Annual Research & Review in Biology

37(9): 36-41, 2022; Article no.ARRB.89989
ISSN: 2347-565X, NLM ID: 101632869

Determination of In-door Air Quality by Estimating Microbiological Load from the Ambient Air among Basic Health Units in the City of Januaria, Brazil - A Cross Sectional Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2022/v37i930530

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/89989

Original Research Article

Received 01 June 2022
Accepted 05 August 2022
Published 13 August 2022

ABSTRACT

Aims: Poor air quality can compromise the health and recovery of patients and even compromise the quality of life and productivity of health professionals, affecting the speed of recovery of patients and allowing the occurrence of nosocomial infections. The present work evaluated the microbiological quality of ambient air in Basic Health Units (BHU), determining the degree of microbiological safety for the population served.
Study Design: This study was conducted with triplicate evaluation of samples of ambient air.
Place and Duration of Study: This study was conducted in the city of Januária, state of Minas Gerais, Brazil, between March 2016 and July 2016.
Methodology: Environmental air samples were collected in five BHU in the urban area of the city, evaluating the contamination by aerophilic mesophilic microorganisms, enterobacteria, molds and yeasts, using the simple sedimentation technique in a Petri dish.
Results: It was verified the presence of mesophilic aerobic bacteria and molds and yeasts in amounts higher than the recommendation used as a parameter for this study, indicating that the hygienic-sanitary conditions in the evaluated BHU are not adequate.
Conclusion: The presence of Enterobacteriaceae in some evaluated sites suggests the possibility of the presence of pathogenic microorganisms, which may pose risks to the health of the population.

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Keywords: Atmospheric contamination; public health; fungi.

1. INTRODUCTION

Microbiological contamination of indoor air is a serious public health problem because it is associated with allergies and respiratory diseases [1]. Airborne transmission is an important route for many microbial pathogens in outdoor and indoor environments, including hospitals [2]. In hospitals, the presence of chemical compounds and biological agents in the indoor air creates conditions that can compromise the recovery of patients, in addition to affecting the health and productivity of employees [3].

For the World Health Organization (WHO) indoor air pollution is the eighth most important risk factor, responsible for 2.7% of disease cases worldwide [4]. It is estimated that about half of the world's population, that is, almost three billion people, suffer from poor indoor air quality, mainly for people in underdeveloped and developing countries [5].

The microbiological contamination of internal environments is affected by the presence of bioaerosols from the external environment and those generated in the environment itself [6]. Ventilation is one of the main factors that interfere with indoor air quality and the occupants of these environments themselves contribute to their pollution through their activities, both through breathing and transpiration, as well as the transport of microorganisms [7].

Particulate matter, ventilation rate and occupation, nature and degree of activity carried out by people occupying a physical space are some of the determinants of the degree of contamination of indoor air [8]. In the specific case of a health unit, air quality can exert a direct and significant influence on the speed of recovery of patients and the occurrence of nosocomial infections [9].

Indoor air quality is a quantitative and qualitative marker used as a sentinel to determine the need to search for polluting sources or environmental interventions [6]. Therefore, air quality sampling and analysis are the first steps to determine whether the environment presents a potential threat to exposed people [10].

This study aimed to evaluate the quality of ambient air in Basic Health Units in the city of Januária, state of Minas Gerais, Brazil, investigating the degree of microbiological safety for the population served in these units.

2. MATERIALS AND METHODS

This work was developed in five Basic Health Units (BHU) in the urban area of the city of Januária-MG. The air quality in the BHU was evaluated using the simple sedimentation technique in a Petri dish described in the Compendium of Methods for the Microbiological Examination Food [11].

In the basic health units, the air contamination in the reception, waiting point, immunization room, nursing office, pharmacy, doctor's office, dressing room and foot test room was evaluated. Samples were collected at different times of the day depending on the location.

Plates with BDA agar, PCA agar and MacConkey agar were used to count molds and yeasts, mesophilic aerobics and enterobacteria, respectively. The Petri dishes were transported in thermal boxes to the collection sites and, later, to the microbiology laboratory of the Federal Institute North of Minas Gerais (IFNMG) where the microbiological analyzes were carried out.

The Petri dishes were distributed to the collection areas and exposed for 15 minutes. Subsequently, the Petri dishes were incubated at 35ºC for 24 to 48 hours for the counting of mesophilic aerobics, 25ºC for 3 to 5 days for the counting of molds and yeasts and at 37ºC for 24 to 48 hours for the counting of enterobacteria. Results were expressed in Colony Forming Units (CFU).cm^2.$week^{-1}$.

3. RESULTS AND DISCUSSION

Several standards and guidelines were developed by a variety of agencies, with no worldwide consensus on harmonizing methodologies for microbiological monitoring of ambient air [9]. There are several recommendations, but no standard method of sampling or analysis of air has been established, and the relationship between microbial counts and the incidence of infections is not well defined [12].

There are no national standards for contamination by aerophilic mesophiles, enterobacteria, or molds and yeasts in

healthcare facilities using the plate sedimentation method. However, the American Public Health Association (APHA) suggests values equal to or less than 30 CFU.cm².week^{-1} for mesophilic aerobics in environments where food is handled. However, this American recommendation is often considered rigid for Brazilian establishments. Considering the count of aerobic mesophilic microorganisms, the recommendation of the Pan American Health Organization (PAHO) [13] is 100 CFU.cm^2.week^{-1} for food processing establishments. It is expected that for the health area, the requirement for air contamination will be more stringent in relation to environments where food is handled.

In order to compare the results, the standards suggested by APHA and by PAHO for mesophilic aerobic bacteria were used in this work, using the same standards for the counts of yeast molds and enterobacteria. The results of the counting of mesophilic aerobics in the ambient air of the five Basic Health Units (BHU) surveyed are presented in Table 1.

As for the count of mesophilic aerobics, all the evaluated sites of the five BHU presented counts above the standard recommended by APHA and by PAHO. It is noteworthy that the higher the mesophilic aerobic count, the greater the possibility of the presence of pathogenic microorganisms. The count of mesophilic aerobic bacteria reflects the bacterial load and is an indicator of the microbiological quality of an environment [2].

The results of the count of molds and yeasts in the ambient air of the five Basic Health Units (BHU) surveyed are presented in Table 2. All the evaluated places presented counts of molds and yeasts above the established standard for mesophilic aerobics of APHA and PAHO.

Table 3 presents the results of the count of enterobacteria in the ambient air of the five Basic Health Units (BHU) surveyed. The results of the Enterobacteriaceae count showed that BHU 4 was the one with the lowest contamination, since, of the five sites evaluated in four, the presence of these microorganisms was not detected. The presence of Enterobacteriaceae may indicate the possibility of contamination by pathogenic bacteria such as the Salmonella genus [14].

Table 1. Count of mesophilic aerobics in the ambient air of five Basic Health Units (BHU) in the city of Januária, state of Minas Gerais, Brazil

Aerophilic mesophilic count (CFU.cm^2.week^{-1})					
Localization	**BHU 1**	**BHU 2**	**BHU 3**	**BHU 4**	**BHU 5**
Reception	4,13 x 10^2	4,85 x 10^2	3,82 x 10^2	4,03 x 10^2	8,27 x 10^2
Waiting point	5,16 x 10^2	*	*	2,06 x 10^2	1, 16 x 10^3
Immunization room	1,86 x10^2	3,82 x 10^3	7,2 x 10^2	2,27 x 10^2	4,34 x 10^2
Nursing office	3,10 x 10^2	*	2,37 x 10^2	*	4,85 x 10^2
Pharmacy	4,30 x 10^3	*	*	5,68 x 10^2	*
Doctor's office	*	1,03 x 10^3	5,20 x 10^3	*	4,44 x 10^2
Dressing room	*	4,85 x 10^2	1,86 x 10^2	4,1 x 10^2	*
Foot test room	*	7,2 x 10	*	*	*

**Unable to perform sampling*

Table 2. Counting of molds and yeasts in the ambient air of five Basic Health Units (BHU) in the city of Januária, state of Minas Gerais, Brazil

Mold and yeast count (CFU.cm^2.week^{-1})					
Localization	**BHU 1**	**BHU 2**	**BHU 3**	**BHU 4**	**BHU 5**
Reception	9,51 x 10^2	3 x 10^2	2,48 x 10^2	2,17 x 10^2	2,27 x 10^2
Waiting point	1,86 x 10^2	*	*	1,65 x 10^2	6,09 x 10^2
Immunization room	5,1 x 10	2,27 x 10^2	1,55 x 10^2	2,06 x 10^2	7,23 x 10^2
Nursing office	1,55 x 10^2	*	1,55 x 10^2	*	1,75 x 10^2
Pharmacy	2,3 x 10^2	*	*	2,17 x 10^2	*
Doctor's office	*	7,2 x 10	1,34 x 10^2	*	1,34 x 10^2
Dressing room	*	1,86 x 10^2	9,3 x 10	8,2 x 10^2	*
Foot test room	*	6,2 x 10	*	*	*

**Unable to perform sampling*

Table 3. Count of enterobacteria in the ambient air of five Basic Health Units (BHU) in the city of Januária, state of Minas Gerais, Brazil

Enterobacteriaceae counts (CFU.cm^2.week^{-1})					
Localization	**BHU 1**	**BHU 2**	**BHU 3**	**BHU 4**	**BHU 5**
Reception	2,0 x 10	6,2 x 10	7,2 x 10	N.D.	2,0 x 10
Waiting point	2,0 x 10	*	*	N.D.	1,44 x 10^2
Immunization room	N.D.	4,1 x 10	5,1 x 10	1,0 x 10	1,0 x 10
Nursing office					
Pharmacy	4,1 x 10^2	*	N.D.	*	3,0 x 10
Doctor's office	N.D.	*	*	N.D.	N.D.
Dressing room	*	N.D.	N.D.	*	1,0 x 10
Foot test room	*	5,1 x 10^2	1,0 x 10	N.D.	*

**Unable to perform sampling. N.D. (Not Detected)*

Bioaerosol monitoring includes measurement of viable microorganisms (culturable and non-culturable) and components or parts of these microorganisms by passive and active collection. However, most of the methods employed represent only approximations of the concentration of fungi or bacteria in environments known to be contaminated [15]. The Petri dish sedimentation method is limited, since it lacks standardization of exposure time, limiting the microbial count [16]. The low cost and simplicity of this method still justify its use in the monitoring of ambient air [17].

Unlike chemical or physical risks, the assessment of exposure to biological risks does not have adequate methodologies and reference standards [10]. There are many different methods to quantify the presence of microorganisms in the air and these differences contribute to the difficulty in comparing the results and, consequently, to the standardization of Maximum Recommended Values (MRV), limits that separate the conditions of absence and presence from the risk of aggression to human health [18].

The quantification of fungi and bacteria is used as a microbiological reference standard for air quality assessment, and this standard is a parameter used as a sentinel to determine the need to search for polluting sources or environmental interventions [4]. The Brazil National Health Surveillance Agency regulated in 2003, through Resolution RE nº 9, the "Reference Standards for Indoor Air Quality in artificially conditioned environments for public and collective use", however, in this Regulation it was defined in terms of contamination biological only the MRV for total fungi, and health units fall within the scope of this regulation [19]. State that the total fungal count may not be the most suitable for hospital environments, since bacteria are responsible for a large number of infections [9].

There are several issues to be resolved before a standard is established in addition to the fact that safe levels of exposure to fungi for susceptible patients are not clear, protocols for collections are lacking (interval and number of samples, volume of air collected and locations for collection), such as also standardization of the technique (culture medium to be used, the incubation temperature and the reading time of the culture plates) [20].

4. CONCLUSION

The presence of mesophilic aerobic bacteria and molds and yeasts in amounts higher than the recommendation used as a parameter for this study, indicates that the hygienic-sanitary conditions in the evaluated UBS are not adequate. In addition, the presence of enterobacteria in some evaluated sites suggests the possibility of the presence of pathogenic microorganisms, which may pose risks to the health of the population served.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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DOI: 10.1086/588660

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/89989