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Occurrence of Pathogenic Bacteria on Public Surfaces within Community Schools in Abeokuta Environs, Ogun State

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Abstract

Bacteria of medical importance abound all around us and are transmitted through different contacts within our community i.e. schools. To determine the possible role of fomites in dissemination of medically important pathogenic microorganisms, a study was carried out in public community schools within Abeokuta environs. The prevalence of bacteria was investigated from 300 fomites (door handles), in fifteen randomly selected secondary schools across Abeokuta South, Abeokuta North and Odeda Local Government Areas. Isolation of different bacteria species was done using standard microbiological methods through the use of Nutrient agar, MacConkey and blood agar after swabbing the fomites using sterile swabs. Bacteriological examinations revealed that almost all the fomites had at least one of the following bacteria in each community school; *Bacillus subtilis* (17.66 %), *Bacillus mycoides* (16 %), *Bacillus megaterium* (12.33 %), *Pseudomonas aeruginosa* (18 %), *Pseudomonas fluorescens* (18 %), *Enterobacter sp* (16 %), *Escherichia coli* (19.67 %), *Citrobacter freudii* (10.33 %), *Klebsiella oxytoca* (16 %), *Staphylococcus aureus* (14 %), *and Staphylococcus saprophyticus* (7 %) from each Local Government area. The data from this study emphasize the importance of fomites as potential source of transferring medically important microorganisms such as pathogenic bacteria in school environments, which may hamper the learning process of the students due to infections/diseases which may arise from frequent contact with these pathogenic bacteria.

Keywords: Fomites, Pathogenic Bacteria, Community Schools, Public health

1 Introduction

Bacteria are ubiquitous microorganisms in both outdoor and indoor environment [1] and have been identified as microbial sources of contamination; inanimate objects (fomites) have been shown to play a role in the transmission of human pathogens either directly, by surface-to-mouth contact, or indirectly, by contamination of fingers and subsequent hand-to-mouth contact [2-4]. If certain physical conditions, such as moisture level, temperature and the presence of organic and inorganic substrates, are met in a school building/environment, microbes can easily proliferate. Just as buildings differ, one from another, also Local government areas differ and so do bacterial concentrations in their indoor and outdoor environment. Bacteria are natural inhabitants of soil and water and some species behave as opportunistic pathogens in man; bacteria grow in water systems where there are dead spaces and parts of the pipework that have low circulation contributing to the formation of biofilms. Pathogenic bacteria serves as agents of varieties of infections; which are a trend and are found much more frequently as the cause of community acquired infections in immunocompromised patients.

Pathogenic organisms, i.e., viruses, bacteria and protozoa, may be excreted in large numbers in biological substances including blood, mucus, saliva, feces and urine [5-10]. Some microbes are infectious at very low doses and can survive for hours to weeks on non-porous surfaces, such as countertops, door handles and telephone hand pieces [11-17]. Fomites are thought to play a role in the spread of the major outbreaks i.e SARS virus, where they are known to survive for up to 96 hours on environmental surfaces and longer in the presence of biological substances [18]. Likewise, contaminated fomites have been implicated

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in the persistence of Norovirus outbreaks between guests in a hotel and on cruise ships [19, 20]. Pathogens are readily transferred to hands from contaminated fomites and to the mouth from contaminated hands [17, 21] hence putting the health of students at risk; if the transfer remain unchecked.

The aim of this study is to investigate the prevalence of pathogenic bacteria isolated from fomites in selected secondary schools within Abeokuta environs; which will provides information on the hygienic status of each community schools within Abeokuta environs and identifies the relative importance of surfaces where exposure rates may be highest and where preventive health measures (i.e. hand washing following exposure and cleaning) may be targeted. Frequently contacted public surfaces from public secondary schools in Abeokuta were monitored for the occurrence of bacteria of public health importance in the school community.

2 Materials and Methods

2.1 Study site

A cross-sectional study design was used; study site was Abeokuta environs. Abeokuta has three local governments namely; Odeda Local Government, Abeokuta South Local Government and Abeokuta North Local Government. Swabs were collected from schools randomly in all the three Local Government. GPS tracker was used to georeference the study sites and obtains their latitudes/longitude coordinates as shown in Table 1.

2.2 Sample collection

A total of 300 swabs were collected from door handles of the classrooms, offices, toilets and the toilet water closet handle in randomly selected secondary schools in Abeokuta, Nigeria. The samples were collected by swabbing (sterile swabs moistened with buffered peptone water) the toilets, offices and the classroom door handles. The samples were properly labeled using reference numbers and then transported to the Laboratory using buffered peptone water transport media (ice pack).

Samples were collected from selected secondary schools in the three Local Government Areas (Odeda LGA, Abeokuta South LGA and Abeokuta North LGA) as indicated by the GPS coordinates of each school. Surfaces sampled from public secondary schools (n=300), were categorized as: Abeokuta South LGA- office doors (27), classroom doors (33), toilet doors (23), toilet water closet handle (17), Abeokuta North LGA- office doors (27), classroom doors (39), toilet doors (21), toilet WC handle (15); Odeda LGA- office doors (28), classroom doors (35), Toilet (21), Toilet WC handle (16). Highest number of samples was recorded from the classroom doors and lowest from the toilet doors respectively from all the local Government Areas. All samples were collected during the summer months (June to July, 2017).

2.3 Culture of the Samples

In the laboratory, the samples were suspended into the buffered peptone water solution. The suspensions were inoculated into blood agar, MacConkey agar and nutrient agar, and plates were incubated at 35°C for 22 hours. MacConkey agar and Nutrient agar were used to isolate microorganisms of public health importance and coliforms present in the swabs taken from the selected secondary schools. These helped in determining the prevalence in each school in different local government.

Table 1: Sampling/site Location, GPS coordinates and Code for fomites sampled.

S/N	SCHOOLS	GPS Coordinates (Latitude/Longitude)	Sampling site / area	Code of fomites
1	Lafenwa High School	7.206/3.278	Abeokuta North LGA	OF1, CD1, TD1, TWC1
2	Baptist Boys High School	7.223/3.292	Abeokuta North LGA	OF2, CD2, TD2, TWC2
3	St Peter's High School	7.183/3.208	Abeokuta North LGA	OF3, CD3, TD3, TWC3
4	Premier Grammar School	7.231/3.168	Abeokuta North LGA	OF4, CD4, TD4, TWC4
5	African Church Grammar School	7.214/3.299	Abeokuta North LGA	OF5, CD5, TD5, TWC5
6	Salawu Abiola Comprehensive High School (Senior)	7.211/3.486	Odeda LGA	OF6, CD6, TD6, TWC6
7	Federal College of Education Grammar School	7.236/3.529	Odeda LGA	OF7, CD7, TD7, TWC7
8	Muslim High School	7.265/3.536	Odeda LGA	OF8, CD8, TD8, TWC8
9	Nasaar-un-deen Grammar School	7.262/3.529	Odeda LGA	OF9, CD9, TD9, TWC9
10	Salawu Abiola Comprehensive High School (Junior)	7.280/3.582	Odeda LGA	OF10, CD10, TD1,0 TWC10
11	St John's Anglican School	7.136/3.355	Abeokuta South LGA	OF11, CD11, TD11, TWC11
12	Abeokuta Grammar School	7.143/3.375	Abeokuta South LGA	OF12, CD12, TD12, TWC12
13	Egba Comprehensive High School	7.171/3.372	Abeokuta South LGA	OF13, CD13, TD13, TWC13
14	Baptist Girls Grammar School	7.147/3.366	Abeokuta South LGA	OF14, CD14, TD14, TWC14
15	Lantoro High School	7.163/3.361	Abeokuta South LGA	OF15, CD15, TD15, TWC15

Key: OF= Office doors, CD= Classroom doors, TD= Toilet doors, TWC= Toilet water closet

2.4 Biochemical Identification

The bacteria isolates were subjected to standard microbiological methods such as morphological characteristics of the colony (shape, size, elevation, surface, margin, color, odor, and pigmentation) and Gram staining to differentiate Gram negative and positive bacteria. Biochemical tests including catalase, oxidase, citrate utilization, Voges-Proskaeur, and methyl-red was carried out on the isolates [22-23]. The morphological and biochemical characteristic of the isolates was compared with the Bergeys Manual of Determinative Bacteriology (1994).

2.5 Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 17.0 for Windows (SPSS, Chicago IL, and U.S.A).

2.6 Ethical approval

Ethical clearance for the study was obtained from both State Ministry for Health & Education (HPRS/381/125); Ogun State and Ethical Review Committee from College of Biosciences (COLBIOS), FUNAAB.

3 Results and Discussion

Bacterial isolates from the sample were morphologically and biochemically identified; bacteria identified include *Bacillus subtilis, Bacillus mycoides, Bacillus megaterium, Pseudomonas aeruginosa, Pseudomonas fluorescens, Enterobacter sp, Escherichia coli, Citrobacter freudii, Klebsiella oxytoca, Staphylococcus aureus, and Staphylococcus saprophyticus* (Table 2). The distribution of the bacteria isolates among the swab samples of the three Local Government Areas shows that the swab samples of fomites taken from Abeokuta North, Abeokuta South and Odeda Local Government Areas have identical bacteria species.

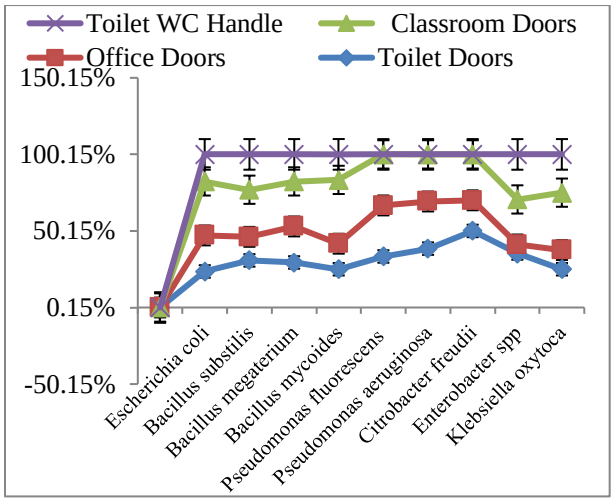

Figure 1: Prevalence of Bacteria per fomites in Odeda Local Government Area of Abeokuta Environs

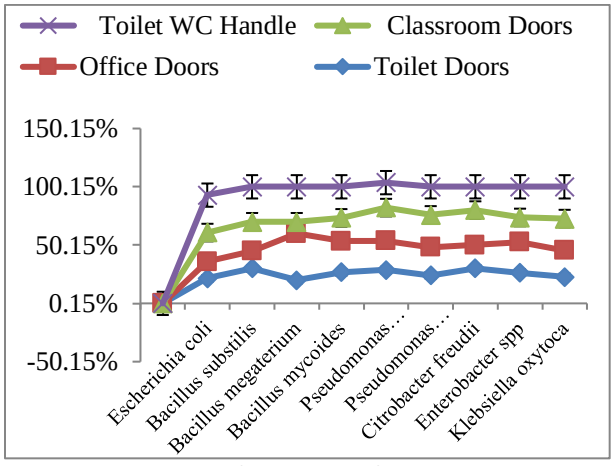

Figure 2: Prevalence of Bacteria per fomites in Abeokuta North Local Government Area of Abeokuta Environs

3.1 Prevalence of identified bacteria species

Figure one, two and three shows the prevalence of bacteria isolate per fomites obtained from the three Local Government Areas. *E. coli* had the highest prevalence from the toilet WC handle sampled from all 3 LGAs; other prevalence rate include *Bacillus subtilis* (17.66 %), *Bacillus mycoides* (16 %), *Bacillus megaterium* (12.33 %), *Pseudomonas aeruginosa* (18 %), *Pseudomonas fluorescens* (18 %), *Enterobacter spp* (16 %), *Escherichia coli* (19.67 %), *Citrobacter freudii* (10.33 %), *Klebsiella oxytoca* (16 %), *Staphylococcus aureus* (14 %), *and Staphylococcus saprophyticus* (7 %).

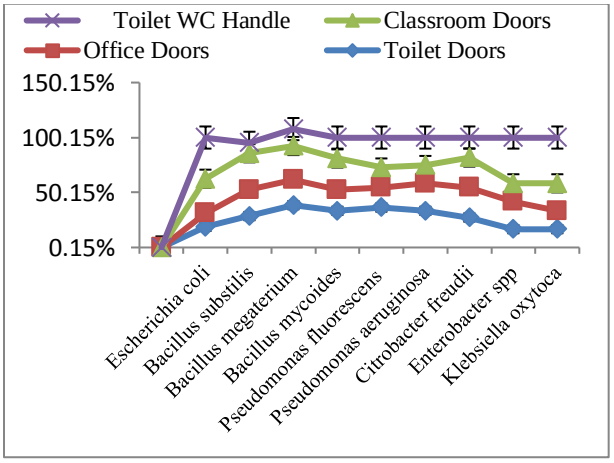

Figure 3: Prevalence of Bacteria per fomites in Abeokuta South Local Government Area of Abeokuta Environs.

The results of the present study revealed contamination of almost all the fomites collected from selected community schools within Abeokuta with different microorganisms which are significantly higher. Medically important microorganisms were isolated from external surfaces of fomites (door handles), the difference being statistically significant (P <0.05); which include *Bacillus subtilis* (17.66 %), *Bacillus mycoides* (16 %), *Bacillus megaterium* (12.33 %), *Pseudomonas aeruginosa* (18 %), *Pseudomonas fluorescens* (18 %), *Enterobacter sp* (16 %), *Escherichia coli* (19.67 %), *Citrobacter freudii* (10.33 %), *Klebsiella oxytoca* (16 %), *Staphylococcus aureus* (14 %), *and Staphylococcus saprophyticus* (7 %). They were all isolated from fomites such as classroom, office, toilet and toilet water closet door handles in selected secondary schools within Abeokuta environs (Abeokuta North LGA, Abeokuta South LGA and Odeda LGA). It has been well documented that contaminated public surfaces spread infectious doses of pathogens to the mouths of exposed individuals following handling [21, 24].

Isolation of *E. coli* which had been detected in all fomites from schools sampled mean that students are constantly in contact with diarrhoeagenic bacteria which is on the increase in country [25]; which is as a result of lack of good sanitary disposal in each school visited. Pathogen survival on fomites is an important factor in evaluating exposure potential.

Table 2: General Morphological, biochemical characteristics and probable identity of bacteria isolated from fomites

S/N	Morphology	Gram	Motility	Glucose	Lactose	Mannitol	Maltose	Indole	Methyl Red	Voges proskauer	Citrate	Novobiocin	H_2S	Sucrose	Urea	Oxidase	Coagulase	Catalase	Probable Identitiy
1	Rod	+	+	+	+	+	-	-	-	+	+		-	+	-	-	NR	+	*Bacillus mycoides*
2	Rod	+	+	+	+	+	+	-	-	+	-		-	+	-	-	NR	+	*Bacillus subtilis*
3	Rod	+	+	+	+	+	+	-	-	-	-		-	+	-	-	NR	+	*Bacillus megaterium*
4	Rod	+	+	+	+	+	+	+	+	-	+		+	+	-	-	-	+	*Citrobacter freudii*
6	Rod	-	+	+	+	+	+	+	+	-	-		-	NR	-	-	NR	+	*Escherichia coli*
7	Rod	+	+	+	+	-	-	-	-	-	+		-	+	-	-	NR	+	*Pseudomonas aeruginosa*
8	Cocci	+	-	+	+	+	+	NR	+	-	+	-	-	+	+	-	-	+	*Staphylococcus saphrophyticus*
9	Rod	-	+	+	-	+	+	-	+	+	+		+	+	+	+	NR	+	*Pseudomonas fluorescens*
10	Rod	-	-	+	+	+	+	-	-	-	+		-	+	-	-	-	+	*Klebsiella oxytoca*
11	Rod	-	+	+	+	+	+	-	-	-	+		-	+	-	-	-	+	*Enterobacter spp*
12	Rod	+	+	+	+	+	+	-	-	-	-		-	+	-	-	NR	+	*Bacillus megaterium*
13	Cocci	+	-	+	+	+	+	NR	+	-	+	+	-	+	+	-	-	+	*Coagulase negative Staphylococcus aureus*

Key: NR= No Reaction, + = Positive Reaction, −= Negative Reaction.

The results of this study suggest further evaluation of student's classroom handle (fomites) as a priority target site, based on the frequency of samples positive for microorganisms of public Health importance and the potential for exposure to the students, a population recognized as being more susceptible to adverse outcomes following exposure to pathogenic microbes [26-28].

The risk of disease transmission via surfaces (fomites) involves a number of factors including the frequency of site contamination and exposure; level of pathogen excreted by the host; likelihood of transfer of the infectious agent to a susceptible individual; virulence of the organism, immunocompetence of the persons in contact; and the practice of control measures (i.e. disinfectant use and personal hygiene) and other factors; although detection of a pathogen does not necessarily determine the risk of infection and disease manifestation in their host.

4. Conclusion

Hygienic measures such as hand washing should be encouraged in schools across Abeokuta environs and other part of the country to prevent the spread of infectious organisms amongst students and staffs in order to create the necessary conditions that enable every child to succeed and part of which is making the school environment free from pathogenic microorganisms that might impair learning process in students.

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