This reduction of hookworm (*Ancylostoma duodenale/Necator americanus*) prevalence could be indicative of a successful control measures intervention, mass drug administration and health enlightenment programs.

Others gastrointestinal parasites identified were *Clonorchis sinensis,* tapeworm, *Hymenolepis diminuta, Hymenolepis nana* and *Schistosoma mansoni* with low prevalences. Poly-parasitic helminths of *A. lumbricoides* and hookworm (*Ancylostoma duodenale/Necator americanus*) and hookworm (*Ancylostoma duodenale/Necator americanus*) and *T. trichiura* 5(4.2%) each. No protozoa were identified. They were found to be statistically significant (p<0.05) (Table 2).

In terms of prevalence and distribution of gastrointestinal parasitic infections in the study population with specific age group, 11-15yrs had high prevalence of 46(13.5%)/340 participants. In this regard, *T. trichiura* was found to be more prevalent 17(37.0%)/46 positive cases within the group followed by *A. lumbricoides* 13(28.3%) and hookworm 8(17.4%). Other age group had prevalence with *A. lumbricoides* (Table 3). The differences were found to be statistically significant (p<0.05). This study recorded prevalence of GIPIs among children to be 83.2%(99/119), which is relatively high. This high prevalence is in accordance with findings from various studies [34,35]. The act of ricky behaviour that predisposes them to infection and less awareness of hand washing practices might be the probable reasons for increased chances of acquiring GIPs in lower age groups.

A total of 119 respondents that were positive for various gastrointestinal parasites, females accounted for 54(6.4%)/839 and 65(9.8%)/661 were males. Both positive respondents had high prevalence of *A. lumbricoides*. This association was found not to be statistically significant (p<0.05) (Table 4). Hadiza et al. (2019) and Ejinaka et al. (2019) in Kaduna and Jos, Nigeria, reported prevalence rate in females than in males and were statistically significant (p<0.05) [36,37].

The distribution of GIPs among the inmates in this study were found to be high during the wet season 102(13.9%)/734 participants while the dry season had 17(2.2%)/766 participants. *A. lumbricoides* 35(34.3%) was most prevalent in this report followed by *T. trichiura* 28(27.5%) and hookworm (*Ancylostoma duodenale/Necator americanus*) 24(23.5%) and others had few prevalence during wet season as shown in Table 5. However, it was found to be statistically significant (p<0.05). The wet season had more prevalence of GIPs which is in agreement with the study of helminthiasis among school children in some rural communities of Abia State [38]. This was found to be statistically significant (p<0.05). On the contrary in Iran, Kiani et al. [39] (2016) in Nahavand County and its weather in summer, had high prevalence of GIPs. This could be as a result of the existence of more agricultural practices during summer. In seasonal variation of transmission pattern of GIPs, rainfall is one aspect of seasonality that is predicted to have strong effects on helminth parasitism [40]. These effects can come about in several ways. First, variation in rainfall can change host susceptibility by altering resource quantity and quality, driving changes in body condition [41] and immunity [42], both of which can influence susceptibility to infection.

The risk factors associated with gastrointestinal parasitic infections such as the use of drugs in the last 3 months, washing of hands with soap, washing of hands after playing with soil, methods of cooking vegetables, contact with domestic animal, putting on shoes outside appeared to be not statistically significant except for the use of toilet paper (Table 6).

Among the respondents that use drug in the last three months who were positive, 8.4% used drug in the last three months while 7.7% did not and was found not statistically significant (p>0.05).

Also, on the method of cooking vegetables, 7.6% of positive respondents had undercooked vegetables while 8.1% cooked their vegetables thoroughly and others as shown in Table 6. These observations were not statistically significant (p>0.05).

On the use of toilet paper, 17.6% of the respondents had positive GIPs while 5.9%did not practice the use of toilet paper however were positive for GIPs. This observation was found to be statistically significant (p<0.05) (Table 6).

Table 1. Demographic characteristics of respondents

Variables	+ve cases N (%)	-ve cases N (%)	Total cases N (%)	*p*-value	Chi-Square (X^2)
Sex					
Female	54(6.4)	785(93.6)	839(100)	0.006	7.6761
Male	65(9.8)	596(90.2)	661(100)		
Age					
1 - 5yrs	15(9.1)	150(90.9)	165(100)	0.001	30.0533
6 - 10yrs	23(8.1)	261(91.9)	284(100)		
11 - 15yrs	46(13.5)	294(86.5)	340(100)		
16 - 20yrs	15(9.3)	147(90.7)	162(100)		
21 - 25yrs	4(4.5)	85(95.5)	89(100)		
26 - 30yrs	4(3.8)	102(96.2)	106(100)		
31 - 35yrs	1(1.1)	87(98.9)	88(100)		
36 - 40yrs	4(4.1)	94(95.9)	98(100)		
41& above	7(4.2)	161(95.8)	168(100)		
Season					
Wet	103(14.0)	632(86.0)	735(100)	0.001	72.9466
Dry	16(2.1)	749(97.9)	765(100)		

Legends: +ve: Positive; -ve: Negative

Table 2. Characterization and identification of gastrointestinal parasites in the study areas

Location	Characterization and identification of Gastrointestinal parasites in the Study Areas													
	AL N(%)	HK N(%)	TT N(%)	TW N(%)	HN N(%)	SM N(%)	CS N(%)	HD N(%)	AL+HK N(%)	HK+TT N(%)	-ve cases N(%)	+ve cases N(%)	Total (N)%	*p*-value
OW	13(50.0)	2(7.7)	5(19.2)	1(3.8)	0(0.0)	0(0.0)	0(0.0)	1(3.8)	2(7.7)	2(7.7)	258(90.8)	26(9.2)	284(100)	0.026
AW	4(80.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(20.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	171(97.2)	5(2.8)	176(100)	
NW	4(30.8)	3(23.1)	3(23.1)	0(0.0)	0(0.0)	2(15.4)	1(7.6)	0(0.0)	0(0.0)	0(0.0)	262(94.9)	13(5.1)	275(100)	
GD	1(8.3)	3(25.0)	5(41.7)	0(0.0)	1(8.3)	0(0.0)	1(8.3)	0(0.0)	1(8.3)	0(0.0)	251(95.4)	12(4.6)	263(100)	
YZW	2(40.0)	2(40.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(20.0)	0(0.0)	0(0.0)	0(0.0)	181(97.3)	5(2.7)	186(100)	
LCO	3(33.3)	1(11.1)	4(44.4)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(11.1)	71(88.7)	9(11.3)	80(100)	
PCH	2(25.0)	1(12.5)	5(62.5)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	55(87.3)	8(12.7)	63(100)	
PRH	1(6.7)	8(53.3)	4(26.7)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(6.7)	1(6.7)	20(55.6)	15(44.4)	35(100)	
BO	1(25.0)	1(25.0)	2(50.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	26(86.7)	4(13.3)	30(100)	
GO	2(50.0)	1(25.0)	1(25.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	36(90.0)	4(10.0)	40(100)	
DB	7(58.3)	0(0.0)	2(16.7)	1(8.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(8.3)	1(8.3)	34(73.9)	12(26.1)	46(100)	
SB	2(33.3)	4(66.7)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	16(72.7)	6(27.3)	22(100)	
Total	42(35.3)	26(21.9)	31(26.1)	2(1.7)	1(0.8)	3(2.5)	3(2.5)	1(0.8)	5(4.2)	5(4.2)	1381(92.1)	119(7.9)	1500(100)	

Legends: OW: Okujagu Waterfront; AW: Abuja Waterfront; NW: Nembe Waterfront; GD: Gambia Diobu; YZW: Yam Zone Waterfront; LCO: Life Care Orphanage; PCH: Port Harcourt Children Home; PRH: Port Harcourt Remand Home BO: Blesam Orphanage; GD: Goodnews Orphanage; DB: David Bassey; SB: Susan Brown; AL: A. lumbricoides; HK: Hookworm (Ancylostoma duodenale/Necator americanus); TT: T. trichiura; TW: Tapeworm; HN; Hymenolepis nana; SM; Schistosoma mansoni; CS; Clonorchis sinensis; HD: Hymenolepis diminuta; -ve: Negative; +ve: Positive; $p<0.05$

Table 3. Age-related prevalence of gastrointestinal parasites among inmates of SWH and LSA

Age	Prevalence of Gastrointestinal Parasites													
	AL N(%)	**HK N(%)**	**TT N(%)**	**TW N(%)**	**HD N(%)**	**HN N(%)**	**SM N(%)**	**CS N(%)**	**AL+HK N(%)**	**HK+TT N(%)**	**-ve cases N(%)**	**+ve cases N(%)**	**Total N(%)**	***p*-value**
1 - 5yrs	10(66.7)	2(13.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(6.7)	0(0.0)	2(13.3)	0(0.0)	150(90.9)	15(9.1)	165 (100)	0.001
6 - 10yrs	11(47.8)	3(13.0)	8(34.8)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(4.3)	261(91.9	23(8.1)	284 (100)	
11 - 15yrs	13(28.3)	8(17.4)	17(37.0)	2(4.3)	1(2.1)	0(0.0)	1(2.1)	0(0.0)	1(2.1)	3(6.5)	294(86.5)	46(13.5)	340 (100)	
16 - 20yrs	0(0.0)	7(46.7)	4(26.7)	0(0.0)	0(0.0)	1(6.7)	0(0.0)	1(6.7)	1(6.7)	1(6.7)	147(90.7)	15(9.3)	162 (100)	
21 - 25yrs	1(25.0)	2(50.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(25.0)	0(0.0)	0(0.0)	0(0.0)	85(95.5)	4(4.5)	89 (100)	
26 - 30yrs	1(25.0)	3(75.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	102(96.2)	4(3.8)	106 (100)	
31 - 35yrs	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(100.0)	0(0.0)	0(0.0)	87(98.9)	1(1.1)	88 (100)	
36 - 40yrs	3(75.0)	0(0.0)	1(25.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	94(95.9)	4(4.1)	98 (100)	
41& above	3(42.9)	1(14.3)	1(14.3)	0(0.0)	0(0.0)	0(0.0)	0(0.0)	1(14.3)	1(14.3)	0(0.0)	161(95.8)	7(4.2)	168 (100)	
Total N(%)	42(35.3)	26(21.9)	31(26.1)	2(1.7)	1(0.8)	1(0.8)	3(2.5)	3(2.5)	5(4.2)	5(4.2)	1381(92.1)	119(7.9)	1500(100)	

Legends: SHW: Social Welfare Homes; LSA: Low Socio-Economic Areas; AL: A. lumbricoides; HK: Hookworm (Ancylostoma duodenale/Necator americanus); TT: T. trichiura; TW: Tapeworm; HN; Hymenolepis nana; SM; Schistosoma mansoni; CS; Clonorchis sinensis; HD: Hymenolepis diminuta; -ve: Negative; +ve: Positive; $p<0.05$

Table 4. Sex-related prevalence of gastrointestinal parasites among the study population

Sex	Prevalence of Gastrointestinal Parasites													
	AL N(%)	**HK N(%)**	**TT N(%)**	**TW N(%)**	**HD N(%)**	**HN N(%)**	**SM N(%)**	**CS N(%)**	**AL+HK N(%)**	**HK+TT N(%)**	**-ve cases N(%)**	**+ve cases N(%)**	**Total N(%)**	***p*-value**
Females	21(38.8)	10(18.5)	14(25.9)	1(1.9)	0(0.0)	0(0.0)	2(3.7)	1(1.9)	1(1.9)	4(7.4)	785(93.6)	54(6.4)	**839(100)**	0.006
Males	21(32.3)	16(24.6)	17(26.2)	1(1.5)	1(1.5)	1(1.5)	1(1.5)	2(3.1)	4(6.2)	1(1.5)	596(90.2)	65(9.8)	**661(100)**	
Total N(%)	**42(35.3)**	**26(21.9)**	**31(26.1)**	**2(1.7)**	**1(0.8)**	**1(0.8)**	**3(2.5)**	**3(2.5)**	**5(4.2)**	**5(4.2)**	**1381(92.1)**	**119(7.9)**	**1500(100)**	

Legends: AL: Ascaris lumbricoides; HK: Hookworm (Ancylostoma duodenale/Necator americanus); TT: Trichuris trichiura; TW: Tapeworm; HN; Hymenolepis nana; SM; Schistosoma mansoni; CS; Clonorchis sinensis; HD: Hymenolepis diminuta; -ve: Negative; +ve: Positive; p<0.05

Table 5. Prevalence of gastrointestinal parasites in relation to seasonal variations

Season	Prevalence of Gastrointestinal Parasites													
	AL N(%)	**HK N(%)**	**TT N(%)**	**TW N(%)**	**HD N(%)**	**HN N(%)**	**SM N(%)**	**CS N(%)**	**AL+HK N(%)**	**HK+TT N(%)**	**-ve cases N(%)**	**+ve cases N(%)**	**Total N(%)**	***p*-value**
Wet	35 (34.3)	24 (23.5)	28 (27.5)	2(1.9)	1(0.9)	0(0.0)	2(1.9)	2(1.9)	3(2.9)	5(4.9)	632 (86.1)	102 (13.9)	734 (100)	0.001
Dry	7 (41.1)	2 (11.8)	3 (17.6)	0 (0.0)	0(0.0)	1(5.9)	1(5.9)	1(5.9)	2(11.8)	0(0.0)	749 (97.8)	17(2.2)	766 (100)	
Total N(%)	42 (35.3)	26 (21.9)	31(26.1)	2(1.7)	1(0.8)	1(0.8)	3(2.5)	3(2.5)	5(4.2)	5(4.2)	1381(92.1)	119(7.9)	1500 (100)	

Legends: AL: Ascaris lumbricoides; HK: Hookworm (Ancylostoma duodenale/Necator americanus); TT: Trichuris trichiura; TW: Tapeworm; HD: Hymenolepis diminuta; HN: Hymenolepis nana; SM: Schistosoma mansoni; CS: Clonorchis sinensis; -ve: Negative; +ve: Positive; p<0.05

Table 6. Risk Factors Associated with Transmission of Gastrointestinal Parasites in the Study Areas

Variables	+ve cases N(%)	-ve cases N(%)	Total cases N(%)	*p*-value	Chi-Square (X^2)
	Use of drug in the last three months				
Yes	41(8.4)	445(91.6)	486(100)	0.618	0.2489
No	78(7.7)	936(92.3)	1014(100)		
	Method of cooking vegetables				
Undercooked	36(7.6)	440(92.4)	476(100)	0.717	0.1309
Thoroughly	83(8.1)	941(91.9)	1024(100)		
	Handwashing with soap				
Yes	72(9.1)	722(90.9)	794(100)	0.219	3.0344
No	47(6.7)	658(93.3)	705(100)		
	Putting on shoes outside				
Yes	112(8.1)	1279(91.9)	1391(100)	0.544	0.3676
No	7(6.4)	102(93.6)	109(100)		
	Contact with domestic animal				
Yes	13(5.1)	240(94.9)	253(100)	0.071	3.255
No	106(8.5)	1141(91.5)	1247(100)		
	Washing hands after playing with soil				
Yes	101(7.7)	1204(92.3)	1305(100)	0.472	0.5166
No	18(9.2)	177(90.8)	195(100)		
	Use of toilet paper				
Yes	46(17.6)	215(82.4)	261(100)	0.001	40.6309
No	73(5.9)	1166(94.1)	1239(100)		

Legend: +ve: Positive; -ve: Negative

The risk factors associated with gastrointestinal parasitic infections such as the use of drugs in the last 3 months, washing of hands with soap, washing of hands after playing with soil, methods of cooking vegetables, contact with domestic animal, putting on shoes outside appeared to be not statistically significant except for the use of toilet paper that was statistically significant (p<0.05). These findings are in contrast with other studies of which in studies by Hailegebriel [43], Abossie and Seid [44] all in Ethiopia do not have significant risk among sex. This variation might be as a result of outdoor activities especially use of bare-footed involved by the males. Kiani et al. [40] in their study had significant risk factors during summer. Age, educational level, employment status, occupation, contact with domestic animals in this study were considered not significant risk factors. Other study in Iran had significant risk factors of GIPs [39].

We recommend that there is room for further improvement on knowledge of the epidemiology and transmission routes on the identification of *C. sinensis* in this geographical location as there are more fish and snail consumers. Knowledge of the epidemiology and transmission routes of *H. diminuta* needs to be improved since rodents, particularly rats, are the definitive hosts and natural reservoirs. There is a need for effective health education for behavioural changes related to personal hygiene and mass treatment for the sustainable control of gastrointestinal parasitic infections.

4. CONCLUSION

Based on this study, prevalence was significantly higher among males and younger age groups, which covered the school age in the inmates of social welfare homes and low socio-economic areas. *A. lumbricoides* was the most predominant gastrointestinal parasites among this study population. Furthermore, in spite of a significant reduction in the prevalence of gastrointestinal parasites the prevalence and incidence still a major public health concern in Port Harcourt. Thus, effective and sustainable control policies should be considered for public health advantages.

CONSENT AND ETHICAL CLEARANCE

Ethical Clearance was sought from the Rivers State Hospitals Management Board and the study was approved by the Ministry of Social Welfare and Rehabilitation. Another approval was obtained from the community leaders of the study areas together with the informed consent and questionnaire for approval of the study. Confidentiality of the data were kept at all stages of the research work.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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