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# Microbiological Assessment of Day Care Fomites and Air Quality in Ayobo Community, Lagos

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**Abstract**

The microflora of fomites and air in day-care centres was investigated using standard microbiological procedures. Each of these samples was collected twice in a day, after and before sanitation. The total heterotrophic bacterial and fungal count of samples collected after sanitation ranged from $5.2x10^6$ to $2.88x10^7$ CFU/ml, and from $1.0x10^6$ to $8.0x10^6$ CFU/ml, respectively, while samples collected before sanitation ranged from $6.5x10^6$ to $2.88x10^7$ CFU/ml, and from $1.0x10^6$ to $9.7x10^6$ CFU/ml, respectively. The microorganisms isolated in the study included: *Staphylococcus aureus, Serratia spp., Shigella flexneri, Citrobacter spp., Salmonella typhi, Pseudomonas aeruginosa, Enterobacter aerogenes, Proteus vulgaris, Escherichia coli, Aspergillus niger, Penicillium chrysogenum, Aspergillus flavus,* and *Rhizopus stolonifer*. Data on the assessment of the day-care indoor environment were obtained using a questionnaire. Due to some suspected factors, such as seasonal climatic changes and poor hygiene practices, a high record of resistance of the microorganisms to most antibiotics was observed. All Gram-negative bacteria isolated were resistant to Septrin and Chloramphenicol, while *Serratia sp., Citrobacter spp., S. typhi, P. aeruginosa, E. aerogenes* and *P. vulgaris* were susceptible to one or several antibiotics. Sanitation is a tool used to control the presence and spread of pathogenic microorganism, but only when carried out using an appropriate and effective method. Every day-care centre should ensure they always practice and teach good hygiene for the safety and wellbeing of the children.

**Keywords**: antibiotics, day-care, fomites, hygiene, microbial flora, sanitation

**Резюме**

Микрофлората на фомитите и въздуха в дневните центрове е изследвана с помощта на стандартни микробиологични процедури. Всяка от тези проби се събира два пъти на ден, след и преди саниране. Общият брой хетеротрофни бактерии и гъбички в пробите, събрани след саниране, варира съответно от $5.2x10^6$ до $2.88x10^7$ CFU/мл и съответно от $1.0x10^6$ до $8.0x10^6$ CFU/мл, докато пробите, събрани преди санирането, варират от $6.5x10^6$ до $2.88x10^7$ CFU/мл и съответно от $1.0x10^6$ до $9.7x10^6$ CFU/мл. Микроорганизмите, изолирани в изследването, включват: *Staphylococcus aureus*, *Serratia* spp., *Shigella flexneri*, *Citrobacter* spp., *Salmonella typhi*, *Pseudomonas aeruginosa*, *Enterobacter aerogenes*, *Proteus vulgaris*, *Escherichia coli*, *Aspergillus niger*, *Penicillium chrysogenum, Aspergillus flavus u Rhizopus stolonifer*. Данните за оценката на закритата дневна детска стая са получени с помощта на въпросник. Поради някои предполагаеми фактори, като сезонни климатични промени и лоши хигиенни практики, се наблюдава висока резистентност на микроорганизмите към повечето антибиотици. Всички изолирани грам-отрицателни бактерии са резистентни към септрин и хлорамфеникол, докато *Serratia* sp., *Citrobacter* spp*., S. typhi, P. aeruginosa, E. aerogenes* и *P. vulgaris* са податливи на един или няколко антибиотика. Хигиенизирането е инструмент, използван за контрол на наличието и разпространението на патогенни микроорганизми, но само когато се извършва с помощта на подходящ и ефективен метод. Всеки детски център трябва да гарантира, че практикува и преподава добра хигиена по всяко време за безопасността и благосъстоянието на децата.

## Introduction

Understanding the microbial community structure of a built environment is important because human beings spend >90% of their time in indoors (Santos *et al.,* 2012), and evidence is accumulating that both human and environmental

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microbiomes shape human health (Chen *et al*., 2012). In some studies, the microbiome of fomites in university classrooms, offices, restrooms, subways, residences, health care facilities and other settings has been researched on (Li *et al.,* 2014; Afolabi *et al.,* 2018), but there is paucity of data on children's day- care centres in Lagos, Nigeria.

A day care can be said to be a child-care facility that parents take their children to during the daytime for care, supervision, and learning (Li *et al.,* 2014). Day-care centres typically provide care for infants and pre-schoolers, although some day cares also offer before- and after-school care for school-aged children (Azdogdu *et al.,* 2010), either in their own homes, in the home of a relative or other caregiver, or in a centre-based facility. The workers at the day-care centres take care of the children's requirements in terms of feeding, nurse caring, excretion, and general comforts (Olaitan and Adeleke, 2006).

Infants and young children are more prone to infectious diseases and are more amenable to immediate care because some of the diseases suffered are environmental in origin and can be contained and prevented by an intelligent nurse who has acquired the relevant basic hygiene skills (Azor-Martinez *et al.,* 2018). Studies have revealed that children, including babies and infants within the ages of 6 months to 4 years, gain from the day-care environment, including its quality instruction, structure, and social lessons (Santos *et al*., 2012). In addition, their staff are trained and supervised, there are more resources and equipment available, care is still available when a staff member is absent, the centres are more likely to be licensed and subject to state regulation. Children in centre-based care exhibit slightly better cognitive development than those cared for in homes, possibly because they have more opportunities to relate with other children and are exposed to more learning materials (Afolabi *et al.,* 2018). While some of the disadvantages are costs which are higher than other types of care, the background of staff can vary greatly, and there is often greater staff turnover, larger groups of children may mean less individual attention for the child, and there is a greater likelihood of exposure to communicable illnesses (Li *et al.,* 2014).

Children in the day-care centres are exposed to infection due to contact with the physical environment of the place (Azor-Martinez *et al.,* 2018). Dirty environment may harbour infectious agents and predispose to skin infections (Adeleke *et al.,* 2012). A good day care is however able to keep its environment in good working order, free from all preventable epidemics (Adedire *et al.,* 2016). Day-care centres have been implicated as settings for the spread of communicable diseases, especially diarrhoea, among young, susceptible children (1-5years) due to poor hygiene with the staff of the day care (Azor-Martinez *et al.,* 2018).

Fomites are inanimate objects that become colonized with microbes and serve as potential intermediaries for transmission to humans (Santos, 2012). Fomites carry and spread disease and infectious agents; they can also be called passive vectors. There is a huge array of everyday objects that can become fomites if they come into contact with infectious agents, such as a range of microbes, viruses, bacteria, and fungi (Aydogdu *et al.,* 2010). Fomites in day cares include children's toys, furniture, cots, couches, tables, toilet seats, door knobs, etc. In this research, a few of these fomites were used as a case study, which included door and toilet handles, floors, toys, baby cots, and also the air quality.

Based on the increase in the demand for day-care centres to care for infants in various communities, there has been a prevailing increase in the rate of infection among the children at these day-care centres (Olaitan and Adeleke, 2006). Due to the limited study of the microbiome on fomites and indoor air in children's day-care centres majoring on the impact sanitation has in preventing the spread and recurrence of infections on the children. This study was aimed at discovering the observable impact sanitation has in reducing or eradicating the microorganisms present in day-care centres. The aim of this study was to assess the microbiome present on the day-care fomites and indoor air after sanitation and before sanitation, and to discover the impact sanitation has in reducing the rate of children's exposure to infections.

## Materials and Methods

*Sampling sites*

Samples were collected from three different day-care centres located in Ipaja Ayobo Local Government Area of Lagos State, Nigeria. The study was carried out in October 2020, within the duration of three weeks.

*Sampling*

Permission was taken from the authorities of the day-care centres prior to sample collection. Samples were collected in the morning after proper cleaning, and disinfection of the day care was

carried out and in the afternoon after the day's activities had ended. A total of 30 samples were collected from all day-care centres. The samples collected were from day-care fomites (floors, door knobs, toys, and cots) and indoor air.

The medium used (Nutrient, MacConkey and potato dextrose agar) was prepared according to manufacturer's instruction. The settling plate technique was employed to sample air and swab stick was used for collection of samples on the fomites in the day-care centres. All the samples obtained were cultured using standard microbiological procedures.

*Characterization and identification of isolates*

The bacterial isolates were characterized on the basis of their colonial morphology, cellular morphology, Gram stain and biochemical reactions. The biochemical tests included: catalase test, oxidase, starch hydrolysis, citrate utilization, coagulase, triple sugar iron agar, carbohydrate fermentation, oxidative and fermentative utilization of sugars (Fawole and Oso, 2007). Similarly, the fungal isolates were characterized based on their macroscopic and microscopic characteristics.

*Antibiotic susceptibility test*

The antibiotics susceptibility test of the isolates was carried out using the Kirby-Bauer disk diffusion technique, according to the methods recommended by the Clinical Laboratory and Standards Institute (CLSI, 2018). The antibiotic discs used were: SXT; Septrin (30 µg), R; Rocephin (25 µg), AM; Amoxacillin (36 µg); CN; Gentamycin (10 µg), PEF; Pefloxacin (10 µg), APX; Ampiclox (30 µg), S; Streptomycin (30 µg), E; Erythromycin (10 µg) for Gram-negative isolates. while SXT; Septrin (30 µg), CH; Chloranphenicol (30 µg), SP; Sparfloxacin (10 µg), CPX; Ciprofloxacin (30 µg), AM; Amoxacillin (30 µg); AU; Augmentin (10 µg), PEF; Pefloxacin (30 µg), OFX; Tarivid (10 µg) for Gram-positive isolates. After incubation, the test plates were examined for confluent growth and zone of inhibition.

*Sanitary appraisal*

Each of the day-care centres was examined for possible sources of contamination using parameters such as number of babies, nature of floor, methods of cleaning the floor, frequency of floor cleaning, whether the windows and doors were screened with nets or not, and whether the children were allowed to wear footwear or not.

*Statistical analysis*

Statistical analysis package SPSS 20.0 was used to determine the mean, range, standard deviation, Wilcoxon Test and one way analysis of variance was used to determine the differences within the means.

**Results**

Table 1 shows that the bacterial count of the air, floor, doorknob, toy and cot samples after sanitation ranged from $7.2x10^6$ to $2.02x10^7$ CFU/ml; $1.33x10^7$ to $2.71x10^7$ CFU/ml; $5.2x10^6$ to $1.79x10^7$ CFU/ml; $2.15x10^7$ to $2.88x10^7$ CFU/ml and $1.74x10^7$ to $2.24x10^7$ CFU/ml, respectively. The bacterial count of the air, floor, doorknob, toy and cot samples before sanitation ranged from $6.5x10^6$ to $1.92x10^7$ CFU/ml; $8.4x10^6$ to $2.88x10^7$ CFU/ml; $9.4x10^6$ to $7.8x10^6$ CFU/ml; $1.05x10^7$ to $2.67x10^7$ CFU/ml and $1.11x10^7$ to $2.55x10^7$ CFU/ml, respectively. The bacterial species identified were *Staphylococcus aureus, Serratia* sp*., Shigella* sp*., Citrobacter* sp*., Proteus* sp*., Salmonella typhi, Enterobacter aerogenes, Escherichia coli, Klebsiella* sp., and *Pseudomonas aeruginosa.*

Table 2 shows that the fungal counts of the air, floor, doorknob, toy and cot samples before sanitation ranged from $2.5x10^6$ to $8.0x10^6$ CFU/

**Table 1**. Total heterotrophic bacterial colony count

| Total Heterotrophic Bacteria Count (CFU/ml) | | | | | | |
|---|---|---|---|---|---|---|
| Sample | Day care Centre 1 | | Day care Centre 2 | | Day care Centre 3 | |
| | After Sanitation | Before Sanitation | After Sanitation | Before Sanitation | After Sanitation | Before Sanitation |
| Air Sample | $2.02 \times 10^7$ | $1.25 \times 10^7$ | $7.2 \times 10^6$ | $6.5 \times 10^6$ | $1.70 \times 10^7$ | $1.92 \times 10^7$ |
| Floor | $1.33 \times 10^7$ | $1.32 \times 10^7$ | $1.57 \times 10^7$ | $8.4 \times 10^6$ | $2.71 \times 10^7$ | $2.88 \times 10^7$ |
| Door Knob | $1.79 \times 10^7$ | $7.8 \times 10^6$ | $5.2 \times 10^6$ | $9.4 \times 10^6$ | - | - |
| Toy | $2.88 \times 10^7$ | $1.22 \times 10^7$ | $2.20 \times 10^7$ | $1.05 \times 10^7$ | $2.15 \times 10^7$ | $2.67 \times 10^7$ |
| Cot | $2.01 \times 10^7$ | $1.21 \times 10^7$ | $1.74 \times 10^7$ | $1.11 \times 10^7$ | $2.24 \times 10^7$ | $2.55 \times 10^7$ |

**Table 2**. Total Heterotrophic Fungi colony count

| Total Heterotrophic Fungi Count (CFU/ML) | | | | | | |
|---|---|---|---|---|---|---|
| Sample | Day care Centre 1 | | Day care Centre 2 | | Day care Centre 3 | |
| | After Sanitation | Before Sanitation | After Sanitation | Before Sanitation | After Sanitation | Before Sanitation |
| Air | $9.7 \times 10^6$ | $7.0 \times 10^6$ | $8.0 \times 10^6$ | $2.5 \times 10^6$ | $6.0 \times 10^6$ | $8.0 \times 10^6$ |
| Floor | $6.0 \times 10^5$ | $3.0 \times 10^6$ | $2.0 \times 10^6$ | $1.4 \times 10^6$ | $1.0 \times 10^6$ | $5.0 \times 10^6$ |
| Door Knob | 0 | 0 | 0 | $1.0 \times 10^6$ | - | - |
| Toy | 0 | $2.0 \times 10^6$ | $1.0 \times 10^6$ | $1.0 \times 10^6$ | $1.0 \times 10^6$ | $1.0 \times 10^6$ |
| Cot | $2.0 \times 10^6$ | $8.0 \times 10^6$ | $2.0 \times 10^6$ | $2.0 \times 10^6$ | $3.0 \times 10^6$ | $5.0 \times 10^6$ |

**Table 3**. Sanitary appraisal

| Parameters | Day care 1 | | Day care 2 | | Day care 3 | |
|---|---|---|---|---|---|---|
| Age group | 4 months – 2 years | | 4 months – 6 years | | 1 year – 6 years | |
| Activities | Taking care of the children until parent closes from work | | Taking care of the children until parent closes from work and teaching them academic work. | | Taking care of the children until parent closes from work and teaching them academic work. | |
| Hand washing Practice | Never thought the children hygiene practice | | Constantly thought on hygiene practice | | Seldomly thought | |
| Population | Boys | Girls | Boys | Girls | Boys | Girls |
| | 5 | 4 | 4 | 6 | 4 | 4 |
| Attendance | Never regular | | Seldomly regular | | regular | |
| No. of rooms | 2 | | 5 | | 1 | |
| No. of windows | 2 | | More than five | | 1 | |
| Wearing of Foot wears | Not allowed | | Not allowed | | allowed | |
| Availability of disinfectant | Seldomly available | | Always available | | Seldomly available | |
| Frequency of Cleaning toys | often | | sometimes | | never | |
| Time of Sanitation | In the morning and afternoon | | In the morning and afternoon | | In the morning alone | |
| Cleaning Method | Sweeping and mopping with detergent and disinfectant | | Sweeping and mopping with detergent and disinfectant | | Sweeping alone | |
| Disposal of Waste | Wastes are covered outside | | Waste disposing vehicle | | Wastes are covered outside | |
| Immunization | often immunized | | Seldomly immunized | | Seldomly immunized | |
| Electricity | stable | | stable | | | |
| Location | Far away from the main road | | Close to the main road | | Close to the main road | |
| Screened net | All screened | | All screened | | Not screened | |

ml; $1.4x10^6$ to $5.0x10^6$ CFU/ml; $1.0x10^6$ CFU/ml; $1.0x10^6$ to $2.0x10^6$ CFU/ml, and $2.0x10^6$ to $5.0x10^6$ CFU/ml, respectively.

The fungal counts of the air, floor, doorknob, toy and cot samples after sanitation ranged from $6.0x10^6$ to $9.7x10^6$ CFU/ml; $1.0x10^6$ to $6.0x10^6$ CFU/ml, 0 CFU/ml; $1.0x10^6$ CFU/ml and $2.0x10^6$ to $3.0x10^6$ CFU/ml, respectively. The fungal species identified were *Aspergillus niger, Penicillium chrysogenum, Aspergillus flavus, Rhizopus stolonifer*. The mean total heterotrophic bacterial count (THBC) and total heterotrophic fungal count (THFC) before and after sanitation was not statistically significant ($Z=-0.664$, $\rho > 0.05$) and ($Z$ -0.460, $\rho > 0.05$), respectively.

Table 3 shows the sanitary appraisal of the day-care centres and reveals the possible sources of contaminations.

In centre 3, children were allowed to put on footwear, as many as 8 children were kept in a room with just one window (poor ventilation and over population), cleaning of the floor was done with just water and only in the morning and children's toys were never cleaned. In centres 1 and 2, hygiene practice was carried out constantly and the children also practiced hand washing techniques, the rooms were relatively ventilated, and the floors were cleaned with adequate cleaning materials twice daily.

Table 4 shows the mean microbial load from the different samples obtained from the day-care centres. Microbes were isolated from the air, floors, door knobs, toys and cots. For air samples, the mean of the After Sanitation Bacteria Count (ASB) ($3.64x10^4$) was more than the mean of the Before Sanitation Bacteria Count (BSB) ($3.22x10^4$). Also, for the samples obtained from the toys, the mean ASB ($2.44x10^4$) was higher than the mean BSB ($1.65x10^4$). For the floor samples, the mean ASB ($2.33x10^4$) was lower than the mean BSB ($5.73x10^4$). The mean ASB for Doorknob was also lower ($2.33x10^4$) than BSB ($5.73x10^4$). The Mean ASB for the cots in the day-care centre ($2.00x10^4$) was also lower than the mean obtained before ($2.89x10^4$) the sanitation. All in all, the mean ASB ($2.45x10^4$) was lower than the BSB ($3.54x10^4$).

The mean ASF for the air sample was higher ($7.90x10^4$) than the BSF ($5.83x10^4$). But for the floor sample, the mean ASF ($3.00x10^4$) was lower than the counts obtained before sanitation ($3.13x10^4$).

**Table 4**. Mean Total Microbial Count Mean±Standard Deviation ($10^4$)

| | ASB | BSB | ASF | BSG |
|---|---|---|---|---|
| Air | 3.64±3.1 | 3.22±2.86 | 7.90±1.85 | 5.83±2.91 |
| Floor | 2.33±2.64 | 5.73±5.03 | 3.00±2.65 | 3.13±1.80 |
| Door Knob | 2.33±2.64 | 5.73±5.03 | 0.00±0.00 | 3.33±5.77 |
| Toy | 2.41±4.01 | 1.65±5.77 | 6.67±5.77 | 1.33±5.77 |
| Cot | 2.00±2.50 | 2.89±2.35 | 2.33±5.77 | 5.00±3.00 |
| Total | 2.45±1.70 | 3.54±3.10 | 2.78±3.14 | 3.13±2.79 |

Key: ASB: After sanitation bacterial count; BSB: Before sanitation bacterial count; ASF: After sanitation fungal count; BSF: Before sanitation fungal count

**Table 5.** Antimicrobial sensitivity pattern of Gram-negative bacteria

| Organism | AU | CN | PEF | AM | OFX | S | SXT | CH | SP | CPX |
|---|---|---|---|---|---|---|---|---|---|---|
| *Serratia sp.* | S | R | R | S | R | R | R | R | S | S |
| *S. flexneri* | R | R | R | R | R | R | R | R | R | R |
| *Citrobacter spp.* | R | R | S | R | R | R | R | R | R | R |
| *S. typhi* | S | S | S | S | S | S | R | R | S | R |
| *P. aureginosa* | R | R | R | R | R | R | R | R | R | S |
| *E. aerogenes* | R | R | R | S | R | R | R | R | S | R |
| *P. vulgaris* | R | R | S | R | R | R | R | R | R | S |
| *E. coli* | R | R | R | R | R | R | R | R | R | R |

Key: AU-Augmentin, CN- Gentamicin, PEF- Pefloxacin, AM- Amoxicillin, OFX- Tarivid, S-Streptomycin, SXT- Septrin, CH- Chloramphenicol, SP- Septrin, CPX- Ciprofloxacin, R- Resistance, S-Susceptible.

For the door knobs, the mean score before sanitation ($3.64x10^4$) was higher than the mean count obtained after sanitation ($0.00x10^4$). The toys used in the day-care centre had higher ASF ($6.67x10^4$) than the BSF ($1.33x10^4$), while for the cots the BSF was higher before sanitation ($5.00x10^4$) than the ASF ($2.33x10^4$). All in all, the ASF ($3.64x10^4$) was lower than the count obtained before sanitation of the day-care centres. The population of microbial contamination in the indoor air of the day-care centres was relatively higher than the population of microbes isolated from fomites present in the day-care centres.

Table 5 describes the antibiotic sensitivity test results of the Gram-negative bacteria (*Serratia, Shigella, Citrobacter, Salmonella, Pseundomonas, Enterobacter, Proteus* and *E. coli*) isolated from the day-care centres and it shows multidrug resistance to some antibiotics (Gentamicin, Tarivid and Chloramphenicol) with some sensitivity to Pefloxacin, Ciprofloxacin and Septrin.

Table 6 describes the antibiotic sensitivity test results of the Gram-positive bacteria (*S. aureus*) isolated from the day-care centres and shows multidrug resistance to some antibiotics (Erythromycin, Septrin, Streptomycin, Gentamicin, Amoxicillin, Ciprofloxacin and Tetracycline) with some sensitivity to Pefloxacin and Ampiclox. *S. aureus* showed marked resistance to all antimicrobials except fluoroquinolones (Ampiclox and Pefloxacin).

**Table 6.** Drug sensitivity pattern of Gram-positive bacteria

| Organism | APX | Z | CN | PEF | AM | E | CPX | S | SXT |
|---|---|---|---|---|---|---|---|---|---|
| *S. aureus* | S | R | R | S | R | R | R | R | R |

Key: Z- Tetracycline; CN- Gentamicin, PEF- Pefloxacin, AM- Amoxicillin, S- Streptomycin, SXT- Septrin, SP- Septrin, CPX- Ciprofloxacin, APX Ampiclox, E-Erythromycin, R- Resistance, S- Susceptible.

## Discussion

This research demonstrated the presence of bacteria and fungi on the floors, door knobs, toys, cots and air of three day-care centres within Ayobo-Ipaja. The bacteria species identified were *S. aureus, Serratia sp., Shigella sp., Citrobacter sp., Proteus sp., S. typhi, E. aerogenes, E. coli, Klebsiella sp., P. aeruginosa,* and *Micrococcus sp*. Most of these organisms were Gram-negative bacteria, with only one Gram-positive bacteria. In a related study, *S. aureus, Bacillus spp., Klebsiella sp., Proteus sp., S. faecalis, P. aeruginosa, E. coli, S. dysenteriae, E. aerogenes* and *Micrococcus spp.* were isolated from the fomites of day-care centres in Abeokuta, Ogun, Nigeria (Olaitan and Adeleke, 2006).

Indoor and outdoor microflora are inevitable in our immediate environment as a result of activities of man like raising dust, wearing shoes from outdoor into indoor. Some of the organisms isolated in this study are pathogenic and could be dangerous to human health. *S. aureus* is ubiquitous and may be a part of human flora. Persistent carriage of this organism is more common in children than in adults. Some individuals are regarded as nasal carriers and they may be divided into persistent carriers with high risk of infection and intermittent or non-carriers with low risk of infection (Li *et al*., 2014). This organism also elaborates toxins that can cause specific diseases or syndromes (Adeleke *et al.,* 2012).

*Proteus spp.* is most commonly found in the human intestinal tract as part of the normal human intestinal flora. Inoculum size is important, and it has a positive correlation with the risk of infection (Luzzaro et al., 2009). *E coli* normally live in the intestines of healthy people, but some strains can cause infections in the digestive tract, urinary tract, or many other parts of the body. Most types of *E. coli* are harmless or cause relatively brief diarrhoea (Aydogdu *et al.,* 2010). Few strains such as *E. coli* O157:H7 can cause severe stomach cramps, bloody diarrhoea and vomiting. Young children have greater risk of developing a life-threatening form of kidney failure. *Serratia spp., Klebsiella sp.,* and *Enterobacter sp.* are opportunistic Gram-negative bacteria that may infect the urinary or respiratory tract. Rarely *Klebsiella* causes pneumonia in individuals with weakened immune systems (children). *P. aeruginosa* is a Gram-negative organism that can infect the blood, skin, bones, ears, eyes, urinary tract, heart valves, and lungs, as well as wounds.

The results showed the effect of sanitation on the microbial community of these day cares as follows: there was a decrease in the total heterotrophic count for most bacteria after sanitation and an increase before sanitation, also the absence of some bacteria and fungi was noticed after sanitation, while they were present before sanitation. It is also very important to note that for some of the day-care centres that had the organism present after and before sanitation, poor sanitation method was observed to be the cause. Cleaning and disinfection are basically two separate processes and thorough cleaning must be done prior to disinfectant

use (Chen *et al.,* 2012). The fungal species isolated could also have implications on the health of the children in the day-care centres.

The antibiotic susceptibility test showed multidrug resistance of some of the isolated organisms to antimicrobials. It can be concluded that the children are at higher risk of being infected and spreading these infections due to the presence of these resistant pathogens.

Ventilation systems have a significant effect on indoor air pollutant levels (Aydogdu *et al*., 2010). These findings agree with the findings of Afolabi *et al.* (2018), who disputed those high bacteria counts are associated with high occupancy, poor hygienic conditions of the occupants, and also inadequate ventilation (Azor-Martinez *et al.,* 2018).

One of the fungi genera found in this study was *Rhizopus spp*., which is a fast-growing colony commonly found in indoor environments. The distinctive and most important fungal genera found in the air were *Aspergillus* spp. and *Penicillium* spp., which are closely similar to the fungi collected from different indoor environment (Chen *et al.,* 2012), such as campus schools, houses and hospitals (Afolabi *et al.,* 2018). A study done in Singapore found that the most common fungi present in day-care centres were *Aspergillus*, and *Penicillium* (Chen *et al.,* 2012), which correlates with our findings. The sanitary appraisal of the floors revealed the possible sources of contaminations of the floors to be children's footwear, population and the health status of the children. Santos *et al*. (2012) observed that gastrointestinal diseases continue to be a major health problem in primary schools in the United Kingdom due to surface contamination of carpets.

## Conclusion

Infection is spread most often by children handling contaminated fomites. Dirty environment is one of the sources of infection in day cares. It was observed that despite cleaning the day care, some infectious agents were still present. Therefore, proper cleaning and disinfection of day-care centres is vital to curb the spread and recurrence of infections.

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