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Impact of WASH (Water, Sanitation, and Hygiene) on the Control of Gastrointestinal Parasitic Infections Among Primary School Children in Ogba/Egbema/Ndoni LGA, Rivers State

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Abstract
The impact of water, sanitation and hygiene in the control of gastrointestinal parasitic infections among primary school children in Ogba/Egbema/Ndoni Local Government Area, Rivers State was investigated. The study was carried out for a period of seven months (January 2023 - July 2023). A total of 314 participants (167males and 147 females) from four primary schools (Seat of greatness international school, Omoku, Gre-Gracy International School Obrikom, Community Model Primary School, Omoku and Community primary school Okwuzi) were examined. Parasitological analysis of stool samples was carried out using direct smear and formol-ether sedimentation technique for higher sensitivity. Out of 314 pupils examined, 105(33.4%) were positive for at least one gastrointestinal parasite. The genus of parasites extracted were Ascaris spp., Hookworm spp, Trichuris spp., Strongyloides spp., Entamoeba spp. and Diphyllobothrium spp. with infection rates of 27(8.6%), 11(3.5%), 24(7.6%), 15(4.8%), 16(5.1%) and 5(1.6%) respectively. Multiple infections were recorded in 2.2% of the study participants. The prevalence of infection was higher in males (52.4%) than females (47.6%) but not significant (P>0.05). Higher infection rates were observed in participants who drank untreated public (44.5%) or private water (35.4%), did not wash their hands with water and detergent after defecation (51.7%), had poor hand washing practices (55.6%), used public toilets (53.2%), ate fruits/vegetables without washing (52.2%) and walking barefooted (55.2%). Schools with adequate toilet/sanitary facilities, environmental sanitation practices and treated water supply recorded lower rates of gastrointestinal infections. Risk factors associated with gastrointestinal parasitic infections observed in this study were drinking of untreated public or private water source, not washing hands with water and detergent after defecation, lack of regular hand washing practices, use of public toilets, inadequate washing of fruits/vegetables before eating, walking barefooted and lack of functional toilet/sanitary facilities and clean toilets in schools. Increased personal hygiene, sanitation, provision of standard toilet facilities, availability of good drinking water and proper orientation on personal hygiene in schools is recommended to reduce the prevalence of infections in the study area.

Keywords: Water, Sanitation, Hygiene, Gastrointestinal parasites, Primary school children

Introduction

The understanding of adequate WASH is versatile. WASH has benefits beyond disease control: by saving time, water supplies enable people to engage in other activities (Hutton & Chase, 2018), sanitation provides dignity (Cairncross et al., 2010), and school water, especially with sanitation may be important determinants of attendance, particularly among girls (McMahon et al., 2011). WASH is understood to be important for the control of many infectious diseases (Grimes, 2016). 'Water' refers to domestic water supplies – particularly clean drinking water, but also water for other purposes such as cooking, bathing, and the washing of clothes and household items. 'Sanitation' refers to the safe disposal of waste, in particular excreta: that is, urine and faeces. 'Hygiene' refers to other practices conducive to good

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health, such as washing hands with soap following defecation or handling of anything whether foods, animals or objects that have the potential of transmitting pathogens to humans through direct contact. From a public health perspective, however, adequate WASH is that which prevents the transmission of the water- and excreta-related diseases.

Since most of the WASH-related fraction of global morbidity is caused by bacterial, viral, and protozoal infections, most WASH interventions in developing countries are generally targeted at the control of these diarrhoeal diseases. There is usually a focus on the faeco-oral transmission pathway and interventions primarily focus on water for drinking and handwashing, soap for handwashing, and adequate sanitation to contain faeces. Indeed, the most recent report from the Joint Monitoring Program (JMP) refers primarily to water for drinking rather than for other purposes (WHO & UNICEF, 2015).

The socio-economic and health benefits of safely managed water can only be fully realized alongside safely managed sanitation and good hygiene practices. Without water, sanitation and hygiene (WASH), people's wellbeing, dignity and opportunities are severely compromised, particularly women and girls (United Nations, 2022). Access to water and sanitation are human rights. Hygiene knowledge and facilities are life-saving and highly cost-effective health interventions. Safe drinking-water, sanitation and hygiene are crucial to human health and well-being. Yet, millions of people globally lack adequate WASH services and consequently suffer from or are exposed to a multitude of preventable illnesses. Lack of safe WASH negatively impacts quality of life and undermines fundamental human rights. Poor WASH services also weaken health systems, threaten health security and place a heavy strain on economies.

Safe and sufficient WASH plays a key role in preventing numerous Neglected Tropical Diseases (NTDs) such as trachoma, soil-transmitted helminths, hookworm, tapeworms and schistosomiasis. Diarrheal deaths as a result of inadequate WASH were reduced by half during the Millennium Development Goal (MDG) period (1990–2015), with the significant progress on water and sanitation provision playing a key role (WHO, 2022). However, poor WASH conditions still account for 829,000 diarrheal deaths every year (WHO, 2019) and constrain effective prevention and management of other diseases including malnutrition, NTDs and cholera. The infectious diseases that spread through unsafe water, from improperly disposed human waste and poor hygiene practices have a profound effect on high rates of infant mortality, malnutrition and chronic illness in the general population. Clean water, basic toilets and good hygiene practices are essential for the survival and development of children.

Poor access to improved water and sanitation in Nigeria remains a major contributing factor to high morbidity and mortality rates among children under five (**United Nations Children's Fund, 2022)**. The use of contaminated drinking water and poor sanitary conditions result in increased vulnerability to water-borne diseases, including diarrhea which leads to deaths of more than 70,000 children under five annually. 73% of the diarrheal and enteric disease burden is associated with poor access to adequate water, sanitation and hygiene (WASH), and is disproportionately borne by poorer children (UNICEF, 2022). Frequent episodes of WASH related ill-health in children, contribute to absenteeism in school, and malnutrition. Only 26.5% of the population use improved drinking water sources and sanitation facilities and 23.5% of the population defecate in the open (UNICEF, 2022).

Intestinal parasitic diseases remain a serious public health problem in Nigeria. Poor socioeconomic environment has been a major factor facilitating the spread of these diseases. Assessment of human contribution to disease prevalence and distribution are the first steps in planning effective intervention measures for intestinal parasitic diseases. Unhygienic practices of people dumping excrement or defecating indiscriminately at dumpsites, school areas, nearby bushes, traffic highways, river banks and open fields are still on the increase thereby paving way for the development and spread of gastrointestinal parasites that thrive in poor sanitary environments and conditions. Poor hand and personal hygiene which is a common practice in Nigeria contributes immensely to the spread of gastrointestinal parasites especially in populated areas and rural region with poor water supply. The COVID 19 pandemic brought about an improved level of hand hygiene for the prevention of the spread of the disease, which saw the installation of washing hand sinks and basins in virtually every establishment in the country, including schools. It is however pathetic to know that since the end of the pandemic, people and establishments have resorted back to the previous status quo of neglecting the importance of sanitation, personal and hand hygiene.

The possibility of multiple infections has increased due to the negligence of the concept of good water, sanitation and hygiene in an era and country where people do not take laboratory diagnosis seriously with the belief that one drug

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has the potential of curing a variety of diseases. While researches on gastrointestinal diseases have been conducted in recent times in major local government areas in Rivers state, little is known about the recent status in Ogba/Egbema/Ndoni Local Government Area. It is one of the major cities in River state due to the presence of multinational oil companies and other booming establishments with a relatively high urban population and often affected by flooding.

Aim and objectives of the study

The study was aimed at determining the impact of adequate water supply, proper environmental sanitation and hygiene in control of gastrointestinal parasitic infections among primary school children in selected private and public primary schools located within Ogba/Egbema/Ndoni Local Government Area, in Rivers State.

The objectives were to;

1. determine the overall prevalence of gastrointestinal parasitic infection among primary school children in Ogba/Egbema/Ndoni Local Government Area;
2. determine the prevalence of gastrointestinal parasitic infection among primary school children in relation to schools investigated;
3. assess the prevalence of gastrointestinal parasitic infection among primary school children in relation to gender of the children;
4. examine the influence of household access to water, sanitation and hygiene on the prevalence of gastrointestinal parasitic infection among primary school children in the study area;
5. examine the influence of water, sanitation, and hygiene in schools on the prevalent rates of gastrointestinal parasitic infection among primary school children in the study area

Materials and Methods

Study area: This study was carried out in Ogba/Egbema/Ndoni Local Government Area of Rivers state under Rivers west senatorial district. Omoku is the headquarters of Ogba/Egbema/Ndoni Local Government Area and one of the major cities of the Ogba people and Rivers State. It has a population of about 283,294 people (National Population Commission, 2006)**.** It is located in the Northern part of the state. It lies between latitude 5° 20' 30.01" N and longitude 6° 39' 20.02" E. It consists majorly of upland and has vast arable and fertile land for Agricultural and industrial uses. The area has a humid tropical climate annual rainfall distribution which ranges from 2800mm to 3500mm per annum, with an annual Temperature range of 26°C - 31°C throughout the year with a high relative humidity. The area covers over 1,500ha of farm land. Soils of Ogba/ Egbema/ Ndoni are derived from coastal plain sands (Ezebunwo et al., 2022). The area has a swamp mixture and rainforest with different types of trees with coconut and agroforestry. Farming, fishing, trading and oil company jobs are the major occupations of the inhabitants of the Local Government Area. Omoku is home to a number of schools, both private and public (primary, secondary and tertiary).

Sample collection: Fresh stool samples were collected in the morning hours from each study participants (children) from the selected schools using well labelled sample bottles, and transported in small coolers containing ice packs to Biology research laboratory, Ignatius Ajuru University of Education, Rumuolumeni, Port Harcourt within 2 hours of sample collection.

Laboratory examination: Direct fecal smear examination and Formol-ether concentration techniques by Cheesbrough (2006) and Universe (2023) were adopted for isolation of parasites from the fecal samples. Using direct fecal smear examination, 1g of fecal samples was collected from main sample bottle and transferred to a clean test tube containing about 2ml of normal saline and shaken thoroughly. Drops were collected from the test tubes using pipette and placed on a glass slide for viewing. Iodine was added for contrast enhancement. Samples were viewed under the microscope using x4 and x10 objective lenses

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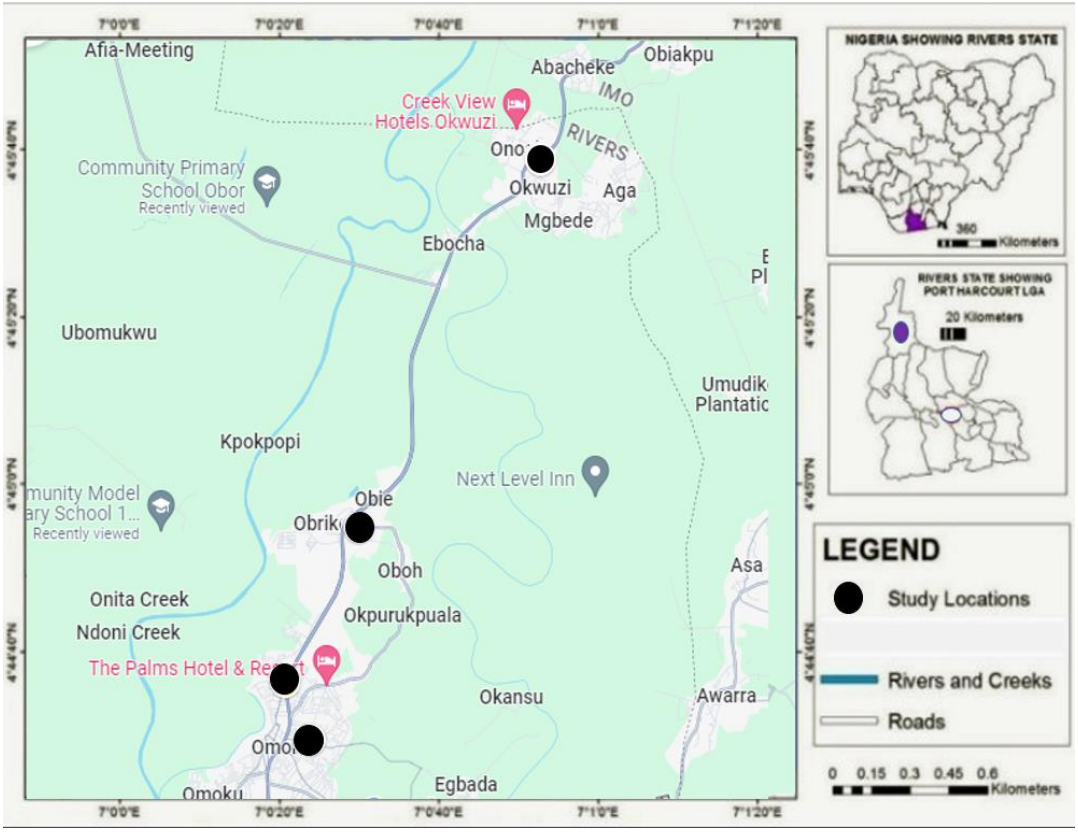

Fig 3.1: Map of Omoku showing study locations

Using formol ether concentration technique**,** about 1g of feces was emulsified in a 250ml beaker containing 10 ml of normal saline and mixed thoroughly with the help of a vortex machine. The mixture was filtered through fine mesh gauze into a centrifuge tube and spun at 2000 rpm for 10 minutes. The supernatant was decanted and the sediments filled with another 10ml of saline solution and centrifuged again to get a clearer supernatant. After the last wash, the supernatant was decanted and 7ml of 10% formalin was added to the sediment, mixed and allowed to stand for 5 minutes to effect fixation. 3ml of diethyl ether was added and a stopper was placed at the top of the tube and shake vigorously. It was then placed in a centrifuge and spun at 1500rpm for 10 minutes. Four layers were visible as a top layer of diethyl ether, plug of debris, layer of formalin, and sediment respectively. The plug of debris was freed from the side of the tube by ringing with an applicator stick and the top three layers carefully decanted. The remaining sediment was mixed with a pipette. One drop each was transferred to a drop of saline and iodine on a glass slide and mixed. It was covered with a coverslip and observed firstly for the presence of parasitic forms under low power (10X) objective, and then high power (40X) objective under the microscope

Determination of WASH status of students and schools examined:
Self-structured questionnaires were also constructed and filled by the researcher to gather sociodemographic and WASH related information on students and school environment respectively, for further data analysis. Information like age, gender, hand and food hygiene habits and sources of water were contained in questionnaires for the children, while information like Availability of water, presence of hand sinks, level of environmental sanitation, outside floor types and availability of good toilet facilities were contained in questionnaires for each selected school.

Data analysis: Data generated were analyzed using SPSS version 23. Chi square and one-way ANOVA were used to test for relationship and compare differences at 0.05 significance level.

Ethical consideration/informed consent: Before commencement of this research, approval was obtained from the ethics committee, Ignatius Ajuru University of Education, Port Harcourt

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Results

Overall prevalence of gastrointestinal parasitic infections among primary school children: The overall prevalence of gastrointestinal parasitic infections among primary school children is presented in Table 1.0. Out of 314 participants examined, 105(33.4%) were positive for at least one gastrointestinal parasitic infection. Parasites belonging to six genera of gastrointestinal parasites were extracted from the study participants. These parasites included *Ascaris* spp., Hookworm, *Trichuris* spp., *Strongylodes* spp., *Entamoeba* spp. and *Diphyllobothrium* spp. with infection rates of 27(8.6%), 11(3.5%), 24(7.6%), 15(4.8%), 16(5.1%) and 5(1.6%) respectively. 7(2.2%) participants had mixed infections.

Table 1.0: Overall prevalence of gastrointestinal parasitic infections among primary school children

	(n=314)	
Gastrointestinal parasites	**No. infected**	**Prevalence%**
Ascaris spp.	27	8.6
Hookworm	11	3.5
Trichuris spp.	24	7.6
Strongyloides spp.	15	4.8
Entamoeba spp.	16	5.1
Diphyllobothrium spp.	5	1.6
Mixed	7	2.2
Total	**105**	**33.4**

Prevalence of gastrointestinal parasitic infections among primary school children in relation to schools investigated

The prevalence of gastrointestinal parasitic infection among children in relation to schools investigated is presented in Table 2.0. The schools investigated were SGI school, GGI school, CMPS Omoku and CPS Okwuzi with sample sizes of 75, 36, 120 and 83 respectively. Of the 75 children examined in SGI School, 8(10.7%) were infected with at least one gastrointestinal parasite. Of the 36 children examined in GGI School, 14(38.9%) were infected with at least one gastrointestinal parasite. Of the 120 children examined in CMPS Omoku, 45(37.5%) were infected with at least one gastrointestinal parasite. Of the 83 children examined in CPS Okwuzi, 38(45.8%) were infected with at least one gastrointestinal parasite. An overall prevalence of 33.4% was recorded. Statistical analysis indicated that there was a significant difference ($P<0.05$, P-value =0.000) between schools and the prevalence of gastrointestinal parasitic infections

Table 2.0: **Prevalence of** gastrointestinal parasitic infections among primary school children in relation to schools investigated

Schools	No. examined	No. infected (%)	No. not infected (%)
SGI School	75	8(10.7)	67(89.3)
GGI School	36	14(38.9)	22(61.1)
CMPS Omoku	120	45(37.5)	75(62.5)
CPS Okwuzi	83	38(45.8)	45(54.2)
Total	314	105(33.4)	209(66.6)

$X^2 = 34.526$, df=3, P-value =0.000 ($P<0.05$)

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Prevalence of **g**astrointestinal parasitic infection among primary school children in relation to gender: **The** prevalence of gastrointestinal parasitic infection among primary school children in relation to gender is presented in Table 3.0. From SGI School, 35(46.7%) of the study participants were males while 40(53.3%) were females. Out of the 35 males examined, 3(8.6%) were infected while out of the 40 females examined, 5(12.5%) were infected with at least one gastrointestinal parasite. From GGI School, 16(44.4%) of the study participants were males while 20(55.6%) were females. Out of the 16 males examined, 7(43.7%) were infected while out of the 20 females examined, 7(35%) were infected with at least one gastrointestinal parasite. From CMPS Omoku, 69(57.5%) of the study participants were males while 51(42.5%) were females. Out of the 69 males examined, 24(34.8%) were infected while out of the 51 females examined, 21(41.2%) were infected with at least one gastrointestinal parasite.From CPS Okwuzi, 47(56.6%) of the study participants were males while 36(43.4%) were females. Out of the 47 males examined, 21(44.7%) were infected while out of the 36 females examined, 17(47.2%) were infected with at least one gastrointestinal parasite. Out of the 105 study participants infected across the schools, 55(52.4%) were males while 50(47.6%) were females. There was no significant relationship (P>0.05, P-value =0.840) between gender and the prevalence of gastrointestinal parasitic infections

Table 3.0: **Prevalence of gastrointestinal parasites in relation to gender**

Schools	Gender	No. examined (%)	No. infected (%)	No. not infected (%)
SGI School	Male	35(46.7)	3(8.6)	32(91.4)
	Female	40(53.3)	5(12.5)	35(87.5)
	Total	75(100)	8(10.7)	67(89.3)
GGI School	Male	16(44.4)	7(43.7)	9(56.3)
	Female	20(55.6)	7(35)	13(65)
	Total	36(100)	14(38.9)	22(61.1)
CMPS Omoku	Male	69(57.5)	24(34.8)	45(65.2)
	Female	51(42.5)	21(41.2)	30(58.8)
	Total	120(100)	45(37.5)	75(62.5)
CPS Okwuzi	Male	47(56.6)	21(44.7)	26(55.3)
	Female	36(43.4)	17(47.2)	19(52.8)
	Total	83(100)	38(45.8)	45(54.2)

X^2 = 0.041, df=1, P-value =0.840 (P>0.05)

Influence of household access to WASH on prevalence of gastrointestinal parasites: The influence of household access to WASH on prevalence of gastrointestinal parasites is presented in Table 4.0. Data on sources of drinking water indicated that, 43.6% of the study participants drank water from public taps(borehole), 17.5% drank from privately owned treated borehole, 25.2% drank from private untreated borehole and 13.7% drank % from water vendors. 44.5% of participants that drank water from public tap(borehole) were infected with at least one gastrointestinal parasite, 16.4% of participants that drank water from private treated borehole were infected with at least one gastrointestinal parasite, 35.4% of participants that drank water from private untreated borehole were infected with at least one gastrointestinal parasite while 16.3% of participants that drank water from water vendors were infected with at least one gastrointestinal parasite. Infection rate was lower in participants that drank water from privately owned treated boreholes and water vendors with prevalence of 16.4% and 16.3% respectively, while highest infection rate was recorded among participants that drank water from public tap (borehole).

Data on toilet hygiene indicated that, 58% of the study participants wash their hands with only water after defecation, 23.5% of the study participants wash their hands with water and detergents after defecation while 18.5% of the study participants only clean their hands with towel or toilet paper. 36.8% of participants that washed their hands with only water were infected with at least one gastrointestinal parasite, 10.8% of participants that washed their hands with water

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and detergents were infected with at least one gastrointestinal parasite while participants the only cleaned their hands with towel or toilet paper recorded a prevalence of 51.7%. The lowest infection rate was recorded among study participants that washed their hands with water and detergents while the highest was observed among participants that only cleaned their hands with towel or toilet paper.

Data on hand washing practices indicated that, 12.7% of the study participants practice hand washing always, 64.3% of the study participants practiced hand washing sometimes while 23% of the study participants recorded a poor level of hand washing practices. 7.5% of participants that practiced hand hygiene always, were infected with at least one gastrointestinal, 30.7% of participants that practiced hand hygiene sometimes, were infected with at least one gastrointestinal parasite while 55.6% of participants that practiced poor hand hygiene were infected with at least one parasite. The lowest infection rate was observed among study participants that practiced hand washing always while the highest was recorded among participants with poor hand hygiene practices.

The conditions of toilet facilities were also analyzed. Data indicated that 29.3% of the study participants used privately owned modern toilets with good water flow, 22.6% used privately owned modern toilet without water flow, 18.2% used public modern toilet with good water flow while 29.9% used public modern toilet without water flow. None of the study participants used pit/bucket latrine toilet ststem.12% of participants that used privately owned modern toilet with water flow were infected with at least one gastrointestinal helminth, 26.7% of study participant that used privately owned modern toilet without water flow were infected with at least one gastrointestinal parasite, 43.9% of the study participants that used public modern toilet with water flow were infected with at least one gastrointestinal parasite while 53.2% of the study participants that used public modern toilet without water flow were infected with at least one gastrointestinal parasite. The lowest infection rate was recorded among participants that used privately owned modern toilet with water flow while the highest was recorded among participants that used public modern toilet without water flow with prevalence rates of 12% and 53.2% respectively.

Data on food hygiene indicated that 30% of the study participants always washed their fruits/vegetables before eating, 48.7% sometimes washed their fruits before eating while 21,3% hardly washed their fruits before eating. 12.8% of participants that always washed their fruits/vegetables before eating was infected with at least one gastrointestinal parasite, 37.9% of participants that sometimes washed their fruits/vegetables before eating was infected with at least one gastrointestinal parasite while 52.2% of participants that hardly washed their fruits/vegetables before eating was infected with at least one gastrointestinal parasite. The lowest infection rate was recorded among participants that always washed their fruits/vegetables before eating while the highest was recorded among participants that hardly washed their fruits/vegetables before eating Data on footwear status indicated that 63.1% of the study participants always put on their household footwears while 36.9% of the study participants do not put on their household footwears always. 20.7% of the participants that always put on their household foot wears were infected with at least one gastrointestinal parasite while 55.2% of the participants that did no put on their household footwears always were infected with at least one gastrointestinal parasite.

Table 4.0: Influence of student's WASH at home on prevalence of gastrointestinal parasites

WASH variables	**Frequency (%)**	**No. infected**
Sources of drinking water		
Public tap (bore hole)	137(43.6)	61(44.5)
Private bore hole (treated)	55(17.5)	9(16.4)
Private bore hole (untreated)	79(25.2)	28(35.4)
Well	0(0)	0(0)
Water vendors (Sachet, bottle etc.)	43(13.7)	7(16.3)
Others (Stream, river etc.)	0(0)	0(0)
Toilet hygiene		

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Hand wash after defecation (Only water)	182(58)	67(36.8)
Hand wash after defecation (water + detergent)	74(23.5)	8(10.8)
Clean hands with towel/toilet paper only	58(18.5)	30(51.7)
Hand washing practices		
Hand hygiene practices (always)	40(12.7)	3(7.5)
Hand hygiene practices (sometimes)	202(64.3)	62(30.7)
Hand hygiene practices (poor)	72(23)	40(55.6)
Conditions of toilet facilities		
Private modern toilet (with water flow)	92(29.3)	11(12)
Private modern toilet (without water flow)	71(22.6)	19(26.7)
Private pit/bucket latrine	0(0)	0(0)
Public modern toilet (with water flow)	57(18.2)	25(43.9)
Public modern toilet (without water flow)	94(29.9)	50(53.2)
Public pit/bucket latrine	0(0)	0(0)
Food Hygiene		
Wash fruit/veg before eating (always)	94(30)	12(12.8)
Wash fruit/veg before eating (sometimes)	153(48.7)	58(37.9)
Wash fruit/veg before eating (hardly)	67(21.3)	35(52.2)
Footwear		
Puts on footwear (always)	198(63.1)	41(20.7)
Puts on footwear (not always)	116(36.9)	64(55.2)

Influence of WASH in schools on the prevalent rates of gastrointestinal parasitic infections: The influence of WASH in schools on the prevalent rates of gastrointestinal parasitic infections is presented in Table 5.0. Schools were rated based on the availability of WASH related facilities and adherence to WASH related standards and practices in percentages. Schools with higher WASH ratings recorded lower prevalence of gastrointestinal parasites. SGI school with a WASH rating of 100% recorded an infection rate of 10.7%, GGI school with a WASH rating of 57.8% recorded and infection rate of 38.9%, CMPS with a WASH rating of 31.6% recorded an infection rate of 37.5% while CPS Okwuzi with a WASH rating of 36.8% recorded an infection rate of 45.8%

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Table 5.0: Influence of school WASH level on prevalence of gastrointestinal parasites

WASH variables	SGI School	GGI School	CMPS Omoku	CPS Okwuzi
Water supply	Yes	Yes	Yes	Yes
Water supply source	Borehole	Borehole	Borehole	Borehole
Water supply source location	In school	In school	In school	In school
Washing of storage tank	Always	Sometimes	Hardly	Hardly
Washing hand sink	Yes	No	No	Not functional
Washing hand sink with detergent	Yes	-	-	-
Toilet type	Modern	Modern	Modern	Modern
Toilet condition	Good/clean	Good/dirty	Bad/dirty	Bad/dirty
Waterflow in toilet	Yes	Yes	Not functional	Not functional
Student to toilet ratio	Good	Good	Poor	Moderate
Dumpsite around school	No	No	No	No
School fence	Yes	Partly	fallen	No
Outside floor type	Interlocked	Sand	Sand	Sand
School compound sanitation	Clean	Clean during dry season	Partially clean	Not clean
Flooding during rainy season	No	Partially	Partially	Partially
School WASH rating %	100	57.8	31.6	36.8
% of infected students	10.7%	38.9%	37.5%	45.8%

Discussion

Water sanitation and hygiene are essential to human health and survival as well as maintenance of a healthy community. They are crucial for prevention and control of gastrointestinal infections. The prevalence of gastrointestinal infections is highly influenced by WASH. This study focused on the impact of water, hygiene and sanitation in the control of intestinal gastrointestinal parasitic infections among primary school children in Ogba/Egbema/Ndoni Local Government Areas of Rivers State.

The overall prevalence of gastrointestinal parasites in the study area was investigated. 33.4% of the study participants were infected with at least one gastro intestinal parasite (Table 1.0). This is higher than results reported by Aschale et al. (2021) and Gbonhinbor et al. (2022), who recorded prevalence rates of 16% and 23.95% respectively. The result was however lower than those reported by Damen et al. (2011), Gboeloh and Ike-Ihunwo (2019), Aribodor et al. (2019) and Gyang et al. (2019) with prevalence rates of 80.9%, 75.7%, 58.1% and 86.2% respectively. Gastrointestinal parasites belonging to six genera extracted were *Ascaris* spp., Hookworm, *Trichuris* spp., *Strongylodes* spp., *Entamoeba* spp. and *Diphyllobothrium* spp. No gastrointestinal *Schistosoma* spp. was extracted from the samples. The absence of gastrointestinal *schistosoma* spp. in the study area may be attributed to the presence of modern sources of water that prevents participants from assessing streams and rivers which may harbor the infective stages of *schistosoma* parasites. This differs from the result reported by Adeniran et al. (2017), who recorded a prevalence of 3.6% *S. mansoni* among children in Abeokuta, Aribodor et al. (2019), who recorded a prevalence of 7.2% *S. Mansoni* among pupils in Enugu state and Alade et al. (2023), who recorded a prevalence of 8% *S. mansoni* among Nigerian school children. *Ascaris* spp. and *Trichuris* spp. were the most prevalent gastrointestinal parasites recorded in the

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study. This conforms to result reported by Aribodor et al. (2019) who also reported *Ascaris* spp. and *Trichuris* spp. as the most prevalent parasites extracted in their study. Hookworm and *Diphyllobothrium* spp recorded the lowest prevalence of parasites extracted.

Out of the Four schools examined, the lowest prevalence of most gastrointestinal parasites extracted was observed in SGI School. This could partly be attributed to high standard of WASH observed in the school. None of the study participant from SGI school was infected with *Trichuris* spp. and *Diphyllobothrium* spp. The prevalence of gastrointestinal parasite in SGI school was 10.7%. CPS Okwuzi recorded the highest prevalence of gastrointestinal parasites with a prevalence of 45.8%, Followed by GGI school and CMPS Omoku with recorded prevalence of 38.9% and 37.5% respectively. Statistical analysis indicated that there was a significant relationship between schools and prevalence of gastrointestinal parasitic infections ($P<0.05$).

The prevalence of gastrointestinal parasite in relation to gender was also analyzed. Out of 105 study participants infected across the schools, 52.4% were males while 47.6% were females. The result is similar to results reported by Abah and Arene (2015), Gbonhinbor et al. (2022) and Gbeghebo et al. (2023), but differs from results reported by Okosa et al. (2023) who recorded higher rates of infection in females. The higher prevalence of gastrointestinal parasites recorded in males could possibly be as a result of male children indulging in more exposing physical activities which required the removal of their footwears to play football, thereby increasing their chances of being infected by any of the soil transmitted helminths in school and areas with poor environmental sanitation. Statistical analysis however indicated that there was no significant relationship between gender and prevalence of gastrointestinal parasitic infection ($P>0-05$).

Multiple infections of species were also observed and recorded in the study. 2.2% of the study participants were positive for multiple infections of more than one species. Although the clinical presentation of parasitic infection may appear similar, they however, require different types of drugs for treatment. This is why clinical presentations (signs and Symptoms) are not always considered as sensitive diagnostic tools, rather standard laboratory diagnosis of gastrointestinal parasites is always recommended and remains the gold standard for a more sensitive result. Albendazole and mebendazole have been used over the years in mass drug administration campaigns for the control of soil transmitted helminth's because they have demonstrated high efficacy with up to 95% egg reduction rate against Hookworm, and a 50% cure rate against *T. trichiura* (keiser & utzinger, 2008; Moser et al., 2017). Repeated administration of albendazole has been suggested for better outcome against *T. Trichiura* (Adegnika et al., 2014). *S. stecoralis* on the other hand, which is one of the soil transmitted helminths, is not sensitive to albendazole and mebendazole and therefore not impacted by large scale preventive treatment campaigns targeting other soil transmitted helminths with albendazole and mebendazole (WHO, 2023). Ivermectin is the drug of choice for control of *S. Stecoralis*. It is also sensitive against *A. lumbricoides*. Metronidazole and tinidazole are sensitive against amoebiasis while praziquantel is useful against taeniasis. Therefore, proper laboratory diagnosis is also necessary before the commencement of any intervention program to achieve higher levels of egg/cyst reduction rates. *A. lumbricoides*, Hookworm and *T. trichiura* do not multiply in the human host, reinfection mainly occurs as a result of contact with infective stages in the environment. *S. Stecoralis* however, multiplies in the host, and in individuals with a compromised immunity, the uncontrolled multiplication can be fatal.

The prevention of gastrointestinal parasites can easily be achieved by provision and maintenance of toilet/sanitary facilities at home and schools, availability of treated water, good and proper environmental sanitation void of waste materials and water, and strict adherence to hand washing practices and personal hygiene. The results of this study showed that infection rates were higher in participants who drank water from public and private untreated boreholes, had poor hand hygiene practices, did not wash their hands with water and detergents, used public toilets, ate fruits and vegetables without washing and moved around bare footed (Table 4.0). These were also considered as risk factors associated with the prevalence of gastrointestinal parasitic infection among the study participants. It was also observed that schools with better toilet/sanitary facilities, environmental sanitation practices and treated water supply recorded lower rates of gastrointestinal infections.

Conclusion

Water hygiene and sanitation have a great influence in the prevalence of gastrointestinal parasites among primary school children. The results of this study indicated significant prevalence of gastrointestinal parasitic infections among children in the selected schools in Ogba/Egbema/Ndoni Local Government Area. Ascariasis and Trichuriasis were the most prevalent gastrointestinal parasitic infection among children in the selected schools located within the study area.

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The infection rate was higher in selected public schools and children from households with poor compliance to Water Sanitation and Hygiene practices. Gender-related infection rates were dependent on each school investigated as no particular pattern of infection between gender was observed, however, from the overall results, males recorded higher infection rates. Hence there is need for intentional adherence to hand washing practices, toilet hygiene practices, environmental sanitation and provision of standard toilet facilities and portable water supply to control the spread of gastrointestinal diseases in selected schools in the study area and households.

Recommendations

1. Intervention program for mass drug administration is recommended for the reduction and control of gastrointestinal parasitic infections among primary school children in the study area
2. Adequate toilet/sanitary facilities should be provided in the two public schools (CMPS Omoku and CPS Okwuzi) with higher infection rates to curb the spread of pathogens from objects to persons
3. Routine environmental sanitation in the selected schools is recommended to maintain a healthy environment for school children and discourage favorable conditions for excreta and water related pathogens and vectors
4. Orientation on the importance of personal hygiene and improved sanitary habit among school children is recommended to prevent hygiene and sanitation related infections
5. Complete fencing in public schools is also recommended to prevent stray animals and scavengers from accessing school premises.

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