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An Analysis of the Role of Fomite (Toilet Door Handle) in the Transmission of Parasitic Diseases: Case Study of Prof. Basil's Boys Hostel in Unizik, Awka, Nigeria

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Authors' contributions

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

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ABSTRACT

The study investigated the level of "Parasitic Contamination of Toilet Door Handles in Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State". This was carried out using a parasitological survey, parasitological examination standard methods of sedimentation and floatation to detect the presence of helminthic eggs, cyst and oocysts. Hundred structured questionnaires were pretested, distributed and analyzed. Out of the 50 samples collected with

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sterile swap sticks from door handles that were examined in Parasitology and Entomology laboratory of Nnamdi Azikiwe University, Awka, a total of 18 (36%) were contaminated. Boys' hostel block D (BHBD) had the higher rate of contamination with 10 (20%) prevalence comprising of *Ascaris lumbricoides* (12%), *Entamoeba histolytica* (8%). Boys hostel block E (BHBE) had the least rate of contamination with 8 (16%) prevalence comprising of *Ascaris lumbricoides* (6%), *Entamoeba histolytica* (10%). There was a significant difference in the role of fomites in transmission of parasitic infection in Basil Boys' Hostel (alpha = 0.05, P value = 0.02479). There was no significant difference in the risk factors of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.079301). There was also a significant difference in the prevention of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.000085). Regular cleaning of hand surfaces such as toilet door handles to reduce the load of parasitic contamination, improved sanitation to reduce environmental contamination with eggs as well as health education and good hand hygiene on safety practice in the student hostels are highly imperative.

Keywords: Analysis; role; fomites; transmission; parasitic diseases.

1. INTRODUCTION

Fomites refer to inanimate objects that can carry and spread disease and infectious agents [1]. Fomites consist of both porous and nonporous surfaces or objects that can become contaminated with pathogenic microorganisms and serve as vehicles in transmission [2]. Meanwhile, when fomites are in constant contact with humans or natural habitats of pathogenic organism, constitute a major source of spread of infectious intestinal parasites that causes diseases (Osterholm *et al*., 2014). Once a fomite is contaminated, the transfer of infectious agents may readily occur between inanimate and animate objects, or vice versa and between two separate fomites if brought together [2]. The fomites include door handles of toilets, showers, hand lockers, especially those found in public offices, hostels and hospitals [3]. Besides the day to day interaction of people, which constitute one way of spreading diseases, the major source of spread of community acquired infections are fomites [4].

Microorganisms constitute a major part of every ecosystem. In these environments, they live either freely or as parasites. Some diseases are easily spread through fomites more than others. However, several factors can influence whether a pathogen on a fomite can successfully transmit to a human. These factors include: The type of pathogen on the fomite, how much pathogen can lead to infection, the temperature of the room, the porosity of the fomite [1]. The land serves as a medium for the propagation of microorganisms from place to place and from person to person. Although it is almost impossible for the land to be free from microorganisms, it harbors microorganisms both as part of body normal flora, as well as transient microbes contacted from the environment [5]. Microbes live as transient contaminants in fomites or hands where they constitute a major health hazards as sources of community acquired infections.

The role of fomites in disease transmission is significant, being that one can easily get contaminated from various sources in the environment and also is readily available for direct contact with objects. While many parasites take the cyclical or biological pattern involving active transmission by vectors, others that take the fecal-oral route also have fomites as a vehicle for transmission. Some of the debilitating neglected tropical diseases caused by geo-helminths e.g. Ascariasis, Whipworm and Hookworm, are in this group [6]. In the university environment, students have access to lecture classroom, hostel rooms, and offices regularly for different purposes. Also, given that the door handles are not routinely disinfected, the opportunity for transmission of contaminating microorganisms is great. The increasing incidence of epidemic outbreaks of certain intestinal parasitic diseases and its rate of spread from one community to the other has become a major public health concern [7].

Overall, there is a lack of understanding concerning the role of fomites in disease transmission. It was only in the 1980s that the role of a person's environment and the objects or fomites within it was properly studied concerning the spread of diseases, in particular respiratory and enteric disease [1]. It is established that unwashed hands can transmit pathogens, especially fecal pathogens, to food product after

visiting the toilet. Investigation of food borne illness showed that poor personal hygiene, primarily ineffective hand washing is an important contributor to food borne illness [8]. The present study showed the striking presence of pathogenic parasites on the toilet door handles of Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

1.1 Statement of Research Problem

Toilets can be found in most homes, offices and other public places like markets, garages and workshops. This is where individuals like traders, students, farmers, artisans and so on go to ease themselves. Here, there is a high level of poor hand hygiene and environmental sanitation which leads to a high rate of contamination of parasitic diseases. Therefore, as a result of the inadequate water supply, the local toilet environment has been subjected to various degrees of parasitic contamination. Most of the water and sanitation programs executed in the district exerted little positive impact and thus, diarrheal diseases are still very high in the towns and villages. Therefore, to be able to tackle any problem, it is important to appreciate the issues that contribute to it. Many health impact research has evidently recognized that the upgrading of water supply and sanitation alone is generally required but not adequate to attain broad health effects if personal and domestic hygiene are not given equivalent prominence.

In addition, most of the public and private toilets are not often disinfected. This leads to spread of parasitic diseases. Routine disinfection of toilet surfaces, toilet door handles, etc, is crucial to control the spread of disease-causing organisms [9]. Most public food sellers, when they make use of the toilet, do not wash their hands properly. They go back their business and handle money for the exchange of food. This act might result in food contamination. An essential measure for preventing food-borne outbreak is hygiene training for food handlers. Food-handling tools can help prevent cross-contamination occurring between money and food through contact with the hands if workers cannot or will not wash hands between tasks [10].

1.2 Justification

Toilet door handle is one of the most common fomite that serves as a path for contamination. It has been shown that the hard, non-porous surfaces such as toilet door handles, have the highest bacterial transfer rates to hands. This is because, no much attention is given to door knobs, utensils, towels and other items that are not regularly cleaned. Also, our environment as it is, supports opening doors before one can gain entrance into almost everywhere. For example, one needs to open a door in order to walk into an office, room or toilet. When you come in contact with a door handle that has been touched by someone with a flu or any sort of contamination, you can pick up the germs that is left on the door knob. Some of the contamination can be transferred from one person to another or may result in auto inoculation [11,12]. Due to the mere insignificance of opening a door, it is not considered necessary by many to wash hands used in opening doors. If you then touch your eyes, mouth, nose or an open wound with such hands, you may become infected.

1.3 Aim of Study

This study was designed to determine the role of fomites in the transmission of parasitic disease, using toilet door handles in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University, Awka, Anambra State as case study.

1.4 Objectives

1. To determine the proportion of parasitic infected toilet door handles in Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.
2. To determine the role of fomite in the transmission of parasitic infections using toilet door handles in Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State.
3. To determine the risk factors of parasitic contamination of toilet door handles in Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State.
4. To ascertain ways of preventing fomite contamination of toilet door handles in Prof. Basil's Boys Hostel, Nnamdi Azikiwe University, Awka, Anambra State.

2. MATERIALS AND METHODS

2.1 Study Area

The study was carried out in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University, Awka which is a Federal University in Nigeria. Awka, the State capital, is situated between longitude 7°07' East and latitude 6°21' North of the Equator [13]. Awka is in the rainforest zone of Nigeria and experience two distinct seasons every year

brought about by two predominant winds that rule the zone: South monsoon wind from the Atlantic Ocean and the North eastern dry winds from across the Sahara Desert. The monsoon wind from the Atlantic Ocean creates eight months of heavy tropical rains, which occur between April and October, followed by four months of dryness (November – March). The relative humidity of Nnamdi Azikiwe University, Awka is about 70% in dry season between September to February, reaching 80% during the wet season from March to August. The annual rainfall is between 2000-3000. Awka community is about 150m above sea level. Awka has a population of 189,654 inhabitants [14]. The inhabitants of the area are predominantly civil servants, traders, farmers, retired civil servants (senior citizens), businessmen, and public servants.

2.2 Advocacy Visits

An advocacy visit was paid to the respective managements of the above-mentioned University hostel blocks. After that, the occupants of the hostels were met which are students and were informed of the practical exercise.

2.3 Study Design

A parasitological survey was carried out on door handles of Prof. Basil's Boys Hostel (Boy's Hostel Block D [BHBD] and Boy's Hostel Block E [BHBE]**)** in Nnamdi Azikiwe University, Awka. It was done using parasitological examination. The portion of the selected buildings sampled was the toilet door handles. The study was carried out over a period of three months from March to May, 2023. The samples were collected at noon when people made use of these door handles so as to maximize the chances of isolation. The collection was done between 12:00noon – 2:00pm. Each sample was transported to Parasitology and Entomology laboratory of Nnamdi Azikiwe University Awka, for parasite larva, eggs and cysts isolation.

Study Population: The inhabitants of the area are predominantly civil servants, students, lecturers, porters and security personnel. A total of two buildings were randomly selected for the study namely: Prof. Basil Boys Hostel Block D [BHBD] and Boy's Hostel Block E [BHBE].

2.4 Specimen Collection

A total of 50 toilet door handles from the randomly selected two buildings were swabbed using sterile swab sticks moistened with 5ml of sterile normal saline by using a tri-directional approach: up and down, left and right and diagonally, which was properly recapped and labelled. The samples were taken to the Parasitology and Entomology laboratory of Nnamdi Azikiwe University, Awka were they were all examined for the presence of parasites.

2.5 Parasitological Assays of Specimen

Parasitological assay of collected samples was conducted at the Parasitology and Entomology laboratory of Nnamdi Azikiwe University, Awka. Both sedimentation (using centrifuge tubes and centrifuge machine at 2000 revolutions per minute in normal saline) and simple flotation (using Zinc sulphate solution of 1.18 – 30 specific gravity) techniques were performed on each sample to isolate and identify parasites. Preserved samples were subjected to centrifugation in normal saline in sterile centrifuge tubes at 2000 rpm for 3 minutes twice. The resultant supernatants were discarded and sediments at the bases of the tubes were mixed in the small volumes of normal saline that drained back from the sides of the tubes. The sediments were stirred with parasitological sterile applicator sticks and a drop each was deposited on a clean grease-free microscope slide, covered with cover slip, stained with a drop of Lugol's iodine solution from the side of the cover slip, and examined microscopically under ×40 objective lens magnification of a research microscope for parasites in order to further enhance detection of parasite stages.

2.6 Sedimentation Method

2ml of filtrate was centrifuged at 2000rpm for 3 minutes and the supernatant was decanted. A drop of each sediment was applied to a freshly cleaned grease-free glass slide and stained with Lugol's iodine (a drop) and a cover slip was gently placed to avoid air bubbles and flooding. The preparation was then examined under a light microscope using ×40 objective lens.

2.7 Flotation Technique

Flotation technique involving the most frequently used zinc sulphate solution which have higher specific gravity than the organisms to be floated was employed so that the organisms rise to the top and the debris sink to the bottom. The main advantage of this technique is to produce a

cleaner material than the sedimentation technique.

2.8 Instrument of Data Collection

Hundred (100) copies of well-structured questionnaire were distributed to and collected back from the hostel inmates/occupants. Prior to this, 20 questionnaires were pretested in a different location.

2.9 Data Analysis

The data collected were subjected to statistical analysis using Analysis of Variance (ANOVA). The Chi-square analysis was used to test for significant differences, as well as relationship respectively in the distribution of microorganisms among toilet door handles.

3. RESULTS

A total number of fifty (50) toilet door handles of two hostel building blocks (Boy's Hostel Block D [BHBD] and Boy's Hostel Block E [BHBE]**)** were examined for parasites. Toilet door handles were found to be contaminated with the parasites: *Ascaris lumbricoides*, and *Entamoeba histolytica,* respectively. Eighteen (18) toilet door handles were contaminated with an overall prevalence of (36.00%).

Table 1 below shows the parasites species identified on the examined toilet door handles in Nnamdi Azikiwe University, Awka. Out of 50 door handles sampled, Boys hostel block D had the highest prevalence of 10(20.00%) from 25 door handles. While, Boys hostel block E had the least prevalence of 8 (16.00%) from 25 door handles.

Using Analysis of variance (ANOVA):
a. Total sum of square (TSS) = EY2 – (EY)2 / N
EY2 =62+42+32+52 =36+16+9+25= 76
(EY)2 = (18)2=324
TSS=76-324/4= -5.
b. Treatment sum of square (TRSS) = (EY1)2/2 + (EY2)2/2 - (18)2/4
TRSS= (10)2/2 + (8)2/2 – (18)2/4
TRSS = (50+32)-81 =1.
c. ESS = TSS-TRSS= -5-1=-6.
Generally Mean square (MS) is given as; S.S/D.f
d. Treatment mean square (TRMS) = TRSS/D.f =1/1=1.
e. Error mean square (EMS) = ESS/D.f = -6/2=-3.
f. F ratio = TRMS/EMS= 1/-3 = -0.33.
F tab; we use degree of freedom for treatment corresponding degree of freedom for errors. Use 0.05 (5%) F-table. i.e 1 corresponding to 2 under 0.05 F-table.
Fcal = -0.33. Ftab = 18.51.

Conclusion: Since Fcal. is less than Ftab; we accept null hypothesis and conclude that there is no significant difference in the number of parasites eggs found on contaminated toilet door handles in Boys' hostels of Nnamdi Azikiwe University, Awka.

Table 2 shows the Respondent's response regarding the role of fomites in transmission of parasitic infections in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University Awka. Out of 100 respondents, 20 responded to parasitic contamination, 40 responded to disease transmission while 40 responded breeding sites for parasites.

Table 1. Proportion of infected toilet door handles in Basil boys' hostels of Nnamdi Azikiwe University Awka, Anambra State

Buildings examined	Number of fomites examined	Number of fomites contaminated	Prevalence (%)
BHBD	25	10	20
BHBE	25	8	16
Total	50	18	36

List 1. Analysis of data

Buildings examined	No. of toilet door handles examined	*Ascaris lumbricoides*	*Entamoeba histolytica*	Total
BHBD	25	6(12)	4(8)	10(20)
BHBE	25	3(8)	5(10)	8(16)
Total	50	9(18)	9(18)	18(36)

Table 2. Respondents' response on the roles of formites in transmission of parasitic infection in Basil boys' hostels of Nnamdi Azikiwe University, Awka

Items	Responses
Parasitic contamination	20
Disease transmission	40
Breeding sites for parasites	40
Total	**100**

List 2. Analysis of data

Items	Response %	No Response %	Total %
Parasitic contamination	20(33.33)	80(66.67)	100
Disease transmission	40(33.33)	60(66.67)	100
Breeding sites for parasites	40(33.33)	60(66.67)	100
Total	**100**		

Table 3. Respondents' responses on the risk factors of parasite contamination of toilet door handles in Basil boys' hostels of Nnamdi Azikiwe University, Awka

Items	Responses
Unwashed/Unclean hand contact	20
Dust particles	10
Lack of sanitation	15
Improper hygiene	20
Lack of access to clean water	10
Improper food hygiene practices	25
Total	**100**

List 3. Analysis of data

Items	Response %	No Response %	Total %
Unwashed/Unclean hand contact	20(16.67)	80(83.33)	100
Dust particles	10(16.67)	90(83.33)	100
Lack of sanitation	15(16.67)	85(83.33)	100
Improper hygiene	20(16.67)	80(83.33)	100
Lack of access to clean water	10(16.67)	90(83.33)	100
Improper food hygiene practices	25(16.67)	75(83.33)	100
Total	**100**		

Table 4. Respondents' response on "Prevention of parasitic contamination of toilet door handles in Basil boys' hostels of Nnamdi Azikiwe University, Awka"

Items	Responses
Proper environmental sanitation	16
Regular hand washing	10
Availability of good water source	24
Public enlightenment/Health Education	15
Personal hygiene	35
Total	**100**

List 4. Analysis of data

Items	Response	No Response	Total
Proper environmental sanitation	16(20.00)	84(80.00)	100
Regular hand washing	10(20.00)	90(80.00)	100
Availability of good water source	24(20.00)	76(80.00)	100
Public enlightenment/Health education	15(20.00)	85(80.00)	100
Personal hygiene	35(20.00)	65(80.00)	100
Total	**100**		

Degree of freedom, d =(r-1) (c-1)
d = (3-1) (2-1)
(2, 1) = 2.
X^2T = (0.05, 2) = 5.991.

Conclusion: We reject null hypothesis (Ho) and say there is a significant difference in the role of fomites in transmission of parasitic infection in Basil Boys' Hostel in Nnamdi Azikiwe University, Awka (alpha = 0.05, P value = 0.02479).

Table 3 shows the Respondents' responses on the risk factors of parasite contamination of toilet door handles in Basil's boy's hostels UNIZIK, Awka. Out of 100 respondents, 20 responded to unwashed/unclean hand contact, 10 responded to dust particles, 15 responded to lack of sanitation, 20 responded to improper hygiene, 10 responded to lack of access to clean water while 25 responded to improper food hygiene practices.

Degree of freedom, d =(r-1) (c-1)
d = (6-1) (2-1)
(5, 1) = 5.
X^2T = (0.05, 5) = 11.070.

Conclusion: We accept null hypothesis (Ho) and say there is no significant difference in the risk factors of parasitic contamination of toilet door handles in Basil Boys' Hostel in Nnamdi Azikiwe University, Awka (alpha = 0.05, P value = 0.079301).

Table 4 shows Respondents' response on "Prevention of parasitic contamination of toilet door handles in Basil boys' hostels of Nnamdi Azikiwe University, Awka" Out of 100 respondents, 16 responded to proper environmental sanitation, 10 responded to regular hand washing, 24 responded to availability of good water source, 15 responded to public enlightenment/Health Education while 35 responded to personal hygiene.

Degree of freedom, d =(r-1) (c-1)
d = (5-1) (2-1)
(4, 1) = 4.
X^2T = (0.05, 4) = 9.488.

Conclusion: We reject null hypothesis (Ho) and say there is a significant difference in the prevention of parasitic contamination of toilet door handles in Basil Boys' Hostel in Nnamdi Azikiwe University, Awka (alpha = 0.05, P value = 0.000085).

4. DISCUSSION

Parasitic infections have received little attention in developing countries. As a rule, ova, cysts and oocyst of parasites are normally found on fomites like toilet door handles [15]. This study was designed to determine the level of parasitic contamination of toilet door handles in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University, Awka, Anambra State. Out of the 50 samples of the door handles examined, a total of 36% were contaminated. In the sampled areas, Boys' hostel block D (BHBD) had the higher rate of contamination 10(40%). The parasites detected were *Ascaris lumbricoides* 6(24%) and *Entamoeba histolytica* 4(16%). Boys hostel block E (BHBE) had the least rate of contamination 8(32%) (highest prevalence). The parasites detected were *Ascaris lumbricoides* 3(12%), *Entamoeba histolytica* 5(20%) (lowest prevalence). This study has revealed the occurrence of the cyst, oocysts and ova of several parasitic protozoans, helminthes, as well as different species of parasites on toilet door handles in selected hostels of Nnamdi Azikiwe University Awka, Anambra State, Nigeria. Chukwudike et al. [16] noted 10 (4%) geo-helminth eggs from palms of pupils in Bwari Area Council, Abuja FCT while Nwankwo et al. [17] note a prevalence rate of 44.2% STH infections due to *Ascaris lumbricoides (*17.2%), *Strongyloides stercoralis* (2.0%), Hookworms (15.0%) and *Trichuris trichura* (9.1%) respectively in Omogho and Awa communities, Orumba North L.G.A, Anambra State.

In assessing the Respondent's response regarding the role of fomites in transmission of parasitic infections in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University Awka (Table 2). Out of 100 respondents, 20 responded to parasitic contamination, 40 responded to disease transmission while 40 responded to breeding sites for parasites. There was a significant difference in the role of fomites in transmission of parasitic infection in Basil Boys' Hostel (alpha = 0.05, P value = 0.02479). This is in agreement with Neely and Sitting [18], who noted that micro-organism that causes infections can be found in toilets door handles as well as surfaces or objects. Fomites consist of either porous or nonporous surfaces or inanimate objects that when contaminated with pathogenic microorganism, can be transferred to a new host thereby serving as vehicles in transmission [15].

Analysis of Respondent's response on the risk factors of parasite contamination of toilet door handles in Basil's boy's hostels of Nnamdi Azikiwe University, Awka (Table 3) revealed that out of 100 respondents, 20 responded to unwashed/unclean hand contact, 10 responded to dust particles, 15 responded to lack of sanitation, 20 responded to improper hygiene, 10 responded to lack of access to clean water while 25 responded to improper food hygiene practices. However, there was no significant difference in the risk factors of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.079301). Addressing social determinants of STH, such as poverty, lack of access to clean water, and inadequate sanitation, is crucial for sustainable control and elimination efforts [19]. Furthermore, the system of potable water is of great concern with regards to helminth infection [20].

Regarding the Respondent's response on "Prevention of parasitic contamination of toilet door handles in Basil boys' hostels of Nnamdi Azikiwe University, Awka" (Table 4). Out of 100 respondents, 16 responded to proper environmental sanitation, 10 responded to regular hand washing, 24 responded to availability of good water source, 15 responded to public enlightenment/Health Education while 35 responded to personal hygiene. There was also a significant difference in the prevention of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.000085). This is in agreement with Umeaneto *et al.,* 2021 who noted that 60% of adults do not wash their hands when required and the first line of defense in preventing the spread of disease is by hand washing that is ignored and must be emphasized strongly by families and schools. Usage of toilet by large number of people and the habits of improper hand hygiene after using toilet or contaminated hard surface could be a major reason for this result. Previous studies like in Baze University Campus, Abuja, Nigeria and Nnamdi Azikiwe University Awka, Anambra State, Nigeria, have shown that frequently used fomites were mostly contaminated and carried higher loads of parasites [8]. The cyst of *Entamoeba histolytica* and ova of *Ascaris lumbricoides* are infective and these two parasites are most likely to be contracted in university environments [21-24].

5. CONCLUSION

This study reveals that toilet door handles in Prof. Basil's Boys Hostel in Nnamdi Azikiwe University Awka, Anambra State are contaminated with parasites with the rate of 36%. In the sampled areas, Boys' hostel block D (BHBD) had the higher rate of contamination 10(40%). The parasites detected were *Ascaris lumbricoides* 6(24%), *Entamoeba histolytica* 4(16%). Boys hostel block E (BHBE had the least rate of contamination 8(32%). There was a significant difference in the role of fomites in transmission of parasitic infection in Basil Boys' Hostel (alpha = 0.05, P value = 0.02479), there was no significant difference in the risk factors of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.079301). There was also a significant difference in the prevention of parasitic contamination of toilet door handles in Basil Boys' Hostel (alpha = 0.05, P value = 0.000085)

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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