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# Microbial Pollution of Indoor Air of the Federal Polytechnic Ede Medical Centre

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**Abstract: Indoor air pollution is a menace to health and wellbeing of the global population. Bacteria and fungi pollution in medical facility may be associated with infections acquired in the facilities. The indoor atmosphere of medical facility can harbor a diverse population of microorganisms which could be airborne and fundamental in infections and sickness to the teaming visitors or patients. The indoor air of different section of the federal polytechnic Ede medical center was assessed for bacteria and fungi. Sterile Nutrient Agar plates and Potato-Dextrose Agar plates were exposed for few minutes in the different section, culture were incubated, observed and enumerated after 24 hours, pure culture isolated for identification and antibiotics sensitivity was observed for each isolate using disc diffusion method. Results shows that *Klebsiella edwardsii, Klebsiella pneumonia* are more frequent in the different sections, *Klebsiela ozoenae, Staphylococcus aureus, Staphylococcus epidermidis, Pseudomonas auriginosa, Micrococcus luteus* are some other bacteria species isolated from the different section observed and fungi isolated includes *Aureobasidium pullulans, Rhizopus oryzae, Rhizopus japanicus, Penicillium camemberti, Neurospora sitophila* and a yeast *Rhodotorula sp*. Colony count for bacteria in all section of the health facility ranges from 20 to 200 count per plate while fungi count ranges between 10 to 90 per plate. The reception and the nurses section were more polluted, they have the highest colony count for bacteria and fungi compare to other section. Results show that 75% of the isolated bacteria were highly susceptible to chloramphenicol and ciprofloxacin, and resistance was observed in 40% of the antibiotics used.**

**Keywords : indoor-Air, Pollution, Bacteria, Fungi, Health-facility**

## STUDY BACKGROUND

Indoor air quality of a building facility is significant to health of the dwellers and visitors. Indoor air quality is a complex and dynamic system, containing biological and non-biological contaminants which are air inhaled by people and is abundantly populated with microorganisms such as dust mites, moulds, fungus and bacteria which form so-called bio-aerosol (Di Carlo *et al*., 2016), Pereira *et al*., 2017). Possible sources of microbial contamination of indoor air includes: people, organic dust, various materials stored in the buildings, the inflowing air from the ventilation spaces and air conditioning systems (Aaron et al., 2015). The presence of bacteria and fungi in indoor air pose a serious problem concerning health protection and environmental wellbeing (Pereira *et al*., 2017). Indoor air pollution result when gaseous or particulate contaminant are released and are increased by adequate ventilation, high temperature and high humidity (Moustafa, 2017). Lucretius, a great philosopher saw dust motes in a sun beam in a dark room and considered the possibility that the motes might carry pestilences (Gregory, 2015: Millar and Keller, 2011) since then it has been well documented that some diseases are transmitted via airborne route.

The indoor environment can potentially place human occupant at a great risk because enclosed air spaces can confined bio-aerosol and allowed them to build up to infectious level (Spendlove and Fannin, 2013). Air, acting as a medium for the transmission or dispersal, contains significant number of microorganisms and carries dust, allergies, moulds spores, exhaust fumes, formaldehydes, organic compounds and other aerosol produced from activities conducted within the building and the inflow air (Srinivasan, 2013). Therefore, there is need to approximate the level of contamination of our environmental air and ascertain the group of microorganism present.

Several studies have recently investigated the concentration of biological particles, such as bacteria and fungi in various indoor environments. Biological particles, comprising bacteria and fungi, contribute about 5% to 34% of the indoor air pollution (Samson *et al*., 2017: Bipasha *et al*., 2013). Indoor air has more pollution than the

outdoor air (Kotzias, 2011: Seyed *et al.,* 2016) and most people spend about 90% of their time in indoor environments therefore the quality of indoor air could significantly affect our general health (Fekadu and Melaku, 2014). Indoor exposure dose of inhaled microorganisms also depends on the microorganism concentration and the individual's body mass (Bragoszewska, Mainka and Pastuszka, 2016). Henceforth, there is need to have prior knowledge of the microbial particle indoor and the concentration compared to the international standard applicable in society.

Microbial indoor air pollution may increase the risk of irritation sensations, allergic sensitization, acute and chronic respiratory disorders and lung function impairment. Exposure to high concentrations of microbes in the air frequently leads to allergies, asthma, hay fever, pneumonia and opportunistic infections (Moustafa, 2017). In recent years, a dramatic increase in the number of allergic reactions to fungal spores has been observed (Jyotshna and Helmut, 2011). Studies show that young people, including students, constitute a large group of allergy sufferers (Abdel*et al.,* 2018). For this reason, regular monitoring of the indoor air quality in public buildings is fully justified.

This study is aimed at evaluating the microbial contamination of the indoor air, the distribution of bacteria and fungi in different sections of the medical center of the Federal Polytechnic Ede, Osun State Nigeria.

## METHODOLOGY

### Study Environment

The study was performed in the Medical Center of the Federal Polytechnic Ede, Osun State, Nigeria. This Federal government licensed Institution of learning was established in February 1992 to award diplomas and certificates. The Medical Center provides medical services for students and staffs of the institution. In addition, the medical center has different sections which includes; records, reception, laboratory, male ward, female ward, injection room, nurse section, doctor office 1, doctor office 2 and doctor office 3.

### Sampling Techniques

Quadruplicate air samples were collected from the ten (10) different sections as listed above using nutrient agar and potato dextrose agar plates and then exposed. Sample collection was done under ambient room temperature and relative humidity during the visiting hours and under normal ventilation where all windows and doors are kept open and there were mechanical ventilations as well.

Media reparation, culturing, isolation and identification of isolated bacteria and fungi was done under aseptic microbiological laboratory condition using standard microbiological techniques as described by Cowan and Steel (1985) and manual for determinative bacteriology (Bucharnan and Gibbons, 1974).

### Culturing, isolation and identification of existing bacteria

Nutrient Agar (NA) was used as a collecting media for bacterial particles. A volume not less than 27 ml of culture medium was placed in a removable glass Petri-dish where plastic ones should not be used because the static charge generated reduces the collection efficiency. The sampling time was 5 min for each run to avoid overestimation of the particle colonies. The samples were incubated at room temperature for 24 to 48 hours. Colonies on each plate were counted and the concentration of biological particles was estimated as colony forming unit (CFU/m3). Using standard microbiological biochemical identification techniques for differentiating bacteria, each isolates were isolated and identified.

### Culturing, isolation and identification of existing fungi

For collecting fungal particles, Potato Dextrose Agar (PDA), which is a broad spectrum medium for fungi, was used. A volume not less than 27 ml of culture medium was placed in a removable glass Petri-dish and allowed to solidify; plastic petri-dish should not be used because the static charge generated reduces the collection efficiency. The sampling time was 5 min for each run of sampling in the different section to avoid overestimation of the particle colonies. The samples were incubated at room temperature for 2 to 7 days. Colonies on each plate were counted and the concentration of biological particles was estimated as colony forming unit (CFU/m3).

Fungi colony from the cultured plates were aseptically cut and transferred into a fresh culture media to obtain pure colony. The colony morphology was observed and growth characteristics studied macroscopically: stained using lactophenol cotton blue and prepared smear is examined microscopically using X40 objective.

**Antibiotics susceptibility pattern of bacteria isolate**

Sensitivity of isolates to antibiotics was conducted using Kirby-Bauer disc diffusion method (Bauer et al., 1966). 0,2ml of 18 hour old broth culture of each pure isolate was inoculated into 20ml molten Mueller-Hinton Agar (CM 0337). This was carefully rotated to facilitate even distribution and the mixture was pour into a sterile Petri-dish and allowed to solidify. A multidisc antibiotics was equivalently fixed on the solidify media plate and allowed to diffused before it was incubated at 35oC for 24 hours. The susceptibility pattern and zone of inhibition in millimeters (mm) was observed and estimated for each isolated organism. The observation was inference according to Kirby-Bauer chat.

## RESULTS AND DISCUSSION

The bacteria concentration in the different section of the medical center varied significantly. The reception has the highest figure, followed by the nurse section; this may be due partly to the influx of patient, visitors and member of staff of the medical center compared to the other section of the facility. Also, the lowest bacteria concentration was recorded in the doctor offices and female ward this may invariably be as a result of appropriate ventilation and less influx of people coming in at a time. The doctor offices has air conditional fixed and this could help reduce the temperature, humidity and reduce microorganisms in the air space. In addition, *Klebsiela Pseudomonas* and *Klebsiela edwardsii* were significantly present in over a quarter of the sample air space. *Klebsiela ozonarae*, *Pseudomonas aeruginosa* and *Staphylococcus aureus* were isolated in more than 11% of the sample space while *Staphilococcus epidermidis* and *Micrococcus leteus* found in less than one-tenth of the sample space.

Fungal concentration in the different section of the medical facility also varied significantly. The nurse section has the highest fungal isolate, followed by the reception and records; also, this may be as a result of poor ventilation and movement and accessibility of people to this section compared to the other section of the facility.

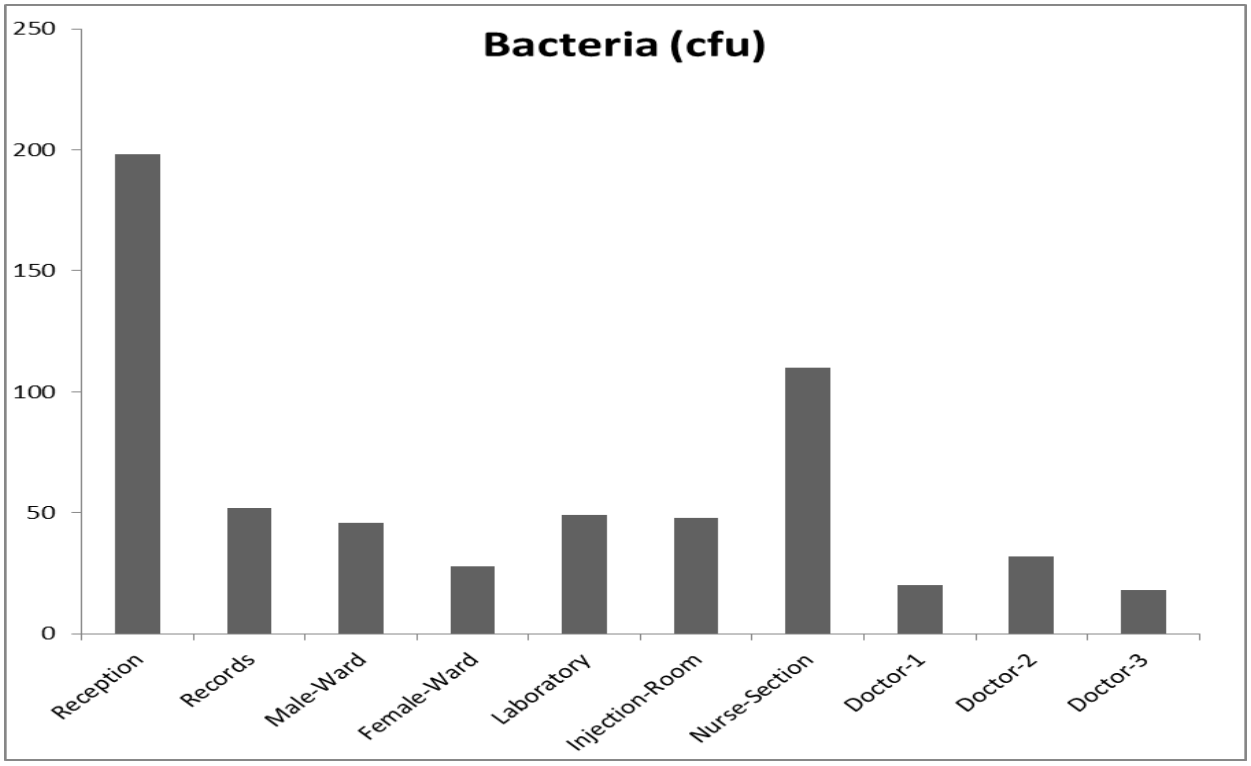


**Figure 1: The average bacteria concentration (CFU/m$^3$) in different section of the sample space is enumerated in figures below;**

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**Table 1: Enumerates the percentage frequency of the different bacteria isolate**

| Bacteria Isolate | Percentage frequency (%) |
|---|---|
| *Klebsiela edwardsii* | 25.0 |
| *Klebsiela pneumonia* | 27.8 |
| *Klebsiela ozonenae* | 11.1 |
| *Staphylococcus aureus* | 11.1 |
| *Staphylococcus epidermidis* | 8.3 |
| *Micrococcus leteus* | 5.6 |
| *Pseudomonas aeruginosa* | 11.1 |

The lower fungal concentration was recorded in the laboratory and the male ward, this may be due to the fact that the laboratory is well ventilated, air conditioned and has restricted access. In addition, six isolates of fungi were cultured from the different sampling section spaces; five moulds – *Aureobasidium pullulans*, *Rhyzopus oryzae*, *Rhyzopus japanicus*, *Penicillium camemberti* and *Neurospora sitophila*, and one yeast, a *Rhodotorula Spp*. The moulds are squarely distributed in the different section of the medical center.

The bacteria found were predominantly Gram positive bacteria while the fungi were mainly phylloplane and soil fungi. The mean concentration of bacteria in this study is nearly equivalent to the World Health Organization guideline (WHO, 2017) value of 500 CFU/$m^3$ while the mean concentration of fungi is significantly lower than this limit. The potential health risk due to the exposure to bacterial and fungal particles in this study will be mainly in relative to the concentration of respirable airborne bacteria and fungi present (Moustafa, 2019) which will consider the size of the isolated bio particle.

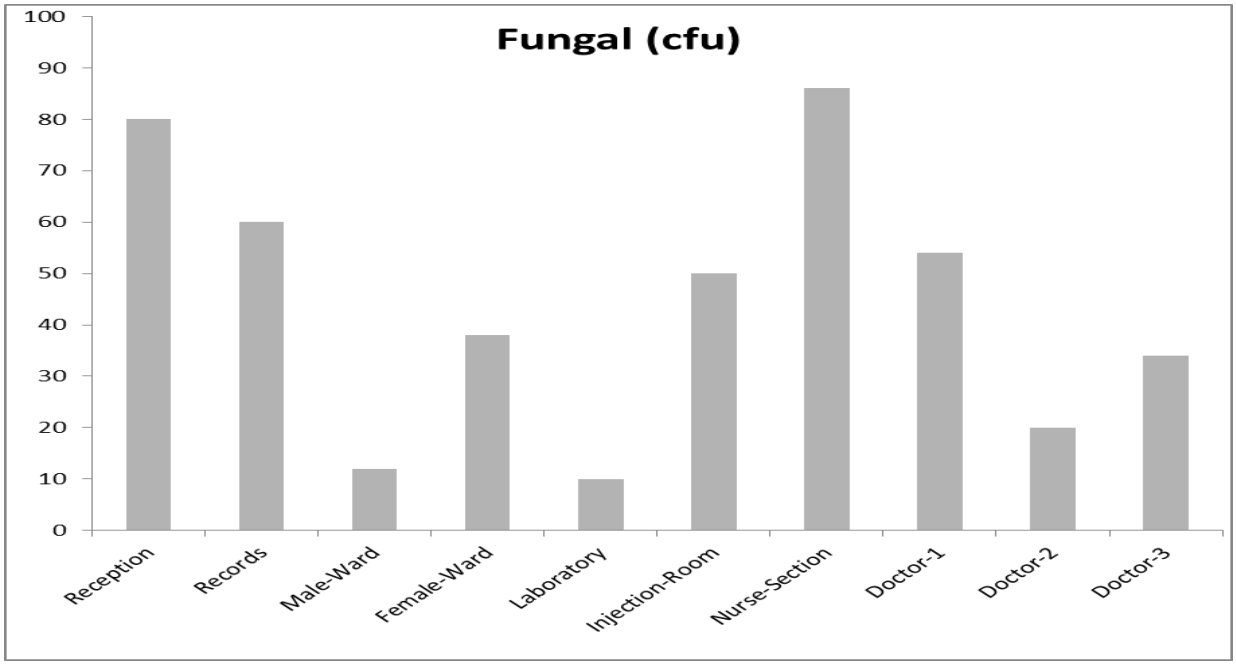

**Figure 2: The average fungal concentration (CFU/m$^3$) in different section of the sample space is enumerated in figures below;**

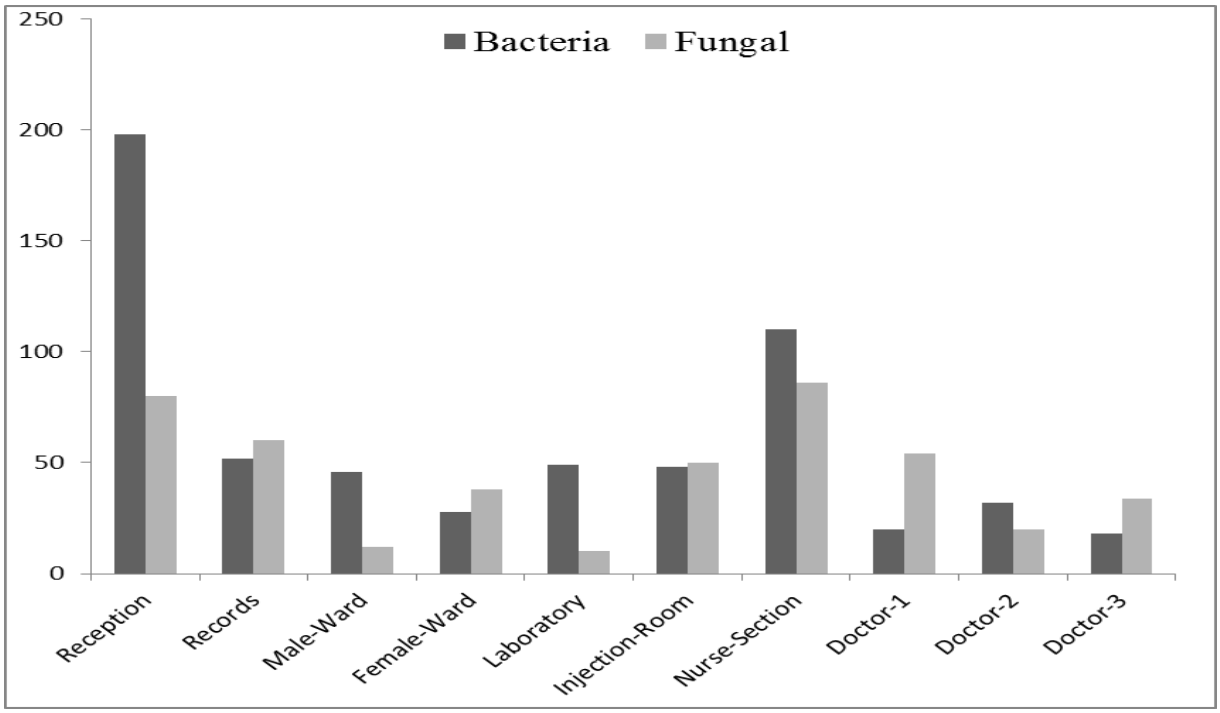


**Figure 3: Comparative chat of the bacteria and fungi concentration (CFU/m$^3$) as obtained in the different section of the medical center;**

The higher level of bacteria than fungal level may be attributed to the dependence of the bacterial growth on the indoor activity (Moustafa, 2019). Meanwhile, the fungal concentration is mainly affected by the outdoor sources (Abdel et al., 2018).
In addition, the isolated bacteria are considerably sensitive to antibiotics, although, high resistance was observed in 40% of the antibiotics used in this study and the fungal particles are highly sensitive to the use of Miconazole – Nitrate. The result is captured in the tables below.

**Table 2: Sensitivity of fungal isolates to antifungal agents**

| Anti-fungal agent | Sensitivity (%) | Resistant (%) |
|---|---|---|
| Fluconazole | 33.33 | 66.67 |
| Miconazole Nitrate | 66.67 | 33.33 |

**Table 3: Sensitivity of bacteria isolates to antibiotics**

| Antibiotics | Sensitivity (%) | Resistant (%) |
|---|---|---|
| Septrin | 38.89 | 61.11 |
| Chloraphenicol | 75.00 | 25.00 |
| Sparfloxacin | 52.78 | 47.22 |
| Ciprofloxacin | 75.00 | 25.00 |
| Amoxicillin | 25.00 | 75.00 |
| Augumentin | 30.56 | 69.44 |
| Gentamycin | 22.22 | 77.78 |
| Pefloxacin | 58.33 | 41.67 |
| Tarvid | 61.11 | 38.89 |
| Streptomycin | 61.11 | 38.89 |

Gram positive bacteria were the common bacterial flora. Most are aerobic saprophyte that are widely distributed in the atmosphere (Hussina et al., 2011) while the Cocci are normal flora of skin and mucous membranes in human and mammals (Mahon et al., 2007). Gram positive bacteria, despite their abundance in the environment are less harmful; however, they have potential to be opportunistic pathogens (Kim and Kim, 2007; Grady et al., 2016). Fungal floras isolated are *Rhyzopus*, *Aureobasidium* and *Penicillium* which are dominant species in both air and accumulated dust globally (Sharma, 2005).

Result also show that the total concentration of bacteria in indoor air of the medical center is higher than the total concentration of fungi. Furthermore, result shows that intensity of people, activity of member of staff, natural and mechanical ventilation, and stirring dust affect the proliferation and concentration of bio-particles. The airborne bacterial isolates and fungal concentrations findings in this study are almost similar to the levels reported by Jyotshna and Helmut (2011). Result also show that ventilation type can modify characteristics of indoor air; the sections with air conditional system and less natural ventilation show low level of contamination. Thus natural ventilation increases infiltration of outdoor microorganisms and mechanical ventilation reduces infiltration of outdoor microorganisms (Borrego et al., 2010). In the present study bacterial concentrations could be classified as high even though there are no acceptable threshold values for microbial contamination, because the isolated microorganism in exposure cultural method can only estimate approximately 1% of total available in the rooms. The airborne concentrations of bacteria and fungi were below the maximum value (500 CFU CFU/$m^3$) set by the WHO, the Brazilian standard (750 CFU CFU/$m^3$), and UK standard (500 CFU CFU/$m^3$), (Ross et al., 2004) but above the value proposed for hospital wards, 200 CFU CFU/$m^3$ (Krajewska et al., 2004).

## CONCLUSIONS

Assessment of microbial air quality of public buildings is important to inform human risk associated. Public buildings with natural ventilation and high intensity of occupancy had the worst microbiological air quality. The Federal Polytechnic Ede Medical center is an important category of indoor environments accessible to both students and members of staff of the institution and their family and these groups have sensitive immune systems which makes them vulnerable to microorganism contamination.

The high bacterial level in the indoor air of the medical center is an indication that more need to be done to ensure safety of facility user who may be exposed to high microbial concentrations. The bacterial and fungal concentrations clearly varied regarding type of human activity, intensity of occupancy and ventilation.

Therefore, it recommended more indoor environment studies and more public health programs in the school medical center buildings in order to achieving a healthy and good indoor air quality. Periodic cleaning operation and maintenance activities of various indoor spaces should be organized as a preventive measure. Increasing the ventilation by means of mechanical systems can also play a role in improving the indoor air quality. Also, it is

important to assess the respirable fractions of bio - particle to have a more profound relation between the concentration of microorganism in indoor air and the health effect.
The main limitation in this study were; microbial flora were analyzed using air -sampling - culture based technique which only capture approximately1% of total microbial particles (Toivola et al., 2002). Also, microbial concentrations vary greatly in time and space, and relatively low number of samples and short time sampling may not accurately reflect variation with time and season.

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