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HAND WASHING PRACTICES AND THE OCCURRENCE OF ENTEROPATHOGENIC BACTERIA AMONG RESIDENTS OF A NIGERIAN UNIVERSITY

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ABSTRACT

Hand washing is known to be an important preventive strategy and a major step in infection control. However, compliance is low in most communities. The present work investigated the relationship between the levels of compliance to hand washing and related this to the occurrence of infectious bacteria in the test population. A questionnaire which contained information on bio-demographic characteristics and hand hygiene practices was applied to 100 individuals in the study population. Microbiological samples were obtained, Total Colony Counts was done and the isolates were identified using standard bacteriological methods. The results showed that 46% of the respondents wash their hands before eating food; 40% of the test population washes their hands after using the toilet; while none of the respondents wash their hands after handling money. The highest bacterial load was found in the 0-15 years age group. The most highly occurring isolate was *Salmonella enterica* (23.7%). These results confirm the low level of compliance to hand hygiene in the test population and underscores the need to effectively break the fecal-oral transmission route via hands through effective interventions such as hand washing with soap and water.

Key Words: enteropathogenic bacteria, hand washing, compliance

LES PRATIQUES DE LAVAGE DES MAINS ET L'APPARITION DE BACTERIES ENTEROPATHOGENES PARMIS LES RESIDENTS D'UNE UNIVERSITE NIGERIANE.

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RESUME

Le lavage des mains est connu pour être une stratégie préventive importante dans le contrôle des infections. Néanmoins, la conformité est faible dans la plupart des communautés. Le présent travail a étudié les niveaux de conformité au lavage des mains et a rapporté cela à la présence de bactéries infectieuses dans la population d'essai. Un questionnaire contenant des informations sur les caractéristiques bio - démographiques et les pratiques d'hygiène des mains a été appliqué à 100 individus de la population étudiée. Les échantillons microbiologiques ont été recueillis, les dénombrements totaux de colonies ont été effectués et les isolats ont été identifiés en utilisant de méthodes bactériologiques standard. Les résultats ont montré que 46% des personnes interrogées se lavent les mains avant de manger de la nourriture; 40% de la population d'essai se lavent les mains après avoir utilisé les toilettes ; alors qu'aucun des répondants ne se lave les mains après avoir touché de l'argent. Le charge bactérienne la plus élevée a été observée dans le groupe d'âge 0 - 15 ans. L'isolat le plus fréquent était *Salmonella enterica* (23,7%). Ces résultats confirment faible niveau de conformité à l'hygiène des mains dans la population d'essai et souligne la nécessité de rompre efficacement la voie de transmission fécale - orale via les mains par des interventions efficaces telles que le lavage des mains avec du savon et de l'eau.

Mots clés: Bactérie entéropathogène, lavage de main, conformité.

INTRODUCTION

Hand washing, defined as the vigorous, brief rubbing together of all surfaces of lathered hands, followed by rinsing under a stream of water in order to remove dirt and infectious microorganisms (1) is perhaps the single most important preventive strategy and a major step in infection control (2). Studies have shown that the basic control of fecal-oral route of spreading potentially pathogenic microorganisms

through food by food handlers may be achieved thorough hand-washing, particularly at critical points in the food dispensing process (3-5). Moreover, optimal hand hygiene behavior is considered to be the cornerstone of healthcare associated infection (HCAI) prevention (6-8). This is because healthcare workers (HCWs) are known to play a major role in the propagation of micro-organisms within the healthcare environment and may spread these to

patients and ultimately from one patient to another (6, 9).

Bacteria, particularly those belonging to the family *Enterobacteriaceae* have been found to be associated with a large percentage of human diseases and these have been grouped, depending on the mode of transmission under different classifications such as those transmitted in healthcare settings (nosocomial), airborne, soil transmitted etc. Some members of the bacterial family *Enterobacteriaceae* produce endotoxins that, when released into the bloodstream following cell lysis, cause a systemic inflammatory and vasodilatory response such as endotoxic shock which can be rapidly fatal (10). Regardless of the method of transmission; bacterial infections may be controlled to a large extent through hand hygiene (11).

There are two principal types of skin flora associated with the hand, namely, resident and transient flora. These microbial and viral floras play a major role in the epidemiology of infections (12). Resident floras are permanent inhabitants of the skin and are found mainly on the surface of the skin. These are non-pathogenic on intact skin but are capable of causing infections on non-intact skin. Examples include bacteria such as *Staphylococcus epidermidis*, *Staphylococcus hominis*, *Propionibacteria*, *Micrococci* and few species of fungi such as *Pityrosporum* (13). These organisms often serve the protective function of protecting against infection by transient organisms through microbial antagonism and the competition for nutrients in the ecosystem (13). Transient floras on the other hand, are microorganisms found only at times on the hand and are easily removed by hand washing. Transient flora organisms usually do not multiply on the skin but survive and occasionally multiply and cause disease. These are acquired from infected persons and/ or inanimate surfaces (fomites) that contain deposits of causative microbes. The transmissibility of transient flora depends on the species of microorganism, its ability to survive on the skin, the population on the hand and the dermal water content.

The simple practice of hand washing is known to reduce the risk of microbial transmission greatly from one person to another as well as limit transmission from a contaminated site to a clean one (2). However, the level of hand hygiene compliance remains low worldwide (14); the lack of appropriate infrastructure (such as water supply in resource poor countries where potable water is frequently inaccessible) and equipment to enable hand hygiene performance (poor location of hand washing kit), the cultural background, and even religious beliefs can play important roles in hindering good hand hygiene practices (15, 16, 17). Moreover, individual cognitive factors such as perception and knowledge of the

transmission risk, social pressure, conviction of hand hygiene efficacy in preventing the spread of diseases, little or no idea on the proper way to wash hands, personal evaluation of perceived benefits against the existing barriers have been identified as reasons for non-compliance with hand hygiene practices (6,18,19).

Hand hygiene behavior appears to be homogenous and has been classified into two types of practices namely, the inherent hygiene practice which occurs when hands are visibly soiled, gritty or sticky. On the other hand, elective hand hygiene practice occur when hand cleansing is performed when hands are not obviously dirty but common social interactions such as shaking of hands, touching of a patient (e.g. taking a pulse or taking blood pressure) by a HCW or having contact with an inanimate object in an infected person's surroundings (9). According to behavioral theories, the elective hand hygiene practice is the component most likely to be omitted and is responsible for most compliance issues in hand hygiene practice particularly among HCWs (20).

The World Health Organization (WHO) has set guidelines on the proper way to conduct hand-washing as follows: the hands must be wetted with clean water (this is important in order to enable the soap make better contact with the hand surface); then lather behind the hands and between the fingers and under the finger nails by rubbing together with the soap, ensuring that the soap gets to every corner; scrub for at least 20 seconds (to ensure that all the germs on the hands are eradicated); rinse thoroughly with clean water, to take away the soap and finally dry with clean piece of cloth, to avoid the transfer of germs (21).

There are other hand hygiene techniques such as wearing of hand gloves and using alcohol or non alcohol-based hand rubs. Alcohol and non-alcohol based hand rubs are considered to be the gold standard for hand hygiene in most clinical situations. This hand hygiene technique is promoted and recommended by the CDC and the WHO and embraced by many national hand hygiene guidelines, based on the evidence of better microbiological efficacy, less time required to achieve the desired effect, point of patient care accessibility and a better skin tolerance profile (6,22,23). However, there has been a lot of concern regarding their lack of efficacy against spore-forming pathogens. Apart from iodophors used at concentrations remarkably higher than the one used in antiseptics, no hand hygiene agent (including alcohols, chlorhexidine, hexachlorophene, chloroxylenol and triclosan) is reliably sporicidal against *Clostridium* or *Bacillus spp* (6, 21). Mechanical friction while washing hands with soap and water is perhaps the only effective intervention against spore forming bacteria as the

spores are physically removed from the surface of contaminated hands (24).

With the foregoing, the present study was aimed at investigating the relationship between the level of awareness and compliance to hand washing as a personal hygiene technique at the Redeemer's University. Moreover, the study was focused on determining whether or not any relationship exists between poor hand hygiene and the occurrence of bacteria of the family *Enterobacteriaceae* as a predictor of risk for potentially serious infections in the test population.

MATERIALS AND METHODS

The Study population, Experimental Design and Collection of Samples

The study population consisted of members of the Redeemer's University community from various walks of life including University students, staff (academic and non-academic), staff children, construction workers, laborers and traders. Demographically, these individuals were of different age brackets and of different levels of education. A 12 item questionnaire which contained information on bio-demographic characteristics and hand hygiene practices was applied to 100 individuals in the study population. A sample size of 91 by simple random cluster sampling technique considering $P=0.5$ as the estimated proportion of hand contamination in the study population, $d=0.09$ was calculated as the desired level of precision, at a confidence level of 95%. The actual sample size was extended to 100 in anticipation of unexpected circumstances in the course of the study. Microbiological samples were obtained from every individual that completed the questionnaire using sterile swabs dipped in saline solution across the palms and fingers of the individuals. Data collected were entered and analyzed using SPSS-16 statistical software. Proportions were compared using Chi-square test and 'p' value less than 0.05 was considered statistically significant.

Microbiological analyses

Swab sticks pre-moistened in sterile normal saline used for collecting samples were dipped in 10ml sterile normal saline and thoroughly stirred using a vortex. Serial dilution was performed into dilutions 10^{-1} , 10^{-2} , 10^{-3} , 10^{-4} , 10^{-5} . 1 ml of dilutions 10^{-1} , 10^{-3} , 10^{-5} was inoculated in duplicates onto Eosine Methylene Blue (EMB) agar and incubated at 37°C for 24 hours. The colonies were then counted and the pure colonies were sub-cultured on nutrient agar. EMB agar was used to screen for members of the family *Enterobacteriaceae*, the bacterial contaminants of interest. The bacteria isolates were identified based on shape, colony, color, and Gram's staining reactions

and biochemical tests such as methyl red, Vogues-Praskauer, Citrate, Urease, Indole, Motility, Catalase, Oxidase, Lysine decarboxylase and Sugar fermentation tests. The Duncan's Multiple Range Test ($p \leq 0.05$) was used to compare the mean Total Colony Counts for the demographic groups.

RESULTS

There were one hundred (100) participants in the present study. There were 38 males and 62 females giving a male to female ratio of 1:1.5. A majority of these individuals (76%) have a high school education or higher and were above sixteen years of age (Table 1). The questionnaire on the level of awareness and compliance to hand washing as a personal hygiene technique among residents of Redeemer's University, Ede, Nigeria was completed by all of the 100 persons from whom swab samples were taken for microbiological evaluation. Tables 2 and 3 show the results of the questionnaire items designed to evaluate the level of awareness and compliance to hand washing as a personal hygiene technique in the test population. The results show that all the male respondents washed their hands at least once a day, whereas 2% of the females do not wash their hands at least once daily after taking their bath in the morning (Table 2a). On the other hand, the proportion of women that wash their hands at least more than once daily was more than those recorded for the males; the number of females that wash their hands at least three times daily was twice the number of men that washed their hands three times a day (Table 2a).

TABLE 1: DEMOGRAPHIC CHARACTERISTICS OF THE SAMPLE POPULATION

Variables	Frequency/ Percentage
Age	
0-15	39
16-21	32
22 and above	29
Total	100
Gender	
Male	38
Female	62
Total	100
Level of Education	
Preschool/ Primary	22
High School	17
Undergraduate	56
Post graduate	5
Total	100

TABLE 2A: HAND HYGIENE PRACTICES WITHIN THE SAMPLE POPULATION: FREQUENCY OF HAND WASHING ON A DAILY BASIS

Questionnaire item: How frequently do you wash your hands daily?	0	1	2	3
Male	0	12	16	10
Female	2	14	26	20
Frequency	2	26	42	30
Percentage	2	26	42	30
Total	100			

Key: 0= None; 1= Once; 2= Twice; 3= 3 or more times

TABLE 2B: HAND HYGIENE PRACTICES WITHIN THE SAMPLE POPULATION: EVENTS THAT TRIGGER HAND HYGIENE COMPLIANCE

Questionnaire item: When do you wash your hands daily?	0	1	2	3	4	5
Male	0	8	12	0	18	0
Female	1	4	28	0	28	0
Frequency	1	12	40	0	46	0
Percentage	2	12	40	0	46	0
Total	100					

Key: 1= Before, during and after preparing food; 2= After using the toilet; 3= After taking care of sick people; 4= Before eating food; 5= After handling money

In order to determine the intrinsic motivators for compliance in the test population, respondents were presented with options on the daily events that would motivate them to wash their hands. The results showed that forty six percent of the respondents (46%) wash their hands before eating food, followed by 40% of the test population who wash their hands after using the toilet. Only 12% of the respondents wash their hands before, during and after preparing food, 2% of the test population does not wash their hands before during or after any of the listed activities, while none of the respondents wash their hands after handling money (Table 2b). Table 3a shows the results when the respondents were asked to indicate what hand hygiene technique they routinely used. This was in order to serve as a predictor of the effectiveness of the hand washing method adopted by the respondents. The results showed that a majority of the subjects (76%) washed their hands with soap and water, 10% used soap, water and hand sanitizer afterwards, 8% washed their

hands with water only, and 4% used hand sanitizer only while 2% of the respondents did not wash their hands at all. Table 3b shows the results of the questionnaire item designed in order to establish the reasons for non-compliance with hand hygiene practice within the test population. 2% of the respondents listed nonchalance as their reason for non compliance, 6% lacked the awareness of the health significance of hand washing, none of the respondents indicated “little or no idea on the proper way to wash hands” as their reason for non compliance. However, a majority listed “laziness” (46%) and “lack of availability of soap and water” (46%). To investigate further whether there is awareness in this population of the proper way to wash hands as recommended by the WHO respondents were asked if of their awareness of “WHO’s recommended way to wash hands”; the results show that 50% of the respondents were unaware of the WHO’s recommended way to wash hands (Table 3c).

TABLE 3A: HAND HYGIENE PRACTICES WITHIN THE SAMPLE POPULATION: HAND HYGIENE TECHNIQUE USED

Questionnaire item: What do you wash your with?	0	1	2	3	4
Male	0	8	28	0	2
Female	2	0	48	4	8
Frequency	2	8	76	4	10
Percentage	2	8	76	4	10
Total	100				

Key: 0= None; 1= Water only; 2= Soap and water; 3= Hand sanitizer only; 4= Soap, water and hand sanitizer afterwards

TABLE 3B: HAND HYGIENE PRACTICES WITHIN THE SAMPLE POPULATION: REASONS FOR NON-COMPLIANCE WITH HAND HYGIENE PRACTICE

Questionnaire item: Reasons for non compliance	0	1	2	3	4
Male	0	4	0	18	16
Female	2	2	0	28	30
Frequency	2	6	0	46	46
Percentage	2	6	0	46	46
Total	100				

Key: 0= Nonchalant; 1= Lack of awareness of the health significance of hand washing; 2= Little or no idea on the proper way to wash hands; 3= Laziness; 4= Lack of availability of soap and water

TABLE 3C: HAND HYGIENE PRACTICES WITHIN THE SAMPLE POPULATION: AWARENESS OF WHO STANDARD OF WASHING HANDS

Questionnaire item: I am aware of WHO's recommended way to wash hands	Yes	No
Male	18	20
Female	32	30
Frequency	50	50
Percentage	50	50
Total	100	

As shown on Table 4, a total of 118 distinct bacterial isolates were obtained from the entire study and these were separated into eight (8) groups based on differences in their cultural characteristics. Biochemical tests were then applied to the representative isolates in order to identify and characterize these isolates. Eight (8) distinct

organisms were identified, namely, *Klebsiella oxytoca*, *Proteus vulgaris*, *Shigella sonneri*, *Morganella morganii*, *Salmonella enteric*, *Serratia marcescens*, *Proteus mirabilis*, *Proteus penneri*. As shown on Table 5, the most highly occurring of these was *Salmonella enterica* (23.7%), followed in descending order by *Shigella sonnei* (16.9%); *Proteus vulgaris* (15.3%); *Klebsiella oxytoca* (13.6%); *Morganella morganii* (10.2%); *Proteus mirabilis* (8.5%); *Proteus penneri* (6.7%) and *Serratia marcescens* (5.1%). Table 6 shows that the highest bacterial load was found in the 0-15 years age group from where 76 distinct isolates, representing the age group from which the highest number of the bacteria were isolated. This number represents more than half the total number of isolates obtained from the entire study (64.4%; Table 6). This was followed in descending order by respondents that were in the 16-21 years and respondents 22 years and older at 28.8% and 6.8% respectively.

TABLE 4: IDENTIFICATION TABLE OF BACTERIAL ISOLATES FROM THE HANDS OF RANDOMLY SELECTED MEMBERS THE REDEEMER'S UNIVERSITY COMMUNITY.

Representative Isolates	Gram Staining	Cell Shape	Oxidase	Catalase	Citrate	Methyl Red	Voges - Praskauer	Motility	Orthinine Decarboxylase	H ₂ S	Lactose	Indole	Suspected organisms
A	-	R	-	-	+	-	+	+	-	-	+	+	<i>Klebsiella oxytoca</i>
B	-	C	-	+	+	-	-	+	-	+	-	+	<i>Proteus vulgaris</i>
C	-	R	-	+	+	+	-	-	+	-	-	-	<i>Shigella sonnei</i> .
D	-	R	-	+	+	+	-	+	-	-	-	+	<i>Morganella morgani</i>
E	-	R	+	+	+	+	-	+	-	+	-	+	<i>Salmonella enterica</i>
F	-	R	-	+	+	-	-	+	-	-	-	+	<i>Serratia marcescens</i>
G	-	R	-	+	+	+	-	+	+	-	-	-	<i>Proteus mirabilis</i>
H	-	R	-	+	+	+	-	+	-	-	-	+	<i>Proteus penneri</i>

Key: C=cocci; R= Rod; + = positive; - = negative

TABLE 5: PERCENTAGE OCCURRENCE OF THE ISOLATES FROM THE ENTIRE STUDY

S/N	Group number	Identified organisms	Frequency of Isolates	Percentage
1	A	<i>Klebsiella oxytoca</i>	16	13.6
2	B	<i>Proteus vulgaris</i>	18	15.3
3	C	<i>Shigella sonnei</i>	20	16.9
4	D	<i>Morganella morgani</i>	12	10.2
5	E	<i>Salmonella enteric</i>	28	23.7
6	F	<i>Serratia marcescens</i>	6	5.1
7	G	<i>Proteus mirabilis</i>	10	8.5
8	H	<i>Proteus penneri</i>	8	6.7
		Total	118	100

TABLE 6: PERCENTAGE OCCURRENCE OF THE ISOLATES AMONG THE AGE GROUPS

Age group (years)	Identities of bacterial isolates isolated from subjects/ respondents								
	<i>Klebsiella oxytoca</i>	<i>Proteus vulgaris</i>	<i>Shigella sonnei</i>	<i>Morganella morgani</i>	<i>Salmonella enteric</i>	<i>Serratia marcescens</i>	<i>Proteus mirabilis</i>	<i>Proteus penneri</i>	Total (%)
0-15	10	4	14	8	28	4	4	4	76(64.4)
16-21	4	12	4	4	0	0	6	4	34(28.8)
22 and above	2	2	2	0	0	2	0	0	8(6.8)
Total (%)	16 (13.6)	18(15.3)	20(16.9)	12(10.2)	28(23.7)	6(5.1)	10(8.5)	8(6.7)	100(100)

DISCUSSION

The fact that hand washing contributes to keeping the individual healthy and free from microbial infection is well established in literature. For example, Aiello et al (25) in a survey carried out at the University of Michigan, USA reported that hand wash hygiene could reduce the spread of flu-like symptoms by up to 75%. Moreover, numerous surveys carried out with the objective of linking hand washing to the reduction of microbial infection particularly in healthcare settings have concluded after series of investigations

that hand washing reduces the transmission of pathogenic organisms from individual carriers (patients) to health care workers and visitors (6, 9, 26).

In addition, an example of how hand washing may serve as a preventive measure against microbial infection is the recent Ebola virus outbreak in Nigeria. When on the 20th of July 2014, Ebola found its way down to Lagos, Nigeria through a traveler from Liberia (a diplomat who went by the name Patrick Sawyer) infected with the virus. Nigerian authorities

were caught unawares, so he was able to infect several other people including health care workers in the hospital where he was taken to for treatment. The number of people infected with Ebola virus in Nigeria as at October 2014 was recorded to be twenty and eight deaths which involved health care workers and innocent victims. However, the rapid interventions in the quarantine of sick individuals by Nigerian HCW, WHO and CDC together with the compliance of citizens to hand hygiene by a combination of hand washing with soap and water and the use of sanitizers especially in public places like banks, airports, schools and so on, led to the removal of the disease from Nigeria. In October 2014, Nigeria was declared free from Ebola (27, 28).

In spite of the obvious advantage of hand hygiene in stemming the spread of infectious diseases, compliance is low even among the enlightened and educated particularly among health workers who should know about the importance of hand washing in personal health and the spread of diseases. In a study conducted to evaluate hand washing practices among medical personnel at the University of Port Harcourt, Nigeria, it was found that only 37.6% washed their hands regularly after interacting with their patients while 33.9% did so only after the days work. 58.3% and 58.9% washed hands before meals and after defecating respectively (29). In the present study, compliance rate to hand hygiene as a means of personal hygiene is equally low as the results showed that only 46% of the respondents wash their hands before eating food, followed by 40% of the test population who wash their hands after using the toilet. Only 12% of the respondents wash their hands before, during and after preparing food, 2% of the test population does not wash their hands before during or after any of the listed activities, while none of the respondents wash their hands after handling money (Table 2b).

The results of the Opara et al, (29) and present studies underscore the fact that the level of education and the awareness of the importance of hand washing to prevention of infection and the spread of disease does not necessarily translate to good compliance. Moreover, the motivators for compliance to hand washing may differ depending on the population of interest. These findings suggest that intrinsic behavioral (e.g., role modeling) and socioeconomic factors such as accessibility or acceptability of soap may play greater roles in the use of soap and other hygiene practices. This is especially important in the case of elective compliance to hand washing when hands are not visibly dirty but may have been exposed to infectious disease causing agents.

The results from the present study indicating that the highest bacterial load (64.4%; Table 6) was found among the children (age 0-15 years old) in the test population is quite worrisome. However, it further underscores the importance of intrinsic behavioral factors such as modeling in order to commit to and comply with good hand hygiene practices. In a related direct observation study conducted in Zimbabwe on 23 caregiver-infant pairs for 130 hours and recorded wash-related behaviors to identify pathways of fecal-oral transmission of bacteria among infants. It was discovered that hand washing with soap was not common and drinking water was contaminated with *Escherichia coli* in half (12 of 22) of the households (30). In another related study conducted in Tanzania, half of the caregivers' dominant hands were positive for *E. coli* in a context where hand washing with soap after fecal contact was rarely practiced (31). Moreover, even in Healthcare settings, studies have shown that compliance to hand washing increased when hand washing is actively supported and promoted by senior administrators and senior physicians (20). In addition, studies have shown that HCWs have a higher likelihood of practicing hand washing when senior members of staff were present (20, 23). These results suggest that children and young adults are less likely to practice hand hygiene when there are no good role models to help them commit to good hygiene practices. Furthermore, the fact that 46% of the respondents in the present study indicated that their non compliance to hand hygiene practice was due to "lack of availability of soap and water" underscores the importance of provision of necessary amenities such as sinks, potable flowing water, soap and clean towels in order to encourage compliance with hand hygiene in the test population.

Although there has been no outbreak of enteric diseases within the test population of this study, the present results showing that eight distinct bacterial organisms from the family Enterobacteriaceae, members of which are associated with fecal contamination is a serious observation and are predictive of possible outbreaks of enteric diseases.

The most occurring of the isolated organisms was *Salmonella enterica*, an organism known to be responsible for causing salmonellosis. *S. enterica* causes four different clinical manifestations: gastroenteritis, bacteremia, enteric fever, and an asymptomatic carrier state. There is an infectious dose (between 10^3 to 10^5 bacilli by ingestion) at which this organism is able to cause disease which varies with the serotype; young children, patients with depressed cell-mediated immunity, or who are elderly may become infected with at a lower infectious dose (32). As reported by Solomons (33) environmental

enteropathy, a chronic subclinical intestinal pathology typically a feature of populations infected with less than 'infectious dose' of enteric pathogens, is common among infants in low-income countries and has been proposed as a cause of childhood stunting (33). Environmental enteropathy, may be a more important cause of poor growth in children than diarrhea because it is characterized by reduced intestinal barrier function and chronic systemic inflammation (34).

Findings from the present study confirms the low level of compliance to hand hygiene in the test population and further underscores the need to effectively break the fecal-oral transmission route via hands through effective interventions such as hand washing with soap and water. Provision of necessary amenities such as sinks, potable flowing water, soap and clean towels coupled with promotion of hand hygiene practice among opinion leaders such as crèche care givers, school teachers, University lecturers and administrators is expected to increase

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the participation of residents of the Redeemer's University Campus, Ede in hand hygiene practice. This in turn is expected to reduce the risk for outbreak of enteropathogenic diseases and may serve as an index case for the entire community within Osun State of Nigeria.

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AUTHORS' CONTRIBUTIONS: FA designed the study; team composed by FA and CHA carried out the studies, acquired and analyzed the data. FA drafted the manuscript and supervised the work and revised the final draft of the manuscript. Both authors read and approved the final manuscript.

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