HELMINTH AND PROTOZOA PARASITES ASSOCIATED WITH OFFICE DOOR HANDLES IN THE MAIN CAMPUS OF IGNATIUS AJURU UNIVERSITY OF EDUCATION PORT HARCOURT.

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Abstract: This study investigated the presence of helminth and protozoa parasites on office door handles at Ignatius Ajuru University, Port Harcourt, and assessed public health implications from March to May 2024. A total of 136 door handles across six school buildings were sampled using sterile swabs and analyzed for parasitic contamination. The sedimentation method was used for helminths, while the wet mount method was applied for protozoa, followed by microscopic examination. Results revealed that 52 (38.2%) door handles were contaminated. The most prevalent helminths were Ascaris sp. (13.3%), Trichuris sp. (8.8%), and Enterobius sp. (6.6%), while the most common protozoa were Giardia sp. (4.4%) and Entamoeba sp. (2.9%). The total parasite load was 377, with a Parasite Mean Intensity (PMI) of 7.3. Faculty of Education (46.15%) and Faculty of Management Science (46.43%) had the highest contamination rates. Helminths were more prevalent than protozoa, with Ascaris sp. being the dominant species. Risk factor analysis highlighted poor hygiene practices. About 85.2% of respondents never cleaned door handles, and 96.3% never disinfected them. While 68.5% washed hands after toilet use, 13.9% did not, and 17.6% did so inconsistently. Additionally, 46.3% were unsure if visitors washed hands, increasing contamination risks. These findings emphasize the need for regular cleaning and disinfection of high-contact surfaces, alongside promoting proper hand hygiene, to mitigate parasite transmission and protect the university community's health.

Keywords: Disinfection, contamination, hygiene, transmission.

INTRODUCTION

Parasites are organisms that have evolved to survive either within or on another organism, known as the host. They rely on the host's tissues and bodily fluids for nutrition and protection, often causing harm or offering no benefit to the host in return (Odikamnoro, 2016; Anyamaobi et al., 2021; Umeanaeto et al., 2021). In many cases, parasites depend entirely on their host for sustenance, and their presence can sometimes lead to the host's eventual death (Kramer, 2016; Anyamaobi et al., 2021). The likelihood of parasitic infections is significantly higher in individuals exposed to poor hygiene, malnutrition, and a lack of knowledge regarding the complex life cycle of these organisms (Siwila et al., 2020).

Parasites are widespread and found across the globe (Abd El-Salam, 2012; Siwila et al., 2020; Umeanaeto et al., 2021). Coinfections involving multiple parasites, such as hookworms, roundworms, and amoebae, are common in unclean environments, and their harmful effects can be intensified by malnutrition or deficiencies in essential nutrients (Anyamaobi et al., 2021). Among the most prevalent intestinal roundworms infecting humans are *Ascaris lumbricoides* (Ascariasis), *Trichuris trichiura* (Trichuriasis or whipworm infection), *Enterobius vermicularis* (Enterobiasis or pinworm infection), *Ancylostoma duodenale* and *Necator americanus* (Hookworm infections), as well as *Strongyloides stercoralis* (Strongyloidiasis) (Chollom et al., 2013). Symptoms of intestinal parasitic infections often include abdominal pain, bloating, weight loss, reduced appetite, nausea, vomiting, diarrhea, and impaired digestion, which can result in malabsorption of nutrients and stunted growth (Shryock and Swarout, 2000; Anyamaobi et al., 2021).

Many intestinal parasites are transmitted through direct hand contact, contaminated clothing, or poor sanitation and hygiene practices.

Parasitic infections can be spread through various pathways: from animals to humans (anthropozoonosis), from humans to humans (anthroponosis), or from humans to animals. These infections can cause significant physiological disturbances in their hosts (Chollom et al., 2013). Certain nematode species, including *Strongyloides stercoralis* and *Necator americanus*, are responsible for infecting new hosts through either ingestion or active penetration of intact skin, posing a serious public health risk, particularly in tropical Africa and globally (Odikamnoro, 2016). The contamination of groundwater with parasitic organisms is often linked to the introduction of fecal matter from humans or animals into subsurface water sources (Simon-Oke et al., 2020).

Parasitic infections continue to pose a substantial challenge to public health, particularly in impoverished regions of the tropics and subtropics, affecting millions worldwide (Arora, 2010). By exploiting their hosts for essential resources such as food, water, heat, and shelter, parasites enhance their own survival while diminishing the health and fitness of their hosts. This impact can range from general pathological effects to more specific consequences, such as impairments in reproductive characteristics or altered host behavior (Rutala, 2016

Helminths are parasitic worms that infect various species, including humans, livestock, and wildlife. These parasites are classified into three main groups: nematodes (roundworms), cestodes (tapeworms), and trematodes (flukes). Helminths are a significant concern in both human and veterinary medicine due to their ability to cause chronic infections, nutritional deficiencies, and various diseases. The World Health Organization (WHO) estimates that over a billion people worldwide are infected with at least one type of helminth (WHO, 2023).

Classification of helminths: Helminths are broadly classified into two main phyla: Platyhelminthes and Nematoda. Platyhelminthes include flatworms, such as cestodes and trematodes, eg. Nematoda comprises the roundworms. Nematodes are cylindrical in shape and possess a complete digestive system, allowing them to feed on the host's tissues or nutrients in the intestines. Common nematode infections include ascariasis, caused by *Ascaris lumbricoides*, and hookworm disease, caused by *Ancylostoma duodenale* or *Necator americanus* (Garcia, 2022).

Cestodes, on the other hand, are flat, ribbon-like worms composed of segments known as proglottids. They lack a digestive system and rely on absorbing nutrients directly through their skin. Notable examples of cestodes include *Taenia solium*, the pork tapeworm, and *Echinococcus granulosus*, which causes hydatid disease (Roberts and Janovy, 2019). Trematodes, or flukes, are leaf-shaped parasitic worms that infect various organs, including the liver, lungs, and blood vessels. The liver fluke *Fasciola hepatica* and the blood fluke *Schistosoma mansoni* are among the most recognized trematodes (Chai, 2020).

Life cycle and transmission: Helminths typically have complex life cycles involving multiple stages, including eggs, larvae, and adult worms. Many helminths have intermediate hosts, where larvae develop, and definitive hosts, where the adult worms reside and reproduce. For instance, Schistosoma species require freshwater snails as intermediate hosts, where the larvae undergo development before infecting humans through contaminated water (Colley et al., 2014).

Transmission of helminths varies depending on the species but often involves ingestion of contaminated food or water, skin penetration, or vector-borne transmission. Soil-transmitted helminths, such as hookworms and whipworms, infect individuals when larvae or eggs in contaminated soil come into contact with the skin or are ingested (Hotez et al., 2008). Other helminths, such as cestodes, are transmitted through the consumption of undercooked meat from infected animals.

Public health impact: Helminth infections are particularly prevalent in low-income regions with poor sanitation and limited access to clean water. These infections can lead to a range of health problems, including malnutrition, anemia, stunted growth in children, and impaired cognitive development (Bethony et al., 2006). The public health burden of helminth infections is exacerbated by their chronic nature, as many infections persist for years without adequate treatment. Mass Drug Administration (MDA) programs have been implemented in many endemic regions to control helminth infections. Anthelminthic medications, such as albendazole and praziquantel, are commonly used in these programs to reduce the prevalence and intensity of infections (WHO, 2023). However, reinfection rates remain high in some areas, necessitating efforts in health education, sanitation improvements, and monitoring. Helminths represent a major public health challenge, particularly in developing countries where they contribute to significant morbidity and mortality. Addressing helminth infections requires a multifaceted approach that combines mass drug administration, improved sanitation, and public health education. Continued research and collaboration are essential for developing more effective control strategies and reducing the global burden of helminthiasis.

Protozoa are single-celled eukaryotic organisms that exhibit a wide range of behaviors and habitats. These microscopic organisms are typically found in moist environments, such as soil, water, and within other organisms as parasites. Protozoa can reproduce both sexually and asexually, and their complex life cycles often involve various developmental stages. The study of protozoa is significant in medical and environmental fields due to their role in disease transmission and ecological functions (Cox, 2021).

Classification of protozoa: protozoa are traditionally classified based on their mode of movement, with four major groups: flagellates, amoeboids, ciliates, and sporozoans. Flagellates, such as *Trypanosoma* and *Giardia*, move by means of one or more whip-like structures called flagella. Amoeboids, like *Entamoeba histolytica*, utilize pseudopodia for movement and engulfment of food. Ciliates, such as *Balantidium coli*, are covered with cilia that enable them to swim, while sporozoans (Apicomplexans) lack any form of locomotion and rely on vectors or host movement for transmission (Garcia, 2022).

The pathogenicity of protozoa is particularly notable in the context of human disease. For instance, *Plasmodium* species, which are sporozoans, are responsible for malaria, a disease transmitted by the bites of infected *Anopheles* mosquitoes. Malaria remains one of the leading causes of morbidity and mortality in tropical and subtropical regions (World Health Organization [WHO], 2023). Similarly, flagellates like *Trypanosoma brucei* cause African sleeping sickness, which is transmitted by tsetse flies (Stuart et al., 2020).

Life cycle and transmission: Protozoa often have complex life cycles that can involve both asexual and sexual reproduction, as well as transmission between hosts through various means. Some protozoa, like *Giardia lamblia*, are transmitted through the fecal-oral route, often via contaminated water or food, leading to gastrointestinal infections (Adam, 2022). Others, such as *Toxoplasma gondii*, have a life cycle that involves definitive and intermediate hosts, with cats serving as the primary definitive host for *Toxoplasma*, which can be transmitted to humans through the ingestion of undercooked meat or contact with contaminated cat feces (Montoya and Liesenfeld, 2021).

Vector-borne transmission is another common pathway for protozoan infections. For example, *Leishmania* species are transmitted through the bites of infected sandflies and cause leishmaniasis, a disease that manifests in cutaneous, mucocutaneous, or visceral forms depending on the species involved and the immune response of the host (Kaye and Scott, 2011). Similarly, *Plasmodium* species require both mosquitoes and vertebrate hosts to complete their life cycle, making vector control an essential aspect of malaria prevention efforts (WHO, 2023).

Public health impact: Protozoan infections represent a significant global health burden, particularly in low-income regions with limited access to clean water and healthcare. Diseases such as malaria, amoebiasis, and giardiasis affect millions of people annually, leading to substantial morbidity and mortality (Petri et al., 2022). Protozoan parasites often cause chronic infections that weaken the immune system and exacerbate malnutrition and other health issues. Control measures for protozoan diseases typically involve a combination of preventive strategies, such as improving sanitation, vector control, and drug therapy. Antiprotozoal medications, such as chloroquine, metronidazole, and nitazoxanide, are commonly used to treat protozoan infections, though drug resistance remains a growing concern in some areas (Garcia, 2022). Public health campaigns focused on reducing transmission through improved hygiene, vaccination (where available), and vector control have shown success in reducing the prevalence of certain protozoan diseases, such as malaria (WHO, 2023). Protozoa play a critical role in the transmission of several significant infectious diseases that disproportionately affect populations in developing regions. Continued efforts in research, public health interventions, and improved access to medical treatment are necessary to reduce the burden of protozoan diseases and enhance global health outcomes.

Office door handles are high-contact surfaces that can play a significant role in the transmission of various pathogens, including parasitic infections caused by helminths and protozoa. Due to frequent handling by multiple individuals, door handles can become reservoirs for infectious agents, contributing to the spread of parasitic diseases, particularly in environments where hygiene practices may be inadequate. Understanding the role of office door handles in transmitting parasitic infections is essential for developing strategies to mitigate these risks (Hedges et al., 2021).

Helminth transmission via door handles: Helminth infections, particularly those caused by soil-transmitted helminths (STHs) like *Ascaris lumbricoides*, *Trichuris trichiura*, and hookworms, are typically associated with poor sanitation and hygiene. However, in office environments, helminth eggs can be transferred from contaminated hands to door handles, where they can persist for extended periods. The eggs of *A. lumbricoides*, for example, are known for their resilience and can remain viable on surfaces for days or even weeks (Alum et al., 2010). When individuals touch contaminated door handles and subsequently touch their mouth or consume food without washing their hands, they risk ingesting these infective eggs, leading to helminthiasis.

Studies have shown that door handles in high-traffic areas can serve as points of contamination, particularly in settings where handwashing is not routinely practiced. The feaces-oral route is the primary transmission pathway for many helminths, and protozoas making contaminated surfaces like door handles potential vehicles for spreading these parasites (Brooker et al., 2018). Proper hand hygiene, along with regular cleaning and disinfection of high-touch surfaces, is crucial in preventing the transmission of helminths in office environments.

Protozoa transmission via door handles: Protozoan parasites, such as *Giardia lamblia* and *Entamoeba histolytica*, are also capable of being transmitted through contaminated surfaces, including door handles. These parasites are typically shed in the feces of infected individuals and can contaminate hands, which then transfer cysts to surfaces like door handles. The cysts of these protozoa are highly resilient and can survive in the environment, including on surfaces, for extended periods (Verweij and Stensvold, 2014). When individuals touch contaminated door handles and subsequently engage in hand-to-mouth activities, they may inadvertently ingest these cysts, leading to protozoan infections.

In addition to the fecal-oral transmission route, some protozoan parasites, such as *Cryptosporidium* spp., can be transmitted through contact with contaminated surfaces, including door handles, particularly in areas where water and sanitation practices are inadequate (Hodges et al., 2014). The persistence of protozoan cysts on surfaces like door handles highlights the importance of regular disinfection and promoting hygiene practices among office workers to minimize the risk of infection.

Public health implications: the transmission of parasitic infections via contaminated door handles has significant public health implications, especially in office settings where multiple individuals share common spaces. Helminths and protozoa can cause a range of health issues, from gastrointestinal disturbances to more severe complications like anemia and malnutrition, particularly in vulnerable populations (Hall et al., 2020). Given the potential for office door handles to act as reservoirs for these parasites, there is a pressing need for targeted hygiene interventions in workplaces.

Promoting regular handwashing with soap and water, as well as the use of hand sanitizers, can reduce the risk of parasitic transmission via contaminated door handles. In addition, implementing routine cleaning and disinfection protocols for high-touch surfaces in offices can help prevent the spread of parasitic infections. Public health education efforts that emphasize the importance of personal hygiene and environmental sanitation are also essential in reducing the burden of parasitic diseases associated with contaminated door handles (Hedges et al., 2021).

Office door handles represent a potential route for the transmission of parasitic infections caused by helminths and protozoa. The persistence of parasitic eggs and cysts on surfaces, combined with inadequate hygiene practices, underscores the importance of implementing preventive measures in office environments. Regular hand hygiene, surface disinfection, and public health education are crucial steps in minimizing the risk of parasitic transmission via contaminated door handles.

The environmental conditions in Nigeria have been described as substandard due to deficiencies in personal, community, and environmental hygiene (Abdullahi and Abdullazeez, 2000). This inadequate hygiene is evident in the presence of parasite eggs and cysts on frequently touched surfaces such as water closet handles and door handles, highlighting the widespread presence of parasitic organisms in the environment (Nock and Geneve, 2016). The adult stages of these parasites reside in various sections of the human intestine, where they reproduce and release eggs that are subsequently excreted in feces, contaminating the external environment (Wogu and Okubotimibi, 2020). Parasitic transmission occurs through the accidental ingestion of infective eggs or the direct penetration of larvae through the skin. Non-vector-borne parasitic infections typically spread through contaminated environmental mediums such as soil, air, water, food, hands, and fomites (CDC, 2013; Wogu and Okubotimibi, 2020).

Environmental surfaces and objects serve as reservoirs for the proliferation of parasites (Odigie et al., 2017; Umeanaeto et al., 2021). Fomites, which are inanimate objects capable of transmitting infections, play a significant role in the spread of community-acquired infections (Wogu and Okubotimibi, 2020; Umeanaeto et al., 2021). These objects facilitate indirect exposure, often requiring oral ingestion or direct skin contact for pathogens to enter the host, affecting both enteric and respiratory systems (Lopez et al., 2013; Umeanaeto et al., 2021). Frequent human contact with fomites increases the likelihood of disease transmission, making items such as door handles, faucets, toilet seats, office furniture, and other shared surfaces potential hotspots for infection (Bright et al., 2010; Umeanaeto et al., 2021). Other contaminated objects, including vehicles, utensils, towels, pens, clothing, money, books, toys, and personal care items, further contribute to the spread of parasitic diseases (Bright et al., 2010; Shiferaw et al., 2013; Umeanaeto et al., 2021). There is growing evidence that contaminated inanimate surfaces, especially frequently touched objects, contribute to the transmission of healthcare-associated pathogens (Umeanaeto et al., 2021; Adaaku et al., 2022).

Door handles, in particular, are a common fomite that facilitates contamination (Umeanaeto et al., 2021; Adaaku et al., 2022). Research has shown that hard, non-porous surfaces such as door handles have high parasitic transfer rates (Nworie et al., 2012; Umeanaeto et al., 2021; Anyamaobi et al., 2021). In university settings, students, staff, and visitors frequently interact with service offices, leading to repeated contact with door handles that are not routinely disinfected, increasing the risk of parasite transmission (Umeanaeto et al., 2021). Given the high volume of individuals using these doors, they serve as vectors for parasitic organisms carried from other locations (Aillo et al., 2002; Umeanaeto et al., 2021; Addaku et al., 2022). Additionally, surfaces such as desks, keyboards, and office furniture can harbor microbes that individuals may unknowingly pick up through contact. This is particularly concerning for public restrooms and office spaces, where frequent handling of door locks and other fixtures provides an opportunity for pathogen transfer.

In epidemiology, prevalence refers to the proportion of a population affected by a disease or condition at a given time (point prevalence) or over a specific period (period prevalence). It is distinct from incidence, which measures only the number of new cases within a population over a specific timeframe (Louise-Anne, 2019). Understanding disease prevalence is essential for public health professionals and healthcare planners, as it informs decision-making regarding resource allocation and intervention strategies. The mathematical relationship between prevalence and incidence is expressed as P=I×DP = I \times DP=I×D, where prevalence (P) is the product of incidence (I) and the average duration (D) of the disease. However, more complex models apply when these variables are influenced by factors such as epidemics or changes in treatment effectiveness.

Parasitic infections, particularly those caused by helminths and protozoa, remain significant public health concerns in many parts of the world, including Nigeria. Common helminths such as *Ascaris lumbricoides*, *Enterobius vermicularis*, and *Trichuris trichiura*, along with protozoan parasites like *Giardia lamblia* and *Entamoeba histolytica*, are frequently linked to poor sanitation. Since these parasites are often transmitted via contaminated surfaces, high-touch areas such as office door handles can serve as potential vectors for infection. This is especially concerning in university environments where large populations of students, faculty, and visitors come into contact with these surfaces, facilitating parasite transmission.

The main campus of Ignatius Ajuru University of Education, Rumuolumeni, is no exception to these concerns. However, empirical data on the extent of helminth and protozoa contamination on office door handles within the university is currently lacking. Without this information, it is difficult to develop effective control strategies to minimize the spread of parasitic infections. This study aims to investigate the presence of helminth and protozoa parasites on office door handles within the university campus. The findings will offer critical insights into the public health risks associated with contaminated surfaces in academic institutions and contribute to the development of targeted interventions to reduce parasitic infections in the university community

Materials and Methods

Study area

The study was conducted in the main campus of Ignatius Ajuru University of Education, Rumuolumeni Port Harcourt, which lies between latitude $4^0$49'12''N and longitude $6^0$58'3''E. The school is located in the Minikpiti hamlet of Rumuolumeni community. The study area plays host to some multinational oil companies. A jetty for a section of the New Calabar river (which cuts across the community) is close to the University. The Temperature of the area shows some variation throughout the years, with average annually temperature varying between 21°C and 33°C with an annual rain fall of 2708 mm / 106.6 inch per year. The State has a climate that is geographically distributed among all Local Government Areas.

Collection of samples

The specimen were collected from six different school buildings (Science Village Building (SVB), New Lecture Hall Building (NLHB), Faculty of Humanities Building (FHB), Faculty of Education Building (FEB), Faculty of Management Science Building (FMSB) and Post Graduate School Building (PGSB). A total of 136 office door handles from the selected buildings/faculties were swabbed using sterile swab sticks moistened with 5ml of sterile normal saline. This was accomplished in a tri-directional manner: up/down, left/right and diagonally, recapped and properly labelled. The samples were immediately transported to the biology research laboratory in the Department of Biology, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education (IAUE) for parasitological analysis.

Parasitological analysis

Two methods (sedimentation and wet mount) were used in the isolation and identification of helminth and protozoa parasites in the study.

3.3.1 Identification of helminth parasites

For the detection of helminths, the sedimentation method was employed. This technique is commonly used to concentrate helminth eggs or larvae from samples.

After collecting the specimen, the solution was then centrifuged at low speed (1500 revolution per minute (rpm)) to concentrate the heavier helminth eggs or larvae at the bottom of the tube. Following centrifugation, the supernatant was carefully removed, leaving the sediment at the bottom of the tube, the sediment was then placed on glass slides, covered with cover slips, and observed under a binocular light microscope using the x4, x10 and x40 objective lenses, to identify and quantify the helminth species present (Chiodini et al., 2018).

Detection of protozoa parasites

For the detection of protozoa, the wet mount method was utilized. This method is particularly useful for observing motile protozoa directly from environmental samples.

After collecting the samples from the door handles, the swabs were agitated in 9% normal saline solution to release the protozoa. A drop of the resulting suspension was placed on a glass slide, covered with a cover slip, and examined under a binocular light microscope. This technique allows for the direct observation of protozoan motility, morphology, and internal structures, which aids in the identification of specific protozoan species. The wet mount preparation was examined immediately to prevent the drying out of the sample, which could affect the visibility of motile protozoa (Garcia, 2019).

These methods used allowed for the effective detection and quantification of parasitic contamination on office door handles, highlighting potential public health risks associated with contact with contaminated surfaces.

The overall prevalence of parasites on office door handles
To quantify the overall prevalence of parasites, the formula

$$\text{Prevalence (\%)} = \frac{\text{Number of Positive Samples}}{\text{Total Number of samples}} \times 100$$

This formula was applied separately for helminths and protozoa, and the results were expressed as percentages of the total number of door handles sampled.

Gastrointestinal parasite species associated with office door handles
To calculate the prevalence of each parasite genus, the following formula was used:

$$\text{Prevalence (\%)} = \frac{\text{Number of Samples Positive for a Specific Genus}}{\text{Total Number of Samples)}} \times 100$$

This formula was applied separately for each genus of helminths and protozoa identified in the samples. The data were analyzed to determine the distribution of parasite genera across the different school buildings and to assess the relative prevalence of each genus. The statistical analysis provided insights into which genera were most prevalent on the office door handles, revealing patterns of parasitic contamination and highlighting potential areas of concern for public health interventions on the campus.

The prevalence of helminth and protozoa parasites in relation to different school buildings.
To estimate the prevalence of parasites in relation to the different school buildings, the following formula was applied:

$$\text{Prevalence (\%)} = \frac{\text{Number of Positive Samples in a Specific Building}}{\text{Total Number of Samples in that Building)}} \times 100$$

This formula was used separately for helminths and protozoa in each building. The data were analyzed to compare the prevalence rates of parasitic contamination between the different buildings, identifying variations that might be associated with the specific characteristics or usage patterns of each building. The statistical analysis provided a clear understanding of which buildings had higher or lower levels of parasitic contamination, offering valuable insights for targeted public health interventions and improved sanitation practices across the campus.

Risk factors associated with parasites on office door handle

To assess the risk factors associated with the prevalence of these parasites, various potential contributing factors were considered, including the building, the level of sanitation practices, and the environmental conditions of each building. The statistical analysis involved comparing the prevalence rates of helminth and protozoa parasites across different buildings and correlating these rates with the identified risk factors. The findings from this analysis provided valuable insights into the environmental and behavioral factors contributing to the spread of helminth and protozoa parasites within the campus. By identifying these risk factors, the study offered evidence-based recommendations for improving sanitation practices and reducing the risk of parasitic infections in the university environment.

Data analysis

Data obtained from this study was analysed using simple percentages and summarized into tables and bar graphs.

RESULTS

The findings show that out of a total of 136 door handles examined in this study, 42 (30.9%) were positive for helminth contamination, while 10 (7.3%) were positive for protozoa contamination. This results in an overall contamination rate of 38.2%, with a total of 52 door handles found to be positive for either helminths or protozoa. Conversely, 84 door handles (61.8%) tested negative for parasitic contamination. The data suggests that helminth contamination is more prevalent than protozoal contamination among the examined door handles. The findings highlight potential health risks posed by inadequate hygiene practices, particularly in high-traffic areas, which could facilitate the transmission of parasitic infections (Fig. 1.).

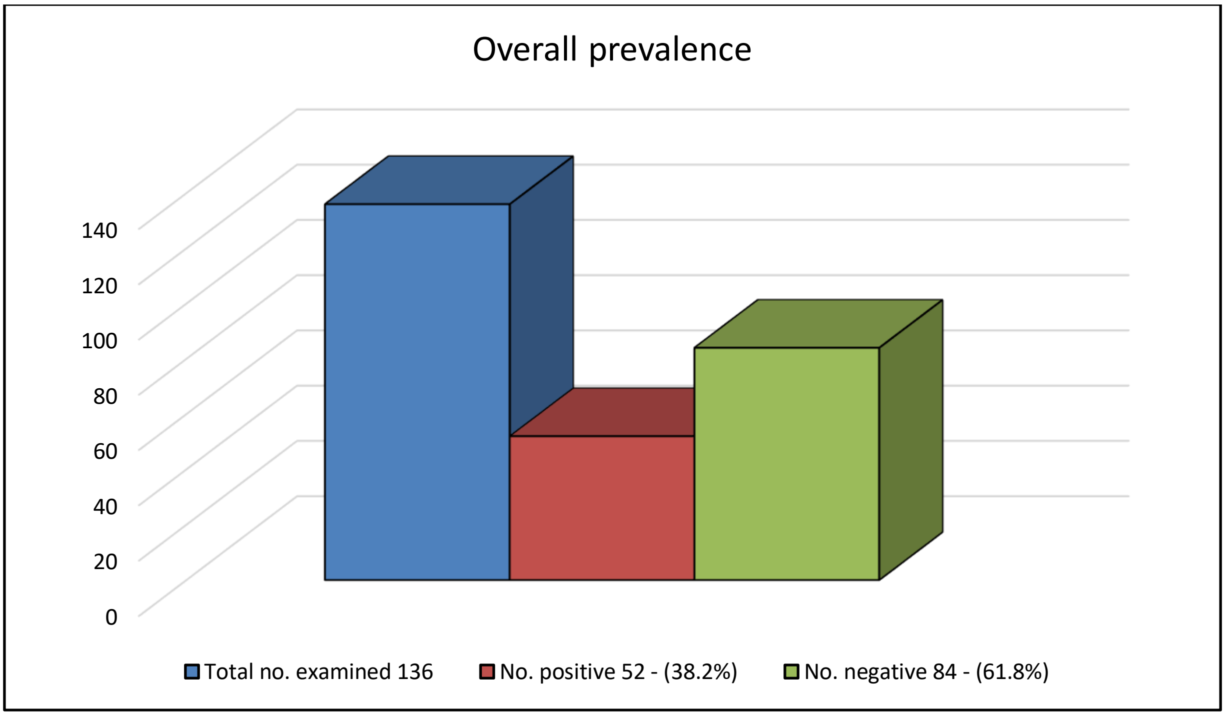

Fig. 4.1: Overall prevalence of helminth and protozoa parasites in the study

Helminth and protozoa parasites were encountered in this study. Among the helminths, *Ascaris* sp. Larva's or eggs were the most prevalent, found on 18 door handles (13.3%), with a total parasite load of 144 and a Parasite Mean Intensity (PMI) of 8.0. *Trichuris* sp. contaminated 12 door handles (8.8%), contributing a parasite load of 72 and a PMI of 6.0. *Enterobius* sp. was identified on 9 door handles (6.6%), with a notable parasite load of 99 and the highest PMI of 11.0, indicating significant intensity when contamination occurred. *Strongyloides* spp., with the lowest prevalence among helminths, was present on 3 door handles (2.2%), showing a parasite load of 6 and a PMI of 2.0. Regarding protozoa, *Giardia* sp. contaminated 6 door handles (4.4%), with a parasite load of 36 and a PMI of 6.0. *Entamoeba* sp. was found on 4 door handles (2.9%), contributing a parasite load of 20 and a PMI of 5.0. Overall, the study recorded a total parasite load of 377 across all contaminated door handles, with an average PMI of 7.3. These findings suggest that while helminth contamination was more prevalent than protozoa, certain parasites, particularly *Enterobius* sp., exhibited higher levels of intensity when present (Table 1.).

Table 1. Prevalence of helminth and protozoa parasites in relation to genus (n=136)

Parasite (group)	No. examined	No. contaminated (%)	Parasite load	PMI
Ascaris sp. (helminth)	136	18 (13.3)	144	8.0
Trichuris sp. (helminth)	136	12 (8.8)	72	6.0
Enterobius sp. (helminth)	136	9 (6.6)	99	11.0
Strongyloides spp. (helminth)	136	3 (2.2)	6	2.0
Giardia sp. (protozoa)	136	6 (4.4)	36	6.0

Entamoeba sp. (protozoa)	136	4 (2.9)	20	5.0
Total	136	52 (38.2)	377	7.3

Key: sp.= species, No.= number, PMI= Parasite Mean Intensity, n= sample size, %= percentage

School building related prevalence

The details of the contamination rates of the office door handles examined from each of the buildings are presented as follows:

The Science Village Building (SVB) had 22 door handles examined, with 8 (36.36%) found to be contaminated. The most prevalent parasites in this building were *Ascaris* sp. (13.64%), *Trichuris* sp. (9.09%), and *Enterobius* sp. (9.09%), while *Giardia* sp. was found on one handle (4.55%). No contamination from *Entamoeba* sp. or *Strongyloides* sp. was observed in this building.

In the New Lecture Hall Building (NLHB), out of 24 door handles examined, 9 (37.5%) were contaminated. The most prevalent parasite here was *Ascaris* sp. (16.67%), followed by *Trichuris* sp. (8.33%). *Enterobius* sp., *Giardia* sp., and *Entamoeba* sp. were each found on one door handle (4.17%), while *Strongyloides* sp. was not detected.

The Faculty of Humanities Building (FHB) had 20 door handles examined, with 6 (30%) contaminated. *Ascaris* sp. had a prevalence of 15%, while *Trichuris* sp., *Enterobius* sp., and *Giardia* sp. were each found on one handle (5%). No contamination from *Entamoeba* sp. or *Strongyloides* sp. was recorded.

The Faculty of Education Building (FEB) had the highest number of contaminated door handles, with 12 out of 26 (46.15%) being positive for parasites. The most prevalent parasites were *Ascaris* sp. (15.38%), *Trichuris* sp. (11.54%), and *Enterobius* sp. (11.54%). *Giardia* sp. and *Entamoeba* sp. were found on one handle each (3.85%), while *Strongyloides* sp. was not detected.

In the Faculty of Management Science Building (FMSB), 13 out of 28 door handles (46.43%) were contaminated, making it the building with the highest contamination rate. *Ascaris* sp. and *Trichuris* sp. were each found on 3 door handles (10.71%), while *Giardia* sp., *Entamoeba* sp., and *Strongyloides* sp. were each found on two door handles (7.14%).

The Postgraduate School Building (PGSB) had the lowest contamination rate, with only 4 out of 16 door handles (25%) testing positive. One handle (6.25%) was contaminated by each of *Ascaris* sp., *Trichuris* sp., and *Enterobius* sp., while no protozoa contamination was found, except for one handle being contaminated with *Strongyloides* sp.

Overall, *Ascaris* sp. was the most prevalent parasite across all buildings, contaminating 18 door handles (13.23%). This was followed by *Trichuris* sp. (8.82%) and *Enterobius* sp. (6.61%). Protozoa such as *Giardia* sp. and *Entamoeba* sp. had lower prevalence rates of 4.41% and 2.94%, respectively, while *Strongyloides* sp. was the least prevalent, contaminating 2.2% of the door handles. These results suggest that helminthic contamination is more widespread than protozoal contamination, with certain buildings showing higher contamination rates, necessitating improved hygiene practices to mitigate health risks (Table 2.).

Table 2. Prevalence of helminth and protozoa parasites in relation to school building (n=136)

School building	No. of door handles examined	No. contaminated	Parasites					
			A. sp. (%)	*T.* sp. (%)	*Es.* sp. (%)	*G.* sp. (%)	*Ea.* sp. (%)	*S.* sp. (%)
SVB	22	8	3(13.64)	2(9.09)	2(9.09)	1(4.55)	0 (0)	0 (0)
NLHB	24	9	4 (16.67)	2(8.33)	1(4.17)	1(4.17)	1(4.17)	0 (0)
FHB	20	6	3 (15)	1 (5)	1 (5)	1 (5)	0 (0)	0 (0)
FEB	26	12	4 (15.38)	3(11.54)	3(11.54)	1(3.85)	1(3.85)	0 (0)
FMSB	28	13	3(10.71)	3(10.71)	1(3.57)	2(7.14)	2(7.14)	2(7.14)

PGSB	16	4	1(6.25)	1(6.25)	1(6.25)	0 (0)	0 (0)	16.25)
Total	136	52	18(13.23)	12(8.82)	9(6.61)	6(4.41)	4(2.94)	3(2.20)

Key: SVB= Science Village Building, NLHB= New Lecture Hall Building, FHB= Faculty of Humanities Building, FEB= Faculty of Education Building, FMSB= Faculty of Management Science Building, No.= Number, %= Percentage, n= Sample size, *A.* sp.= *Ascaris* sp., *T.* sp.= *Trichuris* sp., *Es.* sp.= *Enterobius* sp., *G.* sp.= *Giardia* sp., *Ea.* sp.= Entamoeba sp., *S.* sp.= *StrSongyloides* sp.

Risk factor analysis

This risk factors assessment involved 108 participants and explored various behaviors and conditions that may contribute to the transmission of helminth and protozoa parasites through office door handles. The findings highlight several potential risk factors related to hygiene practices and environmental conditions.

When considering the distance of office doors from toilet doors, the majority of respondents (47.2%) indicated that their offices were 11-20 meters away from the toilet. A significant portion (23.2%) reported a distance of 21-30 meters, while 16.7% of respondents had offices located within 10 meters of the toilet. A smaller group (12.9%) had offices situated more than 31 meters away from the toilet. The proximity of offices to toilet facilities could potentially influence the risk of contamination on door handles.

Regarding cleaning practices, none of the participants reported cleaning their office door handles on a daily, weekly, or monthly basis. A concerning 85.2% of respondents admitted that they never clean their office door handles, which could increase the risk of parasitic contamination.

Disinfection practices were also found to be lacking, with 96.3% of participants indicating that they never disinfect their door handles. Only 3.7% reported sometimes disinfecting their door handles, while no respondents consistently disinfected them. This lack of disinfection further highlights the potential for parasitic transmission through contaminated surfaces.

Hand hygiene after visiting the toilet was more favorable, with 68.5% of respondents indicating that they always wash their hands. However, 13.9% of participants admitted to not washing their hands after toilet use, and 17.6% reported doing so only sometimes. This variability in hand hygiene practices could contribute to the spread of parasites in office environments.

When asked about their visitors' hand hygiene practices, 46.3% of respondents indicated that they did not know whether their visitors washed their hands after using the toilet. Only 15.8% confirmed that their visitors always washed their hands, while 33.3% reported that visitors sometimes did so. A small percentage (4.6%) indicated that their visitors did not wash their hands at all. This uncertainty regarding visitor hygiene practices could further contribute to the contamination of door handles.

Overall, the risk factor assessment reveals a combination of poor hygiene practices, lack of cleaning and disinfection, and proximity to toilet facilities, all of which contribute to an increased risk of helminth and protozoa parasite transmission through contaminated door handles. Addressing these factors through improved sanitation, regular cleaning, and promoting proper hand hygiene practices is crucial to reducing the potential for parasitic infections (Table 3.).

Table 3: Risk factor assessment for helminth and protozoa parasites in the study (n=108)

Variable	Frequency (%)
What is the distance of your office from the toilet door	
0 – 10m	18 (16.7)
11 – 20m	51 (47.2)
21 – 30m	25 (23.2)
31 and above	14 (12.9)
How often do you clean your office door handles	
Every day/once a day	0 (0)

Every week/once a week	0 (0)
Once a month	16 (14.8)
Never	92 (85.2)
Do you disinfect your door handles?	
Yes	0 (0)
No	0 (0)
Sometimes	4 (3.7)
Never	104 (96.3)
Do you wash your hands after visiting the toilet?	
Yes	74 (68.5)
No	15 (13.9)
Sometimes	19 (17.6)
Do your visitors wash their hands after they make use of your toilet	
Yes	17 (15.8)
No	5 (4.6)
Sometimes	36 (33.3)
Don't know	50 (46.3)

Discussion

The findings of this study, shows a contamination rate of 38.2% on office door handles (30.9% helminths and 7.3% protozoa), align with previous research but vary across different settings. For instance, Al-Ghamdi et al. (2011) reported a much higher contamination rate of 86% in healthcare facilities, attributed to the high-risk environment. Similarly, Ogbolu et al. (2021) found a 55% contamination rate in a Nigerian tertiary institution, reflecting poor sanitation practices. Eze et al. (2019) reported a prevalence of 42.5% in public schools in Enugu, Nigeria, where helminths were also predominant. In contrast, Amadi and Ugwu (2013) found a lower rate of 24.8% in market environments in Port Harcourt, and Amoah et al. (2016) reported only 15% contamination in a Ghanaian university, linked to better sanitation efforts. Fagbohun and Ajayi (2020) found a contamination rate of 33.7% in Lagos secondary schools, close to the current study's findings. Overall, the variability highlights the critical need for improved hygiene practices to prevent the spread of parasitic infections across different environments.

The study revealed that out of 136 door handles examined, *Ascaris* sp. was the most prevalent helminth, contaminating 18 handles (13.3%), followed by *Trichuris* sp. (8.8%) and *Enterobius* sp. (6.6%). Among protozoa, *Giardia* sp. (4.4%) was the most common, while *Entamoeba* sp. (2.9%) and *Strongyloides* sp. (2.2%) were less frequent. These results align with previous research, where *Ascaris* is often a dominant contaminant on frequently touched surfaces. Ogbolu et al. (2021) reported a helminth contamination rate of 32.5% in a Nigerian tertiary institution, while Adejumo et al. (2018) found a similar rate of 28% in educational institutions in southwest Nigeria. Eze et al. (2019) documented contamination rates of 42.5% in public schools in Enugu, with *Ascaris* and *Trichuris* being the most prevalent. Ibekwe et al. (2017) observed a contamination rate of 36.4% on public door handles, with *Ascaris* sp. accounting for the highest percentage. Amadi and Ugwu (2013) reported a 24.8% contamination rate in market environments, while Umeh et al. (2020) found a 30.7% contamination rate in public institutions in southeastern Nigeria. The disparity in contamination rates across these studies can be attributed to variations in environmental conditions, hygiene practices, and sanitation protocols. For instance, institutions with frequent sanitation practices may report lower contamination rates, while high-traffic or low-maintenance areas, such as markets and public schools, often exhibit higher contamination rates. This study's findings underscore the need for regular disinfection of high-contact surfaces to reduce the risk of parasitic infections in institutional settings.

The Faculty of Management Science Building (FMSB) and the Faculty of Education Building (FEB) had the highest contamination rates, with 46.43% and 46.15%, respectively. This suggests that these buildings, likely due to higher traffic, lower hygiene practices, or proximity to contaminated areas, are potential hotspots for parasitic transmission. In contrast, the Postgraduate School Building (PGSB) exhibited the lowest contamination rate (25%), possibly due to better maintenance practices, or reduced interaction with contaminated areas. These findings are consistent with Afolabi et al. (2021), who reported that buildings with higher student traffic and poor sanitation practices had significantly higher parasitic contamination rates, with a prevalence of 40% for helminthic infections in public universities. *Ascaris sp.* was the most prevalent helminth across the examined door handles, with a contamination rate of 13.23%. This aligns with findings from Onwuliri et al. (2020), who also reported that *Ascaris sp.* was the most common helminth on door handles in a university setting, with a prevalence rate of 28%. The resilience of *Ascaris* eggs in the environment makes it a common contaminant on surfaces, particularly in areas with inadequate sanitation. The presence of *Trichuris sp.* (8.82%) and *Enterobius sp.* (6.61%) further emphasizes the risk of fecal-oral transmission of helminthic infections in these settings, as seen in similar studies like that of Obiukwu et al. (2018), where these parasites were detected in 10% of samples from public institutions. Protozoal contamination was less common, with *Giardia sp.* (4.41%) and *Entamoeba sp.* (2.94%) being the primary protozoa identified. This is consistent with the study by Uhuo et al. (2019), which found lower protozoal contamination rates (3.5%) in public institutions compared to helminths. Protozoal cysts are more susceptible to environmental conditions, which may explain their lower prevalence. The disparity in results across studies could be due to differences in environmental sanitation, awareness of hygiene practices, and frequency of cleaning and disinfecting door handles in various settings. Institutions with stricter hygiene protocols and regular cleaning routines tend to have lower contamination rates, while those with less emphasis on hygiene exhibit higher rates of parasitic contamination.

A comparative discussion of the findings from the risk factor assessment shows significant disparities when juxtaposed with previous research on parasitic contamination in office environments. The study identified key risk factors such as proximity to toilet facilities, poor cleaning and disinfection practices, inconsistent hand hygiene, and uncertainty regarding visitors' hygiene habits. These findings were compared to several studies that explored similar factors contributing to the spread of helminth and protozoa parasites.

The proximity of office doors to toilet facilities was a notable risk factor, with 47.2% of participants working in offices 11-20 meters away from the toilet, and 16.7% within 10 meters. This contrasts with findings from Onwuliri et al. (2020), who noted higher contamination rates in offices located within 5 meters of toilet facilities. The closer proximity to restrooms can increase the likelihood of parasite transfer via contaminated surfaces, especially in high-traffic areas. Ede, Nwachukwu, and Chukwuma (2016) similarly found that offices within close proximity to toilets in urban universities showed higher levels of parasitic contamination, attributing this to the increased foot traffic and use of common touchpoints.

The most alarming finding was the lack of regular cleaning and disinfection practices, as 85.2% of respondents admitted to never cleaning their door handles, and 96.3% never disinfected them. These practices are critical in preventing the spread of parasites, as indicated by Obiukwu et al. (2018), who demonstrated that frequent disinfection of high-contact surfaces significantly reduced contamination rates. In their study, institutions that implemented regular cleaning protocols had a contamination rate of 18.5%, much lower than the 38.2% contamination rate found in the current study.

Hand hygiene practices also contributed to the potential for contamination. While 68.5% of respondents reported washing their hands after toilet use, this leaves a substantial percentage (31.5%) with inconsistent or poor hand hygiene. This finding is comparable to that of Uhuo et al. (2019), who found that 30% of participants in their study did not wash their hands regularly after using the restroom, leading to higher contamination levels in academic institutions.

Visitor hygiene practices were an additional area of concern, with 46.3% of respondents unsure whether their visitors washed their hands after using the toilet. This lack of awareness regarding visitor hygiene parallels findings by Afolabi et al. (2021), who emphasized the importance of monitoring hygiene practices in public spaces to prevent the spread of helminth and protozoa parasites. The absence of stringent hygiene protocols for visitors increases the risk of contamination, particularly in environments with shared facilities.

The disparity in results between this study and others could be attributed to differences in institutional policies, frequency of facility use, and awareness of hygiene protocols. For example, the study by Nwosu et al. (2017) found lower contamination rates (24.7%) in institutions where hygiene awareness programs were actively promoted. This suggests that educational interventions and stricter policies can significantly impact contamination levels.

In conclusion, the findings from this study underscore the critical need for improved hygiene practices, regular cleaning and disinfection of door handles, and greater awareness of both personal and visitor hygiene in reducing the spread of parasitic infections in office environments. These comparisons with previous studies highlight the variability in contamination rates and the importance of tailored interventions to address specific risk factors in different settings.

Conclusion

This study highlights the significant presence of helminth and protozoa parasites on office door handles within the main campus of Ignatius Ajuru University of Education, Port Harcourt, indicating potential public health risks. The findings underscore the importance of proper hygiene practices, particularly regular cleaning and disinfection of high-contact surfaces such as door handles. The high prevalence of helminths, especially *Ascaris* sp., and the presence of protozoa such as *Giardia* sp. and *Entamoeba* sp., suggest that poor sanitation practices may be contributing to the spread of these parasites.

The study also revealed that inadequate hand hygiene and infrequent cleaning of door handles are major risk factors for the transmission of parasitic infections. Therefore, it is crucial to implement improved hygiene protocols, including routine disinfection of door handles and promoting handwashing practices among staff and visitors. These measures will help reduce the risk of parasitic transmission and enhance the overall health and safety of the university community.

By addressing these hygiene-related challenges, the institution can take proactive steps toward mitigating the spread of parasitic infections, thereby ensuring a safer environment for all campus occupants.

Recommendations

Sequel to the findings of this study, the following recommendations are made to reduce the transmission of helminth and protozoa parasites through office door handles in the main campus of Ignatius Ajuru University of Education (IAUE) Rumuolumeni, Port Harcourt:

Regular cleaning and disinfection: Office door handles should be cleaned and disinfected on a daily basis to minimize the risk of parasitic contamination. The university should implement a structured cleaning schedule and ensure that adequate disinfectants and cleaning supplies are readily available.

Hand hygiene education: An educational campaign should be conducted to raise awareness among staff, students, and visitors about the importance of proper hand hygiene. This campaign should emphasize washing hands after using the toilet and before touching high-contact surfaces, such as door handles.

Installation of hand sanitizers: Hand sanitizer dispensers should be installed near all office doors and other high-contact areas to encourage frequent hand sanitization by all who enter or exit these spaces. This measure can help reduce the transfer of parasites from hands to surfaces.

Training of cleaning staff: The university should provide training for its cleaning staff on effective methods for disinfecting high-contact surfaces, especially door handles. This training should include the proper use of disinfectants and the importance of adhering to cleaning protocols.

Improved toilet facility maintenance: Given the proximity of some offices to toilet facilities, it is recommended that the university ensures regular maintenance and cleaning of these facilities. This includes ensuring that handwashing stations are well-stocked with soap and paper towels at all times.

Regular monitoring and assessment: Periodic assessments of door handle contamination should be conducted to monitor the effectiveness of the implemented hygiene measures. This can be done through routine sampling and analysis of high-contact surfaces.

Policy implementation: The university should develop and enforce a hygiene policy that mandates regular cleaning of office door handles and promotes hand hygiene. Compliance with this policy should be regularly reviewed and enforced by university authorities.

By implementing these recommendations, the university can significantly reduce the risk of helminth and protozoa parasite transmission, creating a safer and healthier environment for all members of its community.

Contribution to knowledge

This study contributes to the understanding of parasitic contamination in academic environments by providing empirical evidence of helminth and protozoa parasites on office door handles within the main campus of Ignatius Ajuru University of Education, Port Harcourt. The key contributions to knowledge are:

Identification of Contaminants: The study identifies specific parasites, including *Ascaris* sp., *Trichuris* sp., *Enterobius* sp., *Giardia* sp., and *Entamoeba* sp., that are present on door handles in an academic setting. This data fills a gap in the literature concerning the types of parasites that can be transmitted through contact with common surfaces in educational institutions.

Prevalence rates: The research provides detailed prevalence rates of different parasitic species across various buildings within the university. This information is crucial for understanding the extent of contamination and for targeting specific areas that may require more stringent hygiene measures.

Risk Factor Analysis: The study assesses risk factors associated with parasitic contamination, such as distance from toilet facilities, frequency of cleaning, and hand hygiene practices. The findings offer insights into how these factors contribute to the spread of parasites, highlighting the need for improved sanitation and hygiene practices in educational settings.

Impact of hygiene practices: By documenting the lack of regular cleaning and disinfection of door handles, as well as the variability in hand hygiene practices, the study underscores the direct impact of hygiene practices on the prevalence of parasitic infections. This evidence supports the development of targeted interventions to enhance cleanliness and reduce contamination risk.

Public health implications: The study emphasizes the public health implications of parasitic contamination in academic environments. It provides a basis for developing and implementing effective hygiene policies and practices to prevent the spread of infections, thereby contributing to the overall health and safety of the university community.

Methodological approaches: The research employs a combination of sedimentation and wet mount methods for parasite detection, which can serve as a reference for similar studies. The methodological approach enhances the reliability of the findings and provides a model for future research on parasitic contamination in different settings.
Overall, this study enriches the existing body of knowledge on parasitic contamination in public spaces, offering practical recommendations for improving hygiene and safeguarding public health within educational institutions.

Implications for public health

The findings of this study have significant public health implications, particularly within academic institutions such as the Ignatius Ajuru University of Education. The presence of helminth and protozoa parasites on office door handles highlights the potential for widespread transmission of parasitic infections through everyday contact with contaminated surfaces. The implications for public health are as follows:

Risk of disease transmission: The contamination of high-contact surfaces, such as office door handles, presents a serious risk for the transmission of parasitic infections, particularly helminthic and protozoal diseases. These parasites can cause a range of health issues, from mild gastrointestinal discomfort to severe systemic infections. If left unchecked, the spread of these parasites within the university environment could lead to outbreaks of parasitic diseases, affecting both staff and students.

Impact on vulnerable populations: Certain populations, such as those with weakened immune systems, children, and the elderly, may be more susceptible to parasitic infections. In an academic setting where diverse populations interact, the presence of parasitic contamination on common surfaces poses a higher risk for these vulnerable groups, potentially leading to more severe health outcomes.

Increased healthcare costs: The spread of parasitic infections can lead to increased healthcare costs, both for individuals and for the institution. Affected individuals may require medical treatment, leading to absenteeism and a potential decrease in productivity. For the university, the costs associated with treating infections, managing outbreaks, and implementing hygiene interventions could strain resources.

Public health education and awareness: The study underscores the need for enhanced public health education focused on hygiene and sanitation practices within the university community. By raising awareness about the risks of parasitic transmission and the importance of proper hygiene, the university can foster a culture of health consciousness that reduces the likelihood of infection.

Importance of environmental hygiene: The findings emphasize the critical role that environmental hygiene plays in preventing the spread of infections. Regular cleaning and disinfection of high-contact surfaces are essential in reducing the risk of contamination. This study highlights the need for public health policies that prioritize environmental hygiene as a key component of disease prevention in public spaces.

Policy development and implementation: The study's outcome provide evidence that can inform the development of health policies and protocols aimed at reducing parasitic transmission in educational settings. These policies could include regular cleaning schedules, installation of hand sanitizers, and educational campaigns to promote hand hygiene and environmental cleanliness. Implementing such measures would not only protect the health of the university community but also set a standard for other institutions to follow.

Community-wide impact: Since educational institutions are integral parts of the wider community, the public health implications extend beyond the campus. Contamination within the university could lead to the spread of parasitic infections to the surrounding community, especially if affected individuals carry parasites into their homes and public spaces. Therefore, addressing this issue on campus can have a broader positive impact on public health in the surrounding area.

Conclusively, this study highlights the importance of proactive public health measures to prevent the transmission of parasitic infections within educational institutions. By addressing the hygiene-related risk factors identified in this study, the Ignatius Ajuru University of Education can safeguard the health of its community and contribute to the overall well-being of the larger public.

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APPENDIX I

QUESTIONNAIRE

Dear participant,

This research work is carried out by a university postgraduate student (masters in view) of the Ignatius Ajuru University of Education (IAUE) Rumuolumeni Port Harcourt.

The aim is to ascertain helminth and protozoa parasites associated with office door handles in the main campus of Ignatius Ajuru University of Education Port Harcourt and the implications for public health. For this cause we would humbly require a swab from your office door handles for parasitological analysis only.

In addition, we would like you to answer a few questions that would help us draw very useful conclusion as well as make suitable recommendations. Finally, be assured that this would be used research purposes only as your very personal details are not required.

1) What is the distance from your office to your toilet?
0-10m
11-20m
21-30m
31and above
2) How often do you clean your office door handle?
Everyday/once a day
Every week/once a day
Once a month,
Never
3) Do you disinfect your door handles?
Yes
No
Sometimes
Never
4) Do you wash your hands after visiting the toilet?
Yes
No
Sometimes
5) Do your visitors wash their hands after they make use of your toilets?
Yes
No
Sometimes
Don't know

Thank you

____
Researcher

APPENDIX II

Table 1. Tabular presentation of overall prevalence of helminth and protozoa parasites

Total no. examined	No. positive for helminths (%)	No. positive for protozoa (%)	Total no. positive	Total no. negative
136	42 (30.9)	10 (7.3)	52 (38.2)	84 (61.8)

Prevalence of helminth and protozoa parasites in relation to genus (n=136)

Parasite (group)	No. examined	No. contaminated
Ascaris sp. (helminth)	136	18
Trichuris sp. (helminth)	136	12
Enterobius sp. (helminth)	136	9
Strongyloides spp. (helminth)	136	3
Giardia sp. (protozoa)	136	6
Entamoeba sp. (protozoa)	136	4
Total	136	52

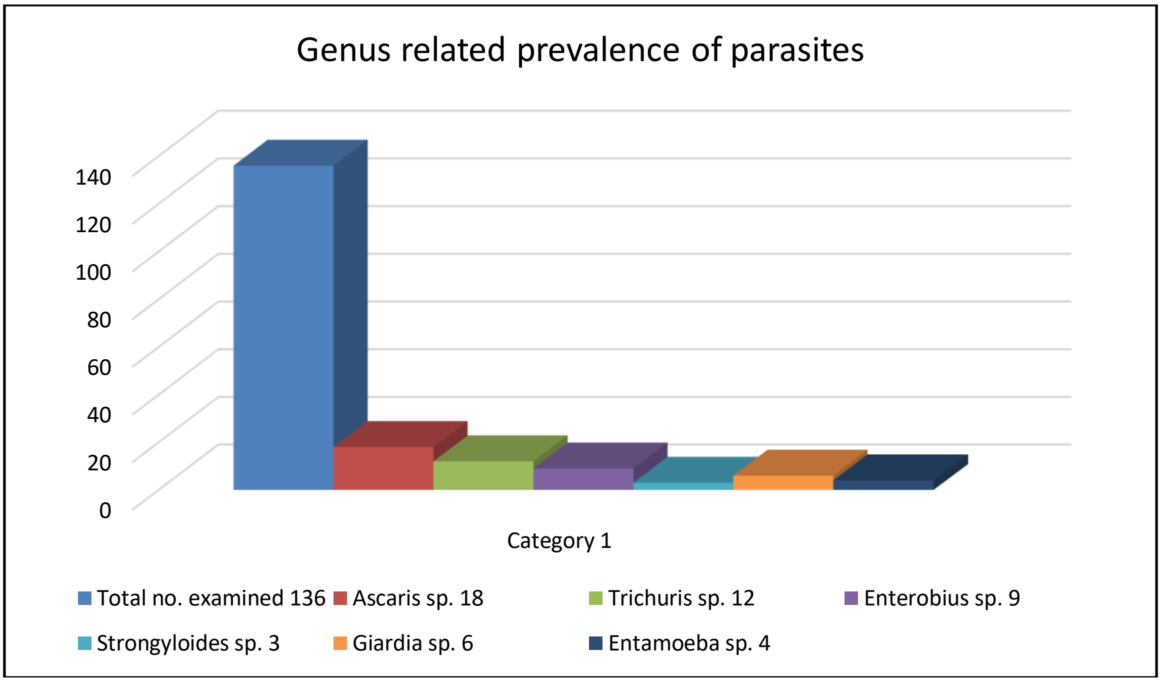

Fig. 1: Graphical presentation of prevalence of genus of helminth and protozoa parasites in the study

Table 2. Prevalence of helminth and protozoa parasites in relation to school building (n=136)

School building	No. of door handles examined	No. contaminated
SVB	22	8
NLHB	24	9
FHB	20	6
FEB	26	12
FMSB	28	13
PGSB	16	4
Total	136	52

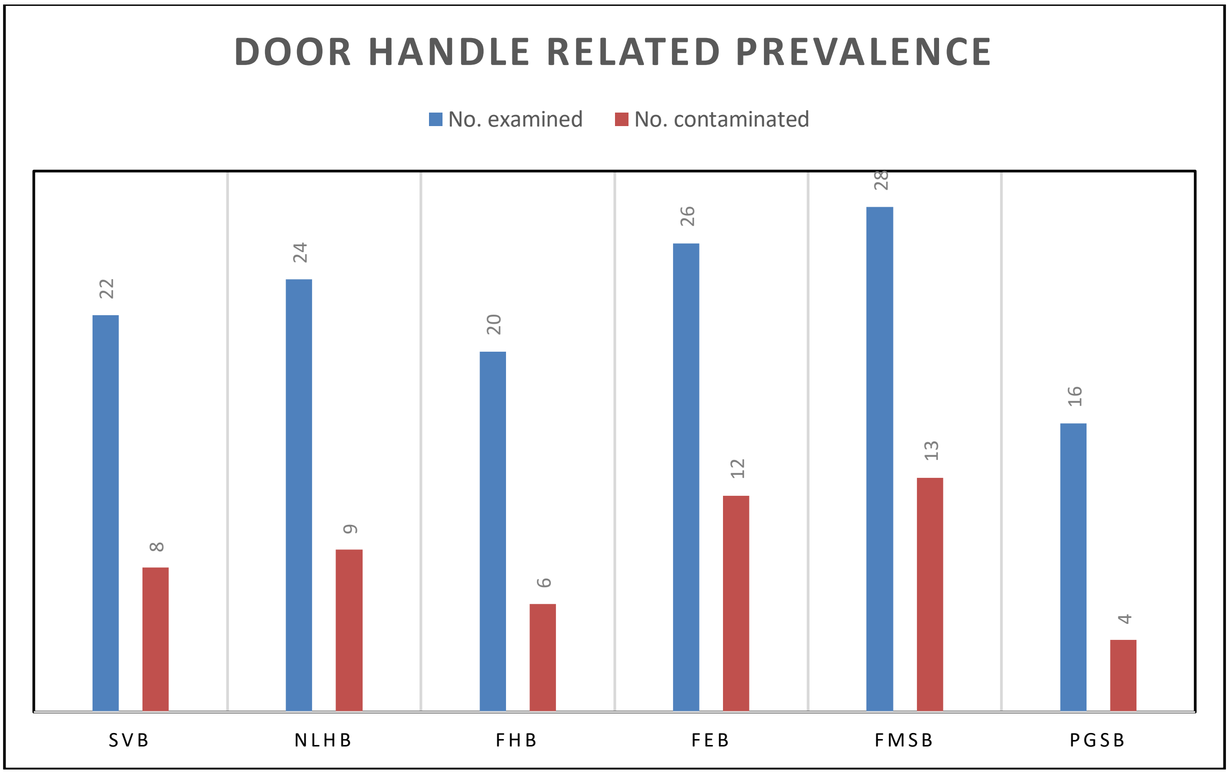

Fig. 2: Graphical presentation of prevalence of helminth and protozoa parasites in relation to number of door handles contaminated