International Journal of Scientific Research Updates

Journal homepage: https://orionjournals.com/ijsru/

ISSN: 2783-0160 (Online)

(RESEARCH ARTICLE)

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# Hygiene practices and exposure to potential hazards among manual faecal sludge evacuators in Ibadan metropolis, Nigeria

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International Journal of Scientific Research Updates, 2023, 05(02), 042–053

Publication history: Received on 26 December 2022; revised on 07 February 2023; accepted on 09 February 2023

Article DOI: https://doi.org/10.53430/ijsru.2023.5.2.0010

## Abstract

The study assessed faecal sludge management methods, hygiene practices and potential health hazards among manual faecal sludge evacuators within Ibadan metropolis. A cross-sectional study was conducted among sixty (60) consented manual faecal sludge evacuators using a validated questionnaire and in-depth interview guide. Hands swab samples were also collected for microbial load count. Quantitative data were analysed using descriptive statistics and t-test at p=0.05. Respondents' mean age was 48.2±13.3 years, 75.0% had at least primary education, 18.3% had spent more than 19 years on the job. Average monthly income was 22,546.80±3,341.90 NGN (1US$=NGN 416). Only 18.3% reported that they use PPE during emptying while 53.3% reported that they usually do hand washing with water and soap. In-depth interview of participants emphasised that the protective foot wear becomes completely soaked and making movement difficult and slow during the emptying operations. Major hazards reported by the manual evacuators were odour (41.7%), gas fumes/aerosols (18.3%) and dust (6.6%). *Salmonella, Shigella and E. coli* were isolated from the hand wash water samples from the manual evacuators. *Eschericia coli* count (cfu/mL) was significantly higher among evacuators without PPE during evacuation $(4.1\pm2.6)\times10^3$) compared to their counterpart with PPE during evacuation $(1.4\pm0.8)\times10^3$). Feacal sludge management by the manual evacuators was unwholesome while utilization of PPE was low among manual faecal sludge evacuators. *Salmonella/shigella* and *E. coli* was higher among evacuators that did not use PPE. Regular use of personal protective equipment and compliance with hygiene standards relating to the work should be enforced among manual fecal sludge evacuators.

**Keywords:** Faecal sludge; Hygiene practice; Hand washing; Fecal sludge emptier

## 1 Introduction

Safe disposal of excreta is of fundamental importance, not only for the health of the community but also because of the social and environmental benefits it brings. However, for many low-income communities particularly in developing countries, installation of a sewerage system with its high cost and need for a piped water supply is not a feasible option. For such communities, on-site disposal (dealing with excreta where they are deposited) offers a hygienic and affordable solution [1]. Globally, about 500 million kg of human faeces is generated in urban areas and about 600 million kg in rural areas, producing a total of over one million tons per day. Most of this biodegradable organic material is disposed of with very little or no treatment particularly in the low income countries [2, 3]. This highly dangerous substance is polluting water and soil and also has become a source of a variety of preventable infections [4, 5].

However, adequate sanitation is fundamental and a prerequisite for safe life and productivity. In contrast, malfunctioning sanitation systems has been reported to cause outbreaks of diseases all over the world. In areas with little or no sanitation facilities, diarrheal mortality is high and has been shown to decrease by 36% after interventions

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of improved sanitation [6]. Often, infections are faeces associated and when present in wastewater and sewage sludge it poses a high risk of infections upon exposure. Furthermore, interventions focusing on sanitation practices have been shown to reduce the percentage in diarrheal morbidity with 36% [7]. As a result of low social economic status of poor citizens in developing countries like Nigeria, they cannot afford the cost of water flush toilets and therefore they mostly practice dry defecation which reduces the demand on water available for use by the public in mostly rural and slum areas.

Nevertheless, these facilities have to be periodically emptied whenever they are filled up. Because of the unavailability cum high cost of sludge evacuation using mechanized fecal emptiers, people prefer to use manual emptier as an alternative. A study carried out by Oloruntoba et al. [8] indicated that mechanical faecal sludge emptiers in Nigerian urban areas are scanty and there are opportunities for more to get into this business. The Manual faecal sludge emptying involves collecting, handling, transporting and disposing of human excreta from dry latrines, open sewer drains, septic sludge pits, open public places using brooms, tin plates, baskets or buckets without any personal protection [9]. The entire process of emptying the filled pit latrine is an unwholesome process that produces foul odour that pollutes the surrounding air environment. Because of the shame associated with the work and the deteriorating foul smell, manual faecal sludge emptying is mostly done at night [10, 11]. The foul smell of this faecal sludge contains noxious gases such as hydrogen sulphide, phosphine and methane, which are known to cause hypoxic injury to lungs that can trigger chest tightness, chest pain, breathing difficulties and a variety of central nervous system symptoms that have been attributed to direct effects of hydrogen sulphide on the brain. Episodes of fever, cold and cough that the workers usually report could signify infection from inhalation of infectious aerosols, dust and noxious gases [12, 13, 14].

In industrialized countries, laws have been passed to abolish manual faecal sludge emptying while sophisticated machines have been employed to carry the process [15]. Unfortunately, this is not the case in developing countries like India and Nigeria where manual faecal sludge evacuation is still rampant due to un-affordability of the mechanical evacuators to pump faecal sludge by entrepreneurs. For example, the use of pit latrines, and septic tanks have been reported to be common sanitation practices in Ibadan, a highy populous mega city and these pit latrines and septic tanks are emptied manually [16]. The activities of these manual faecal sludge evacuators are un-coordinated. While manual faecal sludge evacuators are operated without proper registration, procedure of the mechanized evacuators do not totally empty the faecal sludge in pit latrines/septic tank. Therefore the services of the manual faecal sludge evacuators are usually employed by low income citizens to clear up the pit latrine or septic tank totally. Manual evacuators requires awareness campaigns to understand the implication of their current practices and help them adopt safer practices that will pose minimal risk to their own health and their family at large. This study therefore assessed faecal sludge management practices, hygiene practices and potential health hazards among manual faecal sludge evacuators within Ibadan metropolis.

## 2 Methodology

### 2.1 Study Area

The study was carried out within Ibadan Metropolis (Figure 1). Ibadan is the administrative center of Oyo state and lies within latitude 7° 19' 08" and 7° 29' 25" of the equator and 3° 47' 50" and 4° 0' 22". Ibadan is the third largest metropolitan area (by population) in Nigeria after Lagos and Kano, with a population of 2,258,625 according to the 2006 census [17] and a projected population of 3,565,108 by 2016 [18]. It also has a total area of 1.190m$^2$ (3,123 km$^2$) approximately 50 Km from Lagos by the most direct route. Ibadan has a tropical wet and dry climate with a lengthy wet season and relatively constant temperatures throughout the course of the year. The city experiences an annual rainfall of about 2.500 mm and temperature below 53°F. The physical setting of the city consist of ridges of hills that run approximately in the Northwest – Southwest direction. The largest of these ridges lies in the central part of the city with peaks at Mokola, Mapo and Aremo. These hills range in elevation from 160 m to 275 m above sea level. The heterogeneous characteristics of Ibadan population and rate of influx of newcomers into the city are transforming steadily the predominantly indigenous city to a multicultural, multi-ethnic urban settlement. There are eleven Local government areas (LGAs) in Ibadan Metropolitan area consisting of five urban LGAs in the city and six semi-urban LGAs. This study was carried out specifically in the slums areas in Ibadan such as Foko, Abebi, Beere where the use of dry sanitation is prevalent.

### 2.2 The Manual Evacuation Process

Manual systems use only manual power with hand tools and the activity is majorly carried out at night. Their major tools include buckets, shovels and gloves and are used for both pit latrines and soak away/holding pit particularly in the middle to low income setting of an urban communities. The collection process involves first digging of the soil in a

separate place. The newly dug pit serves as the disposal site for the evacuated sludge. Then the evacuators expose the pit cover or soak away manhole. Thereafter, a conveyance (metal or plastic container) tied to a rope is introduced into the pit to scoop out the faecal waste. Faecal sludge collected are then transported to the newly dug pit and the contents are dumped and thereafter coved up when full. Faecal sludge collected is sometimes transported in vehicles to other disposal sites (legal or illegal).

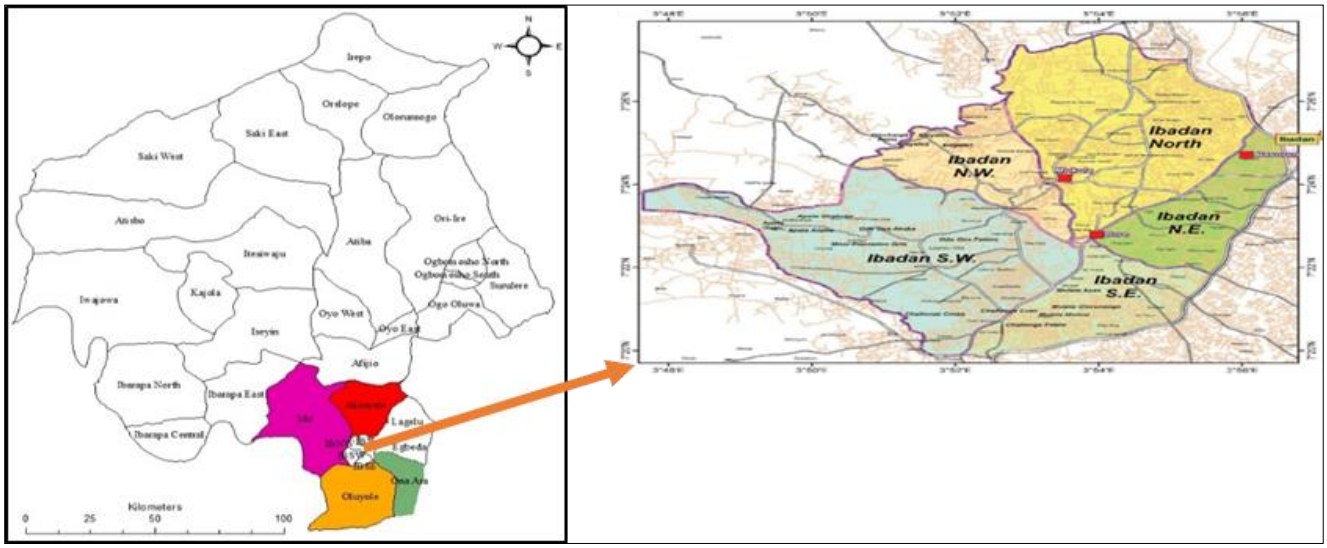


**Figure 1** Map of Ibadan showing study areas

### 2.3 Study design and sampling procedure

The study was cross-sectional in design and it involved survey and collection of manual evacuators' hands swab samples for microbial load count. All the consented (60) manual faecal sludge evacuators within the study setting participated in the study. The consented participants were those that have been doing the job for more than 5 years and aged 18 years and above. Individuals who have had pre-existing medical condition, respiratory disease or skin problems were not considered for the study.

### 2.4 Data collection procedure

A validated, semi-structured, interviewer-administered questionnaire was used to elicit information from the manual faecal sludge evacuators. The questionnaire was grouped into four sections including socio-demographic information; common disposal practices; knowledge of health problems related to unhygienic manual fecal sludge evacuation and health challenges often experienced. In addition, an in-depth interview guide was used to collect information from the most experienced faecal sludge evacuators. The interview captured information on faecal sludge waste management and reported health challenges faced by faecal waste handlers. Two postgraduate students from the field of Public Health, who were conversant with survey were trained prior to administration of data collection instruments. This training was to ensure that they had a good understanding of the research instruments before the commencement of the data collection. The training focused on the objectives and significance of the study, how to secure respondent's informed consent, interviewing skills and how to review questionnaire to ensure completeness. A total of 60 questionnaires were administered and efforts were made to avoid respondents influencing each other in their choices. The research assistants ensured that all the questionnaires were correctly completed by respondents by cross checking immediately before the respondent leaves so that errors detected could be promptly rectified. Data collection lasted for a period of four weeks.

### 2.5 Collection of hand wash water samples for microbial load count

Hand washing was carried out using 350 ml distilled water [19] in a bowl and transferred to labelled sterile plastic bags and it was timed for about 25 seconds. Hand washing was done by washing the fingers against each palm (Figure 2A). The samples were stored in sterile Ziploc bags (Figure 2B) which were further kept within ice packs and carefully transported to the laboratory for analysis on the same day. Hand washing sample collected were appropriately labelled and transported to the Microbiology laboratory for microbiological analysis within two hours of collection.

Key: A- Handwashing process; B- Collected water sample]

**Figure 2** Emptier's hand washing method and collection of water sample

### *2.5.1 Identification and Enumeration of Microorganisms*

Microorganisms were identified using pour plate techniques. This method refers to the measurement of the population of viable organisms in a sample by culturing. The water samples were diluted serially. The serial dilution enabled discrete rather than merged colonies to be formed, thus, facilitating accurate colony count.

### *2.5.2 Culture media and sample preparation*

The culture media which are highlighted in Table 1 were prepared following the manufacturers' instructions. Ten-fold serial dilutions of the hand washings samples were made using sterile water. Aliquots of the appropriate dilution ($10^{-2}$) were plated out on the different culture media using the standard pour plate technique of Harrigan and MacCance [20]. All the glasswares used were sterilized in the hot air oven at 180$^{o}$C for 2-3 hours, while work benches were surface sterilized using 70% ethanol.

### *2.5.3 Procedure*

One (1) ml of each of water sample and the diluents was measured into sterile Petri-dishes using a sterilized pipette. Ten ml of the molten nutrient agar, MacConkey agar, Eosin Methylene Blue (EMB) agar, Salmonella Shigella agar (cooled to 45$^{o}$C) were poured on the samples; one (1) medium for each Petri-dish. The dishes containing the medium and the inoculum were swirled gently. After solidification, the plates were incubated at 37$^{o}$C for 24-48 hours and observed for growth. Morphologically distinct colonies of the bacteria were repeatedly sub-cultured until pure isolates were obtained. The isolated bacteria were identified using their morphological reactions.

**Table 1** Different agar plates used and the appearance of bacterial colonies on them

| Culture media | Description | Expected appearance of target bacteria |
|---|---|---|
| Nutrient agar | It is a general purpose media for the cultivation of non-fastidious bacteria. It was used for the enumeration of the Total aerobic count of the hand-washing water samples in this study. | Not specific |
| Eosin Methylene Blue (EMB) agar | It is a medium which differentiates Escherichia coli from other members of the Coliform group. | Escherichia coli appeared as a colony with green-metallic sheen on this medium. |
| MacConkey agar | It is both a selective and differential medium.<br>It is used for the cultivation of coliforms in samples. | Coliforms are lactose fermenters, so they appeared as pink colonies on this medium. |
| Salmonella – Shigella Agar | This is used for the cultivation of Salmonella and Shigella specie in water samples. | The target bacterium appears as a circular colony with black halo on this medium. |

This was done according to the scheme of Sneath, [21]. The total number of target colonies formed on each plate were counted and the results were expressed in colony forming units per millilitre (Cfu /mL).

$$\text{Cfu/mL} = \frac{\text{No. of colonies} \times \text{volume of sample}}{\text{Dilution factor}}$$

### 2.6 Data management and analysis

Data from the questionnaire and microbial counts were edited daily to ensure completeness. It was serially numbered and the responses coded manually using a coding guide after carefully reviewing the responses. Descriptive statistics such as percentages, frequency counts, mean, and standard deviation were used to summarize the data. Qualitative data from the in-depth interview were analyzed using content analysis and the findings presented using a thematic approach. Microbial counts were compared with PPE utilization and educational attainment among manual evacuators using t-test at a 5% level of significance.

### 2.7 Ethical considerations

Ethical approval was obtained from the University of Ibadan/University College Hospital Joint Ethical Review Board. Participation of the respondents was voluntary and those who decided to withdraw during the study were permitted to do so. Confidentiality of the information was ensured during data collection and names were not requested from the participants.

## 3 Results

### 3.1 Socio-demographic characteristics

Socio demographic characteristics of the respondents is presented in Table 2. Respondents' mean age was 48.2±13.3 years, 48.3% were between the ages of 50 to 59 years. Majority (75.0%) had at least primary education while 66.7% were married. Respondents mean number of year spent on manual evacuation job was 14.3±3.9 years while 18.3% had spent more than 19 years on the job. Approximate average monthly income of the respondents was 22,546.80±3,341.90 naira, 41.7% earned between 10,000-20,000 naira as monthly income. Majority (78.3%) reported that they had not attended any enlightenment programme relating to their work. The three major occupation respondents had previously engaged were trading (31.7%), Plumbing (30.0%) and farming (26.3%) as depicted in Figure 3.

**Table 2** Socio-demographic characteristics

| Characteristics | Frequency (%) |
|---|---|
| **Age category (years)** | |
| 30-39 | 2 (3.3) |
| 40-49 | 13 (21.7) |
| 50-59 | 29 (48.3) |
| 60 and above | 16 (26.7) |
| **Mean age = 48.2±13.3years** | |
| **Level of education** | |
| No formal education | 15 (25.0) |
| At least Primary education | 45 (75.0) |
| **Marital status** | |
| Never married | 3 (5.0) |
| Married | 40 (66.7) |
| Divorced | 11 (18.3) |
| Separated | 6 (10.0) |

| | |
|---|---|
| **Years spent on emptying job** | |
| 10-14 | 27 (45.0) |
| 15-19 | 22 (36.7) |
| Above 19 | 11 (18.3) |
| **Mean number of year = 14.3±3.9 years** | |
| **Approximate monthly income** | |
| < 10,000 | 10 (16.7) |
| 10,000 – 20,000 | 25 (41.7) |
| 20,000- 30,000 | 23 (38.3) |
| >40,000 | 2 (3.3) |
| **Average income = 22,546.80±3,341.90 naira** | |
| **Ever attended enlightenment programme** | |
| Yes | 13 (21.7) |
| No | 47 (78.3) |

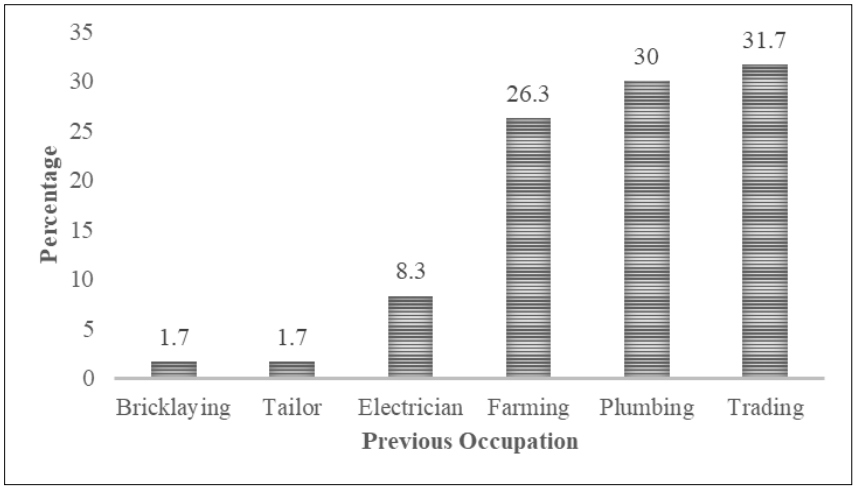


**Figure 3** Previous employment history of faecal sludge **evacuators**

### 3.2 Faecal Sludge management practices

All the participants described the evacuation process as an unwholesome process and the activity is majorly carried out at night. One of the participant's stated that the activities of these faecal sludge evacuators are mostly un-monitored; they intentionally hide from on-site inspection by location inspectors. Most of the participants revealed that faecal sludge generated is mostly managed by the manual faecal sludge evacuator. They also stated that most low income earners who could not afford the services of mechanized pump evacuator usually opt for the services of manual emptier. The collected faecal sludge is transported by buckets to a separately dug pit and thereafter cover up with soil.

"…activities of manual sludge emptiers are mostly un-monitored; they don't do it during the day but intentionally hide from on-site inspection by location inspectors"_(a participant)

**"…**faecal sludge emptied in the stored tank is been transported and buried in a nearby dunged soil and covered up when full"_(a participant).

### 3.3 Hygiene practices and use of personal protective equipment

Few (18.3%) of the manual evacuators reported that they use PPE during emptying work (Figure 4). Only 3.3% stated that they always use the PPE while 15.0% said they sometimes use PPE as presented in Table 3. The major PPE reported by the manual evacuators were hand gloves (23.3%), safety boots (21.7%), nose masks (15.4%) and head cover (11.7%). Also Goggles (5.0%) and Apron (3.3%) were mentioned. A few (11.7%) of the manual evacuators reported that they wash their reusable PPE daily while 5.0% said they wash it once in two weeks. All (100.0%) of the evacuators stated they wash their hands immediately after evacuation work, 53.3% reported that they usually do hand washing with water and soap while 41.7% said they use water alone. About seven per cent (6.7%) stated that they keep long nails, 70.0% said they usually cut their nails as soon as they grow long, 20.0% said they do so immediately they notice that dirt gets stuck inside the finger nails while 10.0% cut their nails anytime they felt like doing. The three major hazards reported by the manual evacuators were odour (41.7%), gas fumes (18.3%) and dust (6.6%) as shown in Figure 5. A majority, 69% of the manual evacuators stated that they feel discomfort wearing PPE at work. However, most of the participants emphasized that they usually experience some inconveniences with the appropriate use of PPE during the emptying process. During an interview session, one of the participants stated that the protective foot wear becomes completely soaked and making movement difficult and slow during the emptying operation. In another interview, participants stressed that the use of hand gloves often prevent proper handling of the bucket and other equipment during operation. Some of their comments are:

*"…protective shoes become really soaked and makes walking inconvenient and slower"_ ( participant 1)*

*"…use of hand gloves prevents proper gripping of the buckets and other emptying appliance during soak away evacuation"…( participant 2)*

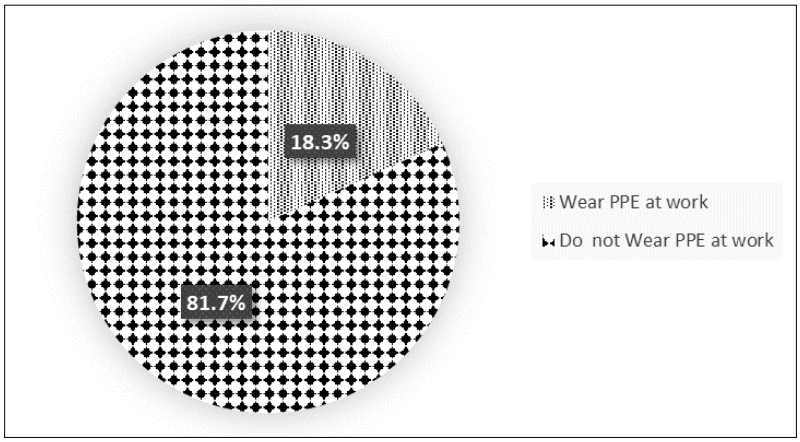


**Figure 4** Personal Protective Equipment usage at work

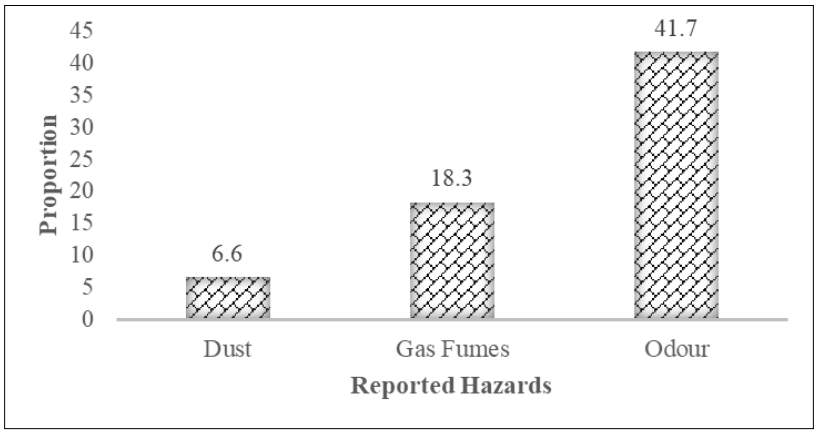


**Figure 5** Reported Hazards manual **evacuators** exposed to during work

**Table 3** Manual faecal sludge evacuators rate of PPE utilization and practice of personal hygiene

| PPE utilization | Frequency (%) |
|---|---|
| **Frequency of wearing PPE at work** | |
| Always | 2 (3.3) |
| Sometimes | 9 (15.0) |
| **Types of PPE evacuators wear at work (*multiple response*)** | |
| Safety boots | 13 (21.7) |
| Hand Gloves | 14 (23.3) |
| Nose masks | 9 (15.4) |
| Goggles | 3 (5.0) |
| Head Cover | 7 (11.7) |
| Apron | 2 (3.3) |
| **Frequency of washing re-usable PPE** | |
| Daily | 7 (11.7) |
| Once in two weeks | 3 (5.0) |
| Monthly | 1 (1.7) |
| Hand washing immediately after work | 60 (100.0) |
| **Materials utilized for handwashing** | |
| Water alone | 25 (41.7) |
| Water and soap | 32 (53.3) |
| Water, soap and sanitizer | 3 (5.0) |
| Keep long nails | 4 (6.7) |
| **Nail cutting practices** | |
| As soon as they are long enough | 42 (70.0) |
| Until dirt gets stuck inside the finger nails<br>Anytime felt like | 12 (20.0)<br>6 (10.0) |

### 3.4 Microbial load and predominant isolates

The mean aerobic count, *E. coli*, Total coliforms and Salmonella/Shigella of the evacuators' hand washings samples were $(6.9\pm3.7)\times10^3$ cfu/mL, $(4.1\pm2.6)\times10^3$ cfu/mL, $(3.1\pm1.8)\times10^3$ cfu/mL and $2.3\pm1.2)\times10^3$ cfu/mL, respectively as given in Figure 6. Microbial load of the evacuators hand washings were compared between evacuators with formal and non-formal educational status, and use of PPE at work as presented in Table 4. Significantly, anaerobic bacterial count (cfu/mL) was higher among evacuators with no formal education $(7.6\pm4.1)\times10^3$ compared to those with at least primary education $(2.8\pm1.7)\times10^3$). Mean *E. coli* count (cfu/mL) was higher among evacuators with no formal education $(3.3\pm1.8)\times10^3$) compared to their counterpart with at least primary education $(1.3\pm0.6)\times10^3$), (p=0.031). Also, *Salmonella/Shigella* counts (cfu/mL) were significantly higher among evacuators with no formal education $(2.9\pm1.3)\times10^3$) compared to those with at least primary education $(1.1\pm0.7)\times10^3$). The Mean *E. coli* counts (cfu/mL) were $(4.1\pm2.6)\times10^3$) and $(1.4\pm0.8)\times10^3$) among evacuators with and without PPE during evacuation respectively, p=0.013. Mean *Salmonella/Shigella* count (cfu/mL) was significantly higher among evacuators with the use PPE $(3.2\pm1.3)\times10^3$) compared to those without the use of PPE $(1.1\pm0.4)\times10^3$). Identified bacteria in the hand washing samples from the manual faecal sludge evacuators were *Staphylococcus*, *E. coli*, *Salmonella* and *Shigella* (Figure 7).

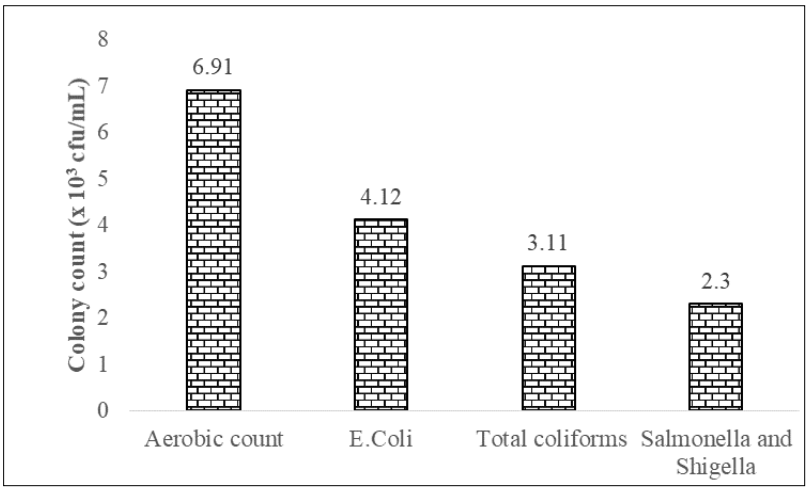


**Figure 6** Microbial load of hand washings from faecal evacuators

**Table 4** Comparison of microbial load between evacuators educational status and use of PPE at work

| **Microorganism** | **Emptier category** | | **t-test** | **p-value** |
|---|---|---|---|---|
| | **With at least primary education (n=15)** | **With no formal education (n=45)** | | |
| Aerobic count | (2.8±1.7) × $10^3$ | (7.6±4.1) × $10^3$ | 17.738 | <0.001 |
| Coliform count | (1.7±0.9) × $10^3$ | (4.7±2.9) × $10^3$ | 14.961 | <0.001 |
| *E. coli* | (1.3±0.6) × $10^3$ | (3.3±1.8) × $10^3$ | 5.053 | 0.031 |
| *Salmonella/Shigella* | (1.1±0.7) × $10^3$ | (2.9±1.3) × $10^3$ | 4.876 | 0.033 |
| | **With PPE (n=11)** | **Without PPE (n=49)** | | |
| Aerobic count | (3.1±1.3) × $10^3$ | (8.3±6.0) × $10^3$ | 19.053 | <0.001 |
| Coliform count | (2.2±1.6) × $10^3$ | (6.3±3.4) × $10^3$ | 16.675 | <0.001 |
| *E. coli* | (1.4±0.8) × $10^3$ | (4.1±2.6) × $10^3$ | 7.266 | 0.013 |
| *Salmonella/Shigella* | (1.1±0.4) × $10^3$ | (3.2±1.3) × $10^3$ | 6.061 | 0.027 |

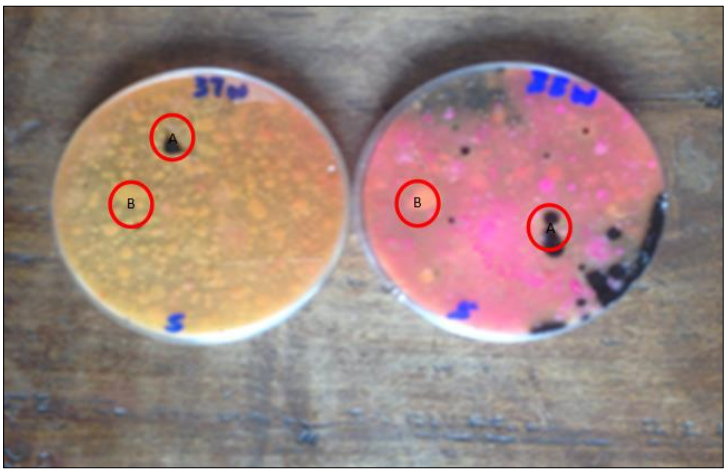


**Figure 7** Growth of *Salmonella* and *Shigella* on Salmonella- Shigella Agar [A-*Salmonella* spp.; B: *Shigella spp.*]

## 4 Discussion

The findings from this research revealed that manual faecal sludge evacuators mostly have been previously engaged in different kinds of jobs. However, as a result of insufficient wages in their normal jobs, they involve themselves in the manual emptying job as a supplementary job. This study revealed that well digging and other manual labours are the predominant work which are combined with faecal sludge emptying. Faecal sludge emptying in Ibadan is an unregulated activity. This study further showed that the work is mostly carried out at night or early morning to evade arrest from local inspectors as their procedures are not as per prescribed methods. Previous studies have reported similar findings [10]. The study also found that manual faecal sludge evacuators within Ibadan metropolis had a poor personal hygiene practices. In this study, low proportion of evacuators engaged in appropriate hand washing practices and personal hygiene after handling faecal sludge as few of them do wash their hand with soap, sanitizer and water. This is evident from the bacteriological examination reported in this study. Basic hygiene behaviours, especially hand-washing with soap and sanitizers after handing faecal waste have been suggested to reduce the occurrence of water-washed infections [22].

The benefits of the use of PPE cannot be over emphasized, like every other occupation, faecal sludge management exposes handlers to physical, chemical and biological hazards at their work stations. This study revealed that dust, odour and chemical or gas fumes/aerosols are the major hazards which manual evacuators are constantly exposed to. However, in spite of these health hazards encountered by faecal sludge evacuators, their utilization of PPE is very low. Previous study has reported similar findings [23]. This study found that Low proportion utilized overall, nose mask and hand gloves during evacuation process. Similar observations were reported by Sridhar *et al.* [16] in their study of business analysis of faecal sludge management in Ibadan. However, faecal sludge evacuators revealed that they usually feel discomfort when they wear their PPE after some time during work. In addition, the respondents narrated that protective shoes becomes really soaked and makes movement inconvenient and slow during their evacuation process. It was also found that use of hand gloves prevents proper gripping of the buckets and other emptying appliances. This concurs with the reports of Tsinda *et al.,* [24] where faecal sludge evacuators experienced discomfort and to save time as some of the reasons for not using PPE during their work.

This study found a wide range of microorganisms such as *Escherichia coli, Salmonella spp., Staphylococcus spp., Shigella spp.* which are isolated from the collected hand wash samples. These microbes have been identified severally to cause diseases of public health concern such as cholera and other various infections. This is in conformity with the findings of Ambedkar *et al*., [25] who reported the presence of *Bacillus species* and *E. coli* among other organisms in the hand wash samples of sewage workers in Egypt. Significant differences were observed in the mean aerobic, coliform, *E. coli* and *salmonella/shigella* counts of evacuators with no formal education and their counterparts with at least primary education. This could be due to the disparities in their educational background because manual faecal sludge emptying processes entails coming in contact with vast microbes and those with no formal education might have little awareness about proper personal hygiene during and after the evacuation process. This is similar to the findings of a study conducted by Sridhar and Oyemade [26] where more microbial loads were recorded from the hand wash sample of sewage workers in a Chinese college compare to the microbial load recorded on the hand wash sample of the administrative staff of the same college. Furthermore, previous study has documented nonuse of PPE among manual feacal sludge emptier [23]. In this study, however, significant differences were observed in the mean aerobic, coliform, *E. coli* and *salmonella/shigella* counts among manual faecal evacuators who used PPE and those that did not. The findings revealed that use of PPE during faecal evacuation might reduce the microbial loads on the hand of the evacuators. Higher load of coliforms from the hand wash samples of faecal sludge evacuators may be due to lack of right method of hand washing, particularly with water, soap and sanitiser after completing the evacuation process.

## 5 Conclusion

This study assessed hazards involved in manual faecal sludge evacuation in Ibadan metropolis. Findings from this study showed that manual faecal sludge evacuation is still prevalent in Ibadan metropolis and despite the hazards they are exposed to, appropriate personal protective equipment use was found to be very low. Also, manual faecal sludge evacuators practiced poor hygiene, improper hand washing and full body cleaning was fairly performed daily after the task. Predominant microbes found in the hand wash samples were *Escherichia coli, Salmonella, Staphylococcus, Shigella, Enterobacter and Flavo bacterium.* Significant differences were observed in the predominant microbe counts among evacuators with no formal education and their counterparts with at least primary education, and those that use PPE and those that did not during evacuation. This could be ascribed to the difference in the educational status and the use of personal protective equipment. Regular training and more frequent informal discussions on health and safety practices

should be ensured and compliance with hygiene standards relating to the work should be enforced among manual fecal sludge evacuators.

## Compliance with ethical standards

*Acknowledgments*

The authors wish to appreciate the cooperation of all the participants who cooperated in this study.

*Disclosure of conflict of interest*

The authors declare no conflict of interest.

*Statement of ethical approval*

Ethical approval was obtained from the University of Ibadan/University College Hospital Joint Ethical Review Board. Participation of the respondents was voluntary and those who decided to withdraw during the study were permitted to do so.

*Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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