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Research Article

Sick Building Syndrome and Microbiological Quality of the Air in a University in the Colombian Southwest

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Abstract

Microorganisms and the biological particles they generate are involved in contamination within buildings, causing problems, like the Sick Building Syndrome (SBS). Although this syndrome has been known for decades and the WHO estimated in 1984 that over 30% of the buildings had such sickness, officially few studies have been documented. The purpose of this work was to evaluate the presence of the SBS in a university in the Colombian southwest and to learn if the microbiological quality of the air inside the buildings could be related with the presence of the syndrome. An exploratory study was conducted, which applied the modified questionnaire of the TNP 290 by the Spanish National Institute for Safety and Hygiene in the Workplace to 60 individuals. The presence of the SBS was established by calculating the prevalence of symptoms in each building. Counts of total aerobic mesophilic and fungi were conducted to determine the microbiological quality of the air and the fungal genera were identified according to their morphology. The results indicated the presence of the syndrome in both buildings evaluated, evidencing microbial counts between 200 and 2000 UFC/m^3, isolating 10 fungal genera, among which we found *Cladosporium* sp. and *Aspergillus* sp. as the most frequent. The binary logistic regression showed no relation between the presence of symptoms of the SBS and the risk factors evaluated.

Keywords: Sick Building Syndrome; Indoor Air Quality; Microbial Contamination; Fungi Bioindicators of Air Quality

Abbreviations

SBS: Sick Building Syndrome; TNP: Technical Notes on Prevention; TMA: Total Mesophyll Aerobic

Introduction

The Sick Building Syndrome (SBS) is known as a set of diverse symptoms of multifactor origin and of positive temporal relationship, affecting over 20% of the occupants of non-industrial buildings, which improve and may even disappear when the individual affected leaves the building [1]. Although its nature is multifactor, evidence exists that biological contamination may influence upon its presence [2]. However, studies regarding the theme in developed countries are not conclusive and in developing countries, where environmental conditions for the growth of potentially pathogenic biological agents are favorable, few published studies exist.

The SBS can be diagnosed through surveys of building occupants; said questionnaires address the perception of the occupants with respect to environmental factors of air, temperature, noise, and lighting at the workplace, as well as satisfaction at work and the symptoms presented related with the syndrome [3]. Different questionnaires or instruments applied exist to evaluate the presence of the SBS. Those described in the Technical Notes on Prevention (TNP), by the Spanish National Institute on Safety and Hygiene in the Workplace, have been taken as reference in Latin America, among which there are the TNP 290 and TNP 380, which have been used in diverse work settings.

Application of these instruments in several studies in Latin America has not been officially published. In a 2015 review on the SBS, our group reported various cases in which the SBS is diagnosed in academic buildings. Among these studies, there is that conducted by Rivera in a modern academic building in Mexico in 2009 and that conducted by Granada in 2011 in older buildings in a university in the city of Quito, Ecuador. Although the conditions of infrastructure and age of these buildings were different, it was possible to isolate potentially pathogenic agents; which is why the authors conclude, in both cases, that maintenance and control of the good microbiological quality of the interior air is primordial to safeguard the health of those working in these buildings [4].

In Colombia, few studies have been carried out on the theme and those existing were conducted in libraries. Thus, Gómez, in 2005, conducted a study to identify the presence of allergens in the dust and environment of four libraries in the city of Bogotá D. C. and their affectation on the health of the workers therein. The results evidenced *Cladosporium* sp. as the fungal species most frequently isolated, followed by *Penicillium* sp. and *Aspergillus* sp. With this study, it was possible to demonstrate that allergic individuals produced large amounts of antibodies because they were in constant contact with the allergens and that high humidity (65.9%) and temperature (19.5 ºC) were related with the presence of fungi in the structures; furthermore, their growth was favored by the accumulation of dust and organic material; relating these as the cause of allergic symptoms [5]. Thereafter, Toloza, in 2012, studied the microbial concentration and composition in the environment in the library at a university in Tunja, Colombia. The results showed high fungal diversity, identifying 34 genera, with the most frequent being *Cladosporium, Paecilomyces* and *Penicillium* [6].

In general, air quality analyses report on the existence of a wide variety of particles of biological origin in work environments, often causing respiratory and systemic diseases and allergies [2]. Among the most-often reported microorganisms, fungi genera have been identified, like *Aspergillus, Cladosporium, Penicillium, Curvularia, Alternaria, Fusarium, Mucor,* and *Chrysonilia*; some of these associated to conditions, such as rhinitis, bronchial asthma, alveolitis or generalized pneumonitis, and severe dermatosis, among others [7-9]. Evidence found in these studies indicate the need to evaluate the quality of air in buildings, especially those open to the public, to establish quality indices dependent on the type of building and its geographic location.

The purpose of this work was to apply an instrument that permitted establishing the presence of the SBS within the administrative offices in a university in the Colombian southwest and know the microbiological quality and fungal biodiversity in the air inside the buildings.

Materials and Methods

Study area and population

This study was carried out in two buildings of a university in Cali, Colombia, corresponding to the administrative area and the administrative offices of the Faculty of Health Sciences, which are located in a central area of the city with high population impact.

Diagnosis of the presence of the SBS

Direct observation of the physical characteristics of the workplace, as well as the work information of its occupants and the presence of the characteristic symptoms of the SBS were evaluated through visual inspection and by applying the modified questionnaire of the TNP 290 by the National Center on Work Conditions of the Spanish National Institute on Safety and Hygiene in the Workplace [10]. This was an exploratory study with the participation of 60 individuals. The presence of the SBS was determined by calculating the prevalence of symptoms in each building and it was diagnosed as positive in buildings in which 20% or more of the occupants had one or more of the symptoms evaluated.

Evaluation of the air quality inside the buildings

To determine the microbiological quality of the air inside, UFC/m3 counts were performed of total mesophyll aerobic (TMA), and fungi present in the administrative offices of both buildings included in the study. For this, the plate sedimentation technique or exposed plate (Petri dishes) was conducted, as described by Omeliansky [11]. The samplings were conducted during three-time intervals, every 15 days and each point was sampled in triplicate, for TMA and fungi, employing soy tripticase agar and Sabouraud agar, respectively. The Petri dishes (90 mm diameter) were placed approximately between 1.0 and 1.5 m from the floor and were exposed during 30 min; thereafter, these were incubated at 28°C from 2 to 7 days.

The data obtained were reported as number of UFC/m3 according to the formula described by Omeliansky.

$N = 5a \times 10^4 (bt)^{-1}$

Where N = UFC/m^3 of air in the internal environment; a = number of colonies per Petri dish; b = Petri dish surface (in cm^2); and t = time of exposure, in minutes.

Then, the fungi genera were identified, which according to their macroscopic morphology, were most frequently present; to identify genus, the keys by Barnett and Hunter, 1998 were used [12].

Establishment of the relationship between the presence of symptoms of the SBS and some risk factors

Through the binary logistic regression, the relationship was established between the symptoms resulting with a prevalence ≥ 20% and independent variables UFC/m3 counts of TMA and fungi, taking $p \leq 0.05$ as level of significance.

Results and Discussion

Characterization of the study population and visual inspection

The study had the participation of 60 individuals, all corresponding to administrative staff or professors with administrative functions, of which 55% worked in the administrative building and 45% in the building for the Faculty of Health Sciences. Ages for the building occupants ranged between 22 and 61 years, the mean seniority in both buildings was seven years and average permanence in the same workplace was five years.

The visual inspection stage evaluated the number of individuals per office and the characteristics of the infrastructure, such as the construction materials, furnishings, conditions of order and cleanliness, deterioration in structures, and ventilation systems, among others. In the administrative building, 20 offices were evaluated; the maximum number of people found per office was six. All the offices evaluated had ceramic floors, ceilings and walls covered with stucco. Half the personnel occupied cubicles separated by dividers made from combined materials, like Formica, cloth, and glass. Most offices showed good cleanliness conditions, although evidencing inadequate storage of large amounts of paper and boxes and some showed signs of humidity. In 80% of the offices air conditioning was used; the mean temperature registered in the ventilation equipment was 21°C, with a minimum of 17°C and a maximum of 26°C. In the building for the Faculty of Health Sciences, the study only kept in mind areas for personnel with administrative functions. Twenty-two offices were evaluated where the maximum number of occupants per office was 10; 68% of the offices had air conditioning systems, the mean temperature registered in the ventilation equipment for the areas evaluated was 22°C, with a minimum of 21°C and a maximum of 23°C. Regarding the building's infrastructure characteristics, the floors in most of the offices were ceramic and 9% were carpeted. According to the information gathered, the building had undergone several remodeling processes, which is why 68% of the ceilings were stucco and 32% in plaster board, most of the walls were covered with stucco and only 5% were in plaster board. Twelve of the offices evaluated had Formica, cloth, and glass division panels, and as in the administrative building, good cleanliness conditions were observed and one of the offices showed humidity on ceilings and walls.

With respect to equipment and furnishings, in both buildings 95% of the offices had computers, 82% had telephones, and 41% had multifunction printers; 77% of the offices had wooden desks; most had closed filing cabinets (64%) and Persian blinds (68%).

It is known that in work environments, high levels of dust, excessive use of computers, high temperatures, little or no outside air ventilation, poor lighting, lack of or inadequate maintenance of air conditioning systems, and insufficient cleaning regimes can directly affect the immunological capacity of the workers, upon exercising control over the threats from the environment in their workplace [13]. In 2009, the WHO, in a review publication including numerous epidemiological studies, demonstrated the existence of sufficient evidence among the factors related with damage in buildings caused by humidity or deterioration and a wide range of effects upon health. The results of these studies revealed that it is necessary to assess the air quality within buildings, especially in buildings open to the public [14].

According to this, although a daily cleaning chronogram and planned and supervised maintenance exists in the buildings evaluated, the visual inspection of the offices showed, in some cases, clutter and accumulation of paper and boxes in inadequate places. In addition, in some offices it was possible to observe signs of deterioration and stains caused by dampness on ceilings and walls, factors that promote the germination of fungal and bacterial spores in the environment. According to the European Agency for Safety and Health in the Workplace, other factors that can promote the presence of microorganisms in the air are the use of artificial ventilation systems and high presence of computer equipment, as is the case of the offices evaluated. In both buildings, similarity was found in the construction materials and in most of the offices there were elements of diverse materials (wood, Formica, cloth, among others), which serve as substrate for fungal growth [15]. In this sense, it is worth highlighting the potential presence of fungus related to wood decomposition, like *Cladosporium* sp. [16], *Aspergillus* sp., and *Penicillium* sp. [17,18] without ruling out the potential risk of pathogen contamination.

Settings with these characteristics have been found favourable for the presence of symptoms of the SBS in similar studies conducted in academic centers, where it is mentioned that the movement of the occupants, the deterioration of the structures and the age of the building are risk factors that increase the presence of these and other fungi or pathogenic bacteria [4].

Prevalence of symptoms and diagnosis of the SBS

The SBS is characterized by the occupants of a building reporting the appearance of a series of symptoms that are difficult to explain. Hence, the first step was to identify and evaluate said complaints, calculating the prevalence of the syndrome's characteristic symptoms, (included in the TNP 290 questionnaire) and diagnosing their presence in those buildings where 20% or more of their occupants report one or more of the symptoms. The questionnaire applied comprised 46 symptoms, divided into 11 groups, of which 8 groups and 19 symptoms had a prevalence above 20%. Symptoms related with respiratory disorders, digestive disorders, and symptoms similar to the common cold did not have a prevalence above 20%.

In the administrative building, 100% of those surveyed responded affirmatively to suffering from at least one of the characteristic symptoms of the SBS; this being 81% women and 19% men. Additionally, the population evaluated in the building for the Faculty of Health Sciences, which reported at least one symptom was 78%, of which 82% were women and 18% men; observing a statistically significant difference in the prevalence presented between women and men. According to this observation, we can suppose that gender can be an influential variable in enduring the symptoms, in both buildings, most of the women reported feeling at least one of the symptoms, results agreeing with those obtained by Martínez (2014) [19]. The data obtained in this study cannot explain why the female gender was affected in a higher proportion; however, Boldú J in a review carried out in 2005, states that factors dependent on the host, like type of personality in the female gender (anxiety and suspicion) may favor the appearance of the SBS [13].

In the administrative building, 17 symptoms were identified with prevalence ≥ 20% (Table 1). Results of the logistic regression showed in this building that the variable of UFC/m^3 count of fungi did not influence in statistically significant manner on the occurrence of any of the symptoms, while the UFC/m^3 count of TMA did influence significantly on eye dryness (0.045), establishing a directly proportional relationship (0.007). Furthermore, in the building for the Faculty of Health Sciences, nine symptoms prevailed with percentages above 20% (Table 1). According to the statistical model used, the microbial counts did not evidence significant influence with relation to the appearance of any of the symptoms evaluated.

Symptoms	Prevalence (%) of Symptoms in Administrative building	Prevalence (%) of Symptoms in the Faculty of Health Sciences
EYES		
Reddening	28	18
Itching	28	7
Dryness	53	32
Lachrymation	22	11
Blurred vision	28	11
NASAL		
Rhinitis (nasal drip)	22	18
Repeated sneezing (more than three)	28	21
THROAT		
Dryness	16	32
Itching, burning	22	18
MOUTH		
Dryness / thirst sensation	28	25
SKIN DISORDERS		
Dryness of the skin	34	7
PAIN SYMPTOMS		
Back	69	39
Muscular	44	25
Articulations	25	18
TENSION SYMPTOMS		
Anxiety	22	18
Exhaustion	25	39
GENERAL DISORDERS		
Difficulty concentrating	3	21
Headache	38	14
Exhaustion/ lack of energy	38	32

Table 1: Characteristic symptoms of the SBS with prevalence ≥ 20%.

It is significant to highlight that globally the most commonly observed symptomatology, with respect to the presence of the SBS, agrees with the wide variety of symptoms manifested by the majority of the occupants of the buildings surveyed. This study reported greater frequency of symptoms related to pain, eyes, and tension, as well as general disorders and disorders of the throat, which can be related with the use of artificial ventilation systems and presence of diverse biological agents; these findings coincide with studies held in other countries in public and private buildings [4].

The results obtained showed that 90% of the workers participating had symptoms (at least one) related with the work environment, which did not respond to any disease pattern. Bearing in mind that the SBS is diagnosed in buildings where 20% or more of the occupants have one or more of the symptoms [10], the results may confirm that both buildings have the syndrome, which indicates that the conditions of the work environment are possibly affecting the health of some workers.

Evaluation of the microbiological quality of the air

To classify the contamination levels, the study took as reference the European Community Sanitary Standard for non-industrial locations [13]. The TMA and fungi counts in the Administrative building (Table 2) showed values, in most of the areas sampled, corresponding to the medium level.

Of the 19 offices sampled in the administrative building, six had TMA counts > 500 UFC/m^3. We highlight the results observed in the area for the Personnel Administration Headquarters, where TMA counts on all occasions sampled were high, even obtaining counts > 2000 UFC/m^3, corresponding to the very high level of contamination. The highest fungi count, in this building, were obtained in the Treasury office where counts were between 500 and 2000 UFC/m^3.

Among the TMA counts obtained in the building for the Faculty of Health Sciences (Table 3), high levels are evident in the offices of the Dean, Reception of the Academic Secretariat, Direction of the Medicine Program, and Public Health Coordination; where UFC/m3 values obtained, in at least one of the occasions sampled, these were > 500 UFC/m^3. As per the fungi count, the results obtained in the Reception of the Academic Secretariat and the office for Attention to Nursing Students show that counts > 500 UFC/m^3 were obtained, corresponding to the high level of contamination.

Offices	UFC/m^3 TMA			UFC/m^3 Fungi		
	I	II	III	I	II	III
Assistance to staff Administration	315	171	236	459	118	79
Headquarters Personnel Administration	2253	576	1048	838	183	236
Reception Syndicate and Personnel	1245	446	406	957	275	249
Treasury	1114	642	262	655	576	341
Accounting Direction	314	236	262	550	288	79
Accounting	184	380	275	315	380	131
Budget	342	367	341	236	183	52
Internal Audit	158	66	105	302	79	53
Syndicate Headquarters	1205	524	210	341	419	131
Billing	197	236	131	537	275	79
Sectional Accreditation Secretariat	1258	210	183	79	79	26
Headquarters Sectional Secretariat	210	52	52	603	52	26
Reception Sectional Rectory	105	52	210	131	210	131
Sectional Rectory	79	157	26	105	79	0
Planning	157	79	131	26	131	79
Reception for the Presidency	314	105	157	26	0	79
Sectional Presidency	341	105	419	79	157	131
Headquarters for the Sectional Presidency	445	183	576	131	105	26
Censorship office	39	26	52	79	39	53
Air quality according to the Sanitary Standard by the European Community for non-industrial locations						

TMA	Fungi	Level
< 50	< 25	Very low
50 - 100	25 - 100	Low
100-500	100 - 500	Medium
500-2000	500 - 2000	High
> 2000	> 2000	Very high

Table 2: Counts of total mesophyll aerobic and fungi in the Administrative building.

Counts of TMA and fungi obtained through the plate sedimentation technique for 30 min. Values per m^3 were obtained by applying Omeliansky's formula.

OFFICES	UFC/m³ TMA			UFC/m³ Fungi		
	I	II	III	I	II	III
Nursing	255	149	149	149	21	21
Epidemiology	21	53	11	43	32	0
Basic Sciences Headquarters	106	255	85	212	0	85
Secretary of Basic Sciences	255	233	106	106	276	64
Dean Faculty of HS	149	531	297	85	276	85
Reception Dean HS	340	233	21	212	42	85
Direction Nursing Program	85	42	53	53	64	53
Attention to Nursing Students	1273	255	212	531	21	127
Psychology professors lounge	308	404	122	101	53	276
Academic Secretary HS	318	198	92	184	106	53
Basic Sciences professors lounge	389	155	134	148	64	120
Headquarters Education Development	435	382	329	414	223	170
Community professors lounge	181	64	223	191	96	212
Reception Academic Secretary	509	212	127	658	297	64
Direction Medicine Program	441	692	280	195	191	221
Coordination Public Health	202	573	361	43	42	149
Graduate Specialized Portfolio	127	297	64	64	85	21

Air quality according to the European Community Sanitary Standard for non-industrial locations

TMA	Fungi	Level
< 50	< 25	Very low
50 - 100	25 - 100	Low
100 - 500	100 - 500	Medium
500 - 2000	500 - 2000	High
> 2000	> 2000	Very high

Table 3: Counts of total mesophyll aerobic and fungi in the building for the Faculty of Health Sciences Counts of total mesophyll aerobic (TMA) and fungi obtained through the plate sedimentation technique for 30 min. Values per m³ were obtained by applying Omeliansky's formula.

Several diseases of microbial aetiology can be contracted in contaminated environments; however, many of these are not due necessarily to exposure to known pathogenic agents, but to the exposure to high microbial loads [20]. In addition, various authors consider that maintaining good air quality is important for the comfort of the occupants of closed spaces, as well as for the conservation of their health [4,21]. The aforementioned indicates that it is essential to know the level of microbial load of indicators, like TMA and fungi, especially within work areas.

It is worth highlighting the lack of a standardized international norm that specifically indicates when the environment in non-industrial buildings is beyond the limits of microbial loads. Crook, in a review conducted in 2010, mentions that some countries have specification guides regarding the number of microorganisms within non-industrial buildings, however, differences exist among these and it is shown that concentrations and type of microorganism can vary depending on the geographic location, season of the year, among other factors [22]. Studies in Latin America suggest that the microbial concentration should not be higher than 1000 UFC/m³ to maintain an uncontaminated environment [4], nevertheless, no difference is made between fungi loads with respect to the bacterial load. In this study, 8 of the 36 offices sampled had fungi counts > 500 UFC/m³ and 11 of them had TMA counts above this same value and in at least one of the periods sampled, six of these offices had TMA counts above 1000 UFC/m³; on the contrary, there were no fungi counts above the value mentioned. Other studies have associated the presence of high bacterial counts (TMA) to overpopulation in closed quarters [15] although in general, in the areas evaluated the TMA count with respect to the fungi count was similar; in areas with higher bacterial counts, no personnel overpopulation was observed in the offices.

The morphological identification of the fungi showed the presence of 10 genera; *Alternaria* sp., *Aspergillus* sp., *Cladosporium* sp., *Curvularia* sp., *Nigrospora* sp., *Penicillium* sp., *Monilinia* sp., *Fusarium* sp., *Paecilomyces* sp. and *Rhizoctonia* sp. The *Cladosporium* sp. was present in a higher number of offices (12 offices), followed by Aspergillus sp. (8 offices) and *Monilinia* sp. (7 offices) (Table 4). Regarding biodiversity, the maximum number of genera present in a single office was five.

Presence (+) or absence (-) of fungal genera: 1. *Alternaria* sp. 2. *Aspergillus* sp. 3. *Cladosporium* sp. 4. *Curvularia* sp. 5. *Nigrospora* sp. 6. *Penicillium* sp. 7. *Monilinia* sp. 8. *Fusarium* sp. 9. *Paecilomyces* sp. 10. *Rhizoctonia* sp.

Building for the Faculty of Health Sciences										
Office	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Basic Sciences Headquarters	+	+	+	-	-	-	-	-	-	-
Secretary of Basic Sciences	-	-	+	-	-	-	-	-	-	-
Dean Faculty of Health Sciences	-	+	-	-	-	+	-	-	-	-
Direction Nursing Program	-	-	+	-	-	-	-	-	-	-
Attention to Nursing Students	-	-	+	-	-	-	-	-	-	-
Psychology professors lounge	+	+	+	-	-	-	-	-	-	-
Basic Sciences professors lounge	+	-	+	+	-	-	-	-	-	-
Headquarters for the Development of Health Education	+	-	+	+	+	-	+	-	-	-
Community	+	+	+	-	+	-	-	-	-	-
Direction Medicine Program	-	-	+	-	-	-	-	-	-	-
Administrative Building										
Office	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Assistance to staff Administration	-	+	-	+	+	+	+	-	-	-
Headquarters Personnel Administration	-	-	-	-	+	+	-	-	-	+
Syndicate Secretariat / Personnel Secretary	-	-	-	+	+	-	+	-	-	-
Treasury	-	-	-	-	-	-	+	-	-	-
Accounting	-	-	+	-	-	+	+	-	+	-
Budget	-	-	-	-	+	-	-	-	-	-
Internal Audit	-	+	-	-	-	+	-	-	-	-
Syndicate Headquarters	-	-	-	-	-	-	-	+	-	-
Billing	-	+	-	-	-	-	-	-	-	-
Headquarters Sectional Secretariat	-	-	-	-	-	-	+	-	-	-
Secretary Sectional Rectory	-	-	+	-	-	-	-	-	-	-
Planning	-	-	-	-	-	+	-	-	-	-
Sectional Presidency	-	-	+	-	-	-	-	-	-	-
Censorship office	-	+	-	-	-	-	+	-	-	-

Table 4: Fungal genera present in the buildings evaluated.

Presence (+) or absence (-) of fungal genera: 1. *Alternaria* sp. 2. *Aspergillus* sp. 3. *Cladosporium* sp. 4. *Curvularia* sp. 5. *Nigrospora* sp. 6. *Penicillium* sp. 7. *Monilinia* sp. 8. *Fusarium* sp. 9. *Paecilomyces* sp. 10. *Rhizoctonia* sp.

Biodiversity is also an important factor to keep in mind, areas with high numbers or traffic of personnel and paper storage, like libraries and archives, have high fungal biodiversity [8,9,23,24]. This study did not have this finding, given that in the Treasury office, where a large accumulation of paper, high traffic of personnel, and medium and high levels of fungal contamination, it was found that variety in terms of fungal genus was low (Table 4). However, in the office for Attention to Administration personnel, with similar characteristics, five fungal genera of the 11 identified were isolated (Table 4), as well as fungi counts at low and medium levels (Table 2). Likewise, this office and those nearby showed the presence of *Monilinia* fungus, a genus related to plant diseases, which could indicate that the fungal contamination comes from the adjoining outside gardens in direct contact with these areas. The Headquarters for Health Education Development also had high biodiversity, isolating five fungal genera (Table 4), besides exhibiting medium levels of contamination (Table 3). This result can be explained because of existence of a vast accumulation of material sensitive to contamination and damage on the office's physical structure, caused by humidity; characteristics that promote the hosting and development of fungal spores [25]. It is worth highlighting that the WHO has stated that, particularly, humidity must be considered an indicator of biological contaminants of the air inside the office, becoming a health risk factor [14].

Of the 10 fungal genera isolated, several are known to cause hypersensitivity reactions [15,19]. Although most studies in the literature are not conclusive, regarding the relationship of the presence of fungi and symptoms associated with the SBS, the results in some studies evidenced certain fungi genera as constant in closed buildings, with artificial ventilation and which use air conditioning; the most frequent being *Cladosporium* sp., *Penicillium* sp., and *Aspergillus* sp. [4,5,8,9,26]. Isolating these genera in this study, especially the higher occurrence of *Cladosporium* sp. and *Aspergillus* sp., coincides with those studies. Both genera manage to grow in diverse substrates, like wood, paper, cotton textiles, paints, and household dust, among others [22]. According to the visual inspection, many of the previous materials were present in the different offices evaluated, which is why it is not surprising to find the presence of these fungal genera. In addition, both genera are related with work environments with artificial ventilation systems and humidifiers, and their growth is favored in warm environments and high relative humidity [9], as that found in the city of Cali, Colombia. Thus, *Cladosporium*, which was present in most of the offices evaluated where fungi counts were > 100 UFC/m^3, is related with respiratory disease, most commonly with asthma and allergic rhinitis, and it has been shown to cause cutaneous, subcutaneous infections, as well as keratitis, among others [5]. Furthermore, *Cladosporium wernekii* is associated with superficial mycoses and dermatomycosis, being the causal agent of the palmar black Tinea, frequent in regions with warm and humid climate, characteristic of many zones in Colombia [27]. Similarly, it has been characterized as an indicator of contamination in spaces where air conditioning is not optimal [28]. Additionally, several studies have shown that exposure to *Aspergillus* sp. can trigger serious respiratory infections and may lead people suffering from asthma to develop Aspergillosis [15]. *Aspergillus* is known for its high pathogenicity and has been associated, among other diseases, with conjunctivitis, onychomycosis, otomycosis, asthma, rhinitis, allergic sinusitis; affecting specially individuals with compromised defense systems [2,7]. The *Aspergillus* genus is as highlighted for its clinical interest, given the great amount of conditions it can provoke directly and because of the aflatoxins [17]. According to neuropsychological studies, *Aspergillus* sp. has even been related with difficulty concentrating and cognitive defects in people living in buildings contaminated by fungi [15].

Finally, it was noted that in offices where *Cladosporium* and *Aspergillus* were isolated, their occupants reported diverse symptoms, like: eye redness, itchiness, and dryness, lachrymation, blurry vision, nasal dryness, rhinitis, repeated sneezing, dryness, itching and sore throat, thirst sensation, difficulty breathing, cough and chest pain, dry skin, rashes, skin peeling and itching; symptoms related with the SBS [2,8,22,29] that could corroborate the potential use of these genera as bioindicators to diagnose the syndrome.

Relationship between microbial counts and the characteristic symptoms of the SBS

Through the binary logistic regression analysis, a significant relationship was not established between the microbial counts and the appearance of most of the characteristic symptoms of the SBS. However, a study must be conducted over time to obtain more conclusive evidence. Similar results were obtained in the study conducted by Martínez MG in 2012 [30], given that although the presence of the SBS was determined, it did not establish a relationship between symptoms and microorganisms in the air and environmental measurements.

Conclusion

This is the first study to evaluate the relationship of air quality within university buildings and the SBS in the Colombian southwest. Although the SBS was identified in both buildings evaluated, the independent variables of UFC/m^3 count of TMA and fungi do not have a statistically significant relationship on the symptoms of the SBS, except for the TMA counts and the symptom of eye dryness. The results obtained in the analysis of the microbiological quality of the air, in most of the offices evaluated in both buildings, mostly corresponded to the medium level of TMA and fungi contamination. Ten fungal genera were isolated, as expected according to the literature, *Cladosporium* sp. and *Aspergillus* sp. being the most frequent, evidence that can propose these microorganisms as bioindicators of the presence of the SBS.

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Conflict of Interest

The authors, herein, declare no potential conflict of interest related with the article. We manifest our independence with respect to the funding and support institutions and that during the execution of the work or in writing the manuscript no interests or values different from those research usually has had been affected. We agree with the contents of the article corresponding to studies not previously published, which will not be submitted to any other journal prior to receiving the decision by the Editorial Committee of the Public Health Journal of Universidad Nacional de Colombia and, if accepted for publication, the journal may publish it in physical and/or electronic format, even on the Internet.

Bibliography

1. Berenguer MJ., *et al*. "El síndrome del edificio enfermo: metodología de evaluación". [On line] Documentos Divulgativos. Instituto Nacional de seguridad e higiene en el trabajo, Madrid, INSHT (1994): 9-10.
2. Rios JM. "La Aeromicología y su importancia para la medicina". *Revista Médico-Científica* (2011): 24(2): 2011 28-42.
3. Cascales M. "Determinación del Síndrome del Edificio Enfermo". *Revista Digital de Prevención Montreal* (2006).
4. Daza MA., *et al*. "Contaminación microbiológica del aire al interior y el síndrome del edificio enfermo". *Biociencias* 10.2 (2015): 37-50.
5. Gómez A., *et al*. "Evaluación de alergenos presentes en polvo y ambiente de algunas bibliotecas de Bogotá D.C". *Universitas Médica* 46.1 (2005): 13-20.
6. Toloza D., *et al*. "Concentración y composición microbiana en el ambiente de la Biblioteca Central Jorge Palacios Preciado de la Universidad Pedagógica y Tecnológica de Colombia". *Acta Biológica* 34.97 (2012): 241-252.
7. De la Rosa MC., *et al*. "El aire: hábitat y medio de transmisión de microorganismos". *Observatorio Medioambiental* 5 (2002): 375-402.
8. Borrego A S and Perdomo AI. "Caracterización de la micobiota aérea en dos depósitos del Archivo Nacional de la República de Cuba". *Revista Iberoamericana de Micología* 31.3 (2014): 182-187.
9. Borrego S., *et al*. "Estudio de la concentración microbiana en el aire de depositos del Archivo Nacional de Cuba. [On line] Universidad Nacional de La Plata". *Augmdomus* 1 (2010): 118-137.
10. Norma Técnica de Prevención. "NTP 290: El Síndrome del Edificio Enfermo: cuestionario para su detección". [On line] Instituto Nacional de Seguridad e Higiene en el Trabajo.
11. Bogomolova E and Kirtsideli I. "Airborne fungi in four stations of the St. Petersburg Underground railway system". *International Biodeterioration and Biodegradation* 63.2 (2009): 156-160.
12. Barnett HL and Hunter B. "Illustrated genera of Imperfect Fungi". 4th Edition. Minnesota, APS Press, (1998).
13. Boldú J and Pascal I. "Enfermedades relacionadas con los edificios". *Anales del sistema sanitario de Navarra* 28.1 (2005):117-121.
14. World Health Organization. Guidelines for indor air quality: dampness and mould (2007).
15. Haleem K and Mohan K. "Fungal pollution of indoor environment and its management". *Saudi Journal of Biological Sciences* 19.4 (2012): 405-426.
16. Sailer MF., *et al*. "Forming of a functional biofilm on wood surfaces". *Ecological Engineering* 36.2 (2010): 163-167.
17. Thacker PD. "Airborne mycotoxins discovered in moldy buildings". *Environmental Science Technology* 38.15 (2004): 282A.
18. Herrera K., *et al*. "Indexseminum y la sección de macrohongos del Herbario de Biología de Guatemala. Evaluación de la contaminación del aire por hongos microscópicos en el Herbario de la Universidad de San Carlos de Guatemala". *Review of Scientific* 23.1 (2013): 26-37.
19. Martínez E., *et al*. "Patologías relacionadas con las condiciones ambientales de un hospital terciario de la Comunidad de Madrid". *MedSegTrab* 60.234 (2014): 53-63.
20. Wolff CH. "Innate Immunity and the pathogenicity of inhaled microbial particles". *International Journal of Biological Sciences* 7.3 (2011): 261-268.
21. Hernández S. "Emisiones contaminantes de materiales de construcción en el interior de los edificios". Caso de los tableros de yeso. *Ciencia Ergo Sum* 14.3 (2007): 333-338.
22. Crook B and Burton N. "Indoor moulds. Sick Building Syndrome and building related illness". s.l: *Fungal biology reviews* 24.3-4 (2010): 106-113.
23. Soto T., *et al*. "Indoor airborne microbial load in a Spanish university". *Anales de Biología* 31 (2009): 109-115.
24. Fekadu S and Melaku A. "Microbiological quality of indoor air in libraries". *Asian Pacific Journal of Tropical Biomedicine* 4.1 (2014): 312-317.
25. Cabral JP. "Can we use indoor fungi as bioindicators of indoor air quality? Historical perspectives and open questions". *Science of The Total Environment* 408.20 (2010): 4285-4295.
26. Jones AP. "Indoor air quality and health". *Atmospheric Environment* 33.28 (1999): 4535-4564.
27. Rueda R. "Micosis superficiales y dermatomicosis". *Colombia Médica* 33. 1 (2002): 10-16.

28. Straus DC. "The possible role of fungal contamination in sick building syndrome". *Frontiers in Bioscience* 3 (2011): 562-580.

29. Molina C., *et al*. "Sick building syndrome. A practical guide. European Concerted Action, Indoor Air Quality and its Impact on Man, Cost project 613, Report No 4, CEC Joint Research Centre, Luxemburg (1989).

30. Martínez MF. "Los principios de la construcción sustentable como una medida para abatir el Síndrome de Edificio Enfermo. Estudio de caso edificios académicos 10, 11 y 12 de la Unidad Profesional Adolfo López Mateos del IPN" México DF (2012).

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