



Journal of Toxicology and Environmental Health, Part A: Current Issues

Publication details, including instructions for authors and subscription information:

<http://www.tandfonline.com/loi/uteh20>

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Joana Madureira^a, Cristiana Pereira^b, Inês Paciência^a, João Paulo Teixeira^b & Eduardo de Oliveira Fernandes^a

^a Institute of Mechanical Engineering, Faculty of Engineering of University of Porto, Porto, Portugal

^b National Institute of Health, Environmental Health Department, Porto, Portugal

Published online: 29 Jul 2014.

To cite this article: Joana Madureira, Cristiana Pereira, Inês Paciência, João Paulo Teixeira & Eduardo de Oliveira Fernandes (2014) Identification and Levels of Airborne Fungi in Portuguese Primary Schools, Journal of Toxicology and Environmental Health, Part A: Current Issues, 77:14-16, 816-826, DOI: [10.1080/15287394.2014.909302](https://doi.org/10.1080/15287394.2014.909302)

To link to this article: <http://dx.doi.org/10.1080/15287394.2014.909302>

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IDENTIFICATION AND LEVELS OF AIRBORNE FUNGI IN PORTUGUESE PRIMARY SCHOOLS

Joana Madureira¹, Cristiana Pereira², Inês Paciência¹, João Paulo Teixeira²,
Eduardo de Oliveira Fernandes¹

¹Institute of Mechanical Engineering, Faculty of Engineering of University of Porto, Porto, Portugal

²National Institute of Health, Environmental Health Department, Porto, Portugal

Several studies found associations between exposure to airborne fungi and allergy, infection, or irritation. This study aimed to characterize airborne fungi populations present in public primary schools in Porto, Portugal, during winter through quantification and identification procedures. Fungal concentration levels and identification were obtained in a total of 73 classrooms. The AirIdeal portable air sampler was used in combination with chloramphenicol malt extract agar. Results showed a wide range of indoor fungi levels, with indoor concentrations higher than outdoors. The most prevalent fungi found indoors were *Penicillium* sp. (>70%) and *Cladosporium* sp. As evidence indicates that indoor fungal exposures plays a role in asthma clinical status, these results may contribute to (1) promoting and implementing public health prevention programs and (2) formulating recommendations aimed at providing healthier school environments.

In Europe more than 64 million students and almost 4.5 million teachers spend many hours per day inside pre-primary, primary, and secondary schools (Eurostat 2013). Children spend more time at school than in any other place except home. Children are particularly vulnerable to indoor air pollution (Madureira et al., 2012; Annesi-Maesano et al., 2013), since their bodies are still developing, children may have altered sensitivity to exposure to xenobiotics, and their immune systems are too immature to respond effectively to environmental attacks (Selgrade et al., 2008; Firestone et al., 2008). Besides, the air volume children inhale in relation to body weight is considerably larger than in adults, and they will probably also have a longer lifetime and a longer foreseeable exposure duration to cope with in their lives (Viegi et al., 2004; Ginsberg et al., 2008). Based upon governmental regulations, school environment is compulsory and thus children

or their parents do not always make decisions concerning their own (school) environment.

The occurrence of pollutant-related disturbances at school may affect children's health, absenteeism, and learning performance, as well as their cultural and social development (Annesi-Maesano et al., 2013). The prevalence of asthma and allergy among children has increased quite rapidly in the last decade (Sun et al., 2009) at such a pace that, according to Etzel (2007), these findings cannot be explained by genetic changes and are more likely to be due to changes in environmental exposures and/or in lifestyle. Many explanations have been offered, including indoor air pollution, since each indoor environment has been made more and more airtight. The indoor air quality (IAQ) in schools is generically characterized by a complex of various exposures to indoor pollutants such as particulate matter (PM), volatile organic compounds

(VOC), formaldehyde, bacteria, and fungi.

Several studies found sufficient evidence to support associations between exposure to airborne fungi and allergy, infection, irritation, and toxicity (Anderson and Bogdan, 2007; Mentese et al., 2009; Seltzer and Fedoruk, 2007; Takigawa et al., 2009; WHO, 2009). Species of *Penicillium*, *Aspergillus*, and *Cladosporium* have been the most frequently associated with allergy and exist both in indoor and outdoor environments (Daisey et al., 2003; Jo and Seo, 2005).

No Europe-wide health-based threshold values exist with respect to biological contaminants indoors. Until now, no apparent data on total or genera-specific concentrations from air samples as indicators of exposure levels were reported for schools in Portugal, and this absence might have delayed the application of preventive strategies. Therefore, more studies are needed to improve our knowledge on the microbial ecology of buildings and the qualitative and quantitative aspects of exposure assessment in occupants. The aim of this study was to determine fungal concentration levels and identify fungi genera in 20 public primary schools in Porto, Portugal, in order to (1) contribute to a review of policies, (2) implement public health prevention programs, and (3) formulate recommendations aimed at providing healthier school environments.

MATERIAL AND METHODS

The study was comprised of 20 public primary schools geographically distributed throughout the city center of Porto, located in the north of Portugal, which has an Atlantic climate, damp but temperate. Depending on the dimensions of each school, four classrooms were selected among the occupied classrooms with similar conditions and representative of the school building. If there were fewer than four classrooms, all were selected. In total, 73 classrooms were included.

This study included walk-through surveys of schools grounds, buildings, and individual classrooms, as well as air sampling. The walk-through and air sampling was conducted in two winter periods, from November 2011 to March 2012 and November 2012 to December 2012, being representative of the heating season. Thirteen schools were sampled in the first period and seven schools in the second period. The measurements were performed during normal classroom activities and under representative conditions.

Walk-Through Inspection and Checklist

A walk-through inspection was completed for each school by a trained researcher to gather information related to school building and classroom characteristics, including: questions about outdoor environment; building structure, age and size, and number of floors; number of occupants; finishing materials and their condition, concerning floors, walls, and ceilings; operable exterior doors and windows; past occurrence and visible problems; heating and ventilation systems; and frequency of cleaning and management procedures. The presence of classroom furniture, as well as chalkboards, copiers, and plants, was also noted, as well as information regarding environmental modifiers, including air fresheners and insecticides.

Air Sampling Procedure

Air samples were obtained using a single-stage microbiological air impactor (AirIdeal, bioMérieux SA) according to NIOSH 0800 method (NIOSH, 1998). The impactor is a hand-held, battery-operated instrument that consists of a holder for a 90-mm-diameter nutrient agar plate and a sieve plate containing 220 holes. A fan draws air through the sieve plate, resulting in airborne particles impacting on the agar plate, and air is exhausted through the side of the sampler. Air was drawn through the sampler at 100 L/min, and sequential duplicate air samples (100 and 250 L) were collected indoors and outdoors. Malt extract

agar (MEA) plates (supplemented with 1% of chloramphenicol) were used for fungi collection. Indoor sampling was performed from the rear of the classroom to minimize class interruption, near the breathing zone of the children, approximately at 0.5–0.7 m from the floor, during morning class time. Outdoor sampling was performed during the same period at 3 m from the main entrance of each school building.

The sampler was cleaned between sample collections with cotton swabs wetted with isopropyl alcohol. After sampling, the agar media plates were sealed, marked, and transported to the lab in a thermal bag for incubation. For each sampling day, agar media blanks were taken into the field but not opened.

Microbial Analysis

MEA plates were incubated at $25 \pm 2^\circ\text{C}$ for 3 d. The number of colonies recovered on the air-sample plates was adjusted using a positive-hole correction factor and results were expressed as colony-forming units per cubic meter of air (CFU/m³). The correction factor was based on the Fellers law (Andersen, 1958). Fungal identification was performed after 7 d of incubation, either on original sampling media—MEA plates or after subculturing procedures. Based on micro- and macro-morphological characteristics, identification of collected fungi was carried out to the highest level that these standard mycological procedures allowed (Atlas and Bartha, 1981). The limit of quantification (LOQ) was established as 10 colony-forming units (CFU)/sample plate.

Carbon Dioxide, Temperature, and Relative Humidity Measurements

For each sampling location, carbon dioxide (CO₂), temperature, and relative humidity (RH) levels were recorded every 5 min simultaneously using an indoor air quality meter IAQ-CALC (model 7545; TSI, Inc.). This monitor includes an infrared nondispersive sensor for CO₂, a thermistor for temperature, and a

thin-film capacitive sensor for RH. The instrument was calibrated according to manufacturer specifications.

Statistical Analysis

SPSS (version 17) software was used for all statistical analysis (SPSS, Inc., released 2009). Fungi concentrations were not normally distributed, so nonparametric tests were used. Spearman's rank correlation coefficient (r_s) was used to realize statistical dependence between airborne fungal concentration and CO₂, temperature, and RH measurements as well as buildings characteristics. Statistical significance was set at $p < .05$.

RESULTS

In total, 73 classrooms representing 20 public primary schools were investigated for total fungal concentrations from air samples as indicators of exposure levels. Most schools (84%) were built prior to 1970 (mean = 1961 (SD = 11.8) years), and none had mechanical ventilation systems. All schools had central heating system (hydronic radiators or electrical appliances). Nineteen percent of classrooms have density of occupation lower than 2 m²/student, a value recommended by ASHRAE 62-2001 (ASHRAE, 2004). Other school building characteristics are described in Table 1.

During air sampling, CO₂ concentration, temperature, and RH levels were measured both indoors and outdoors to evaluate the relationship with airborne fungi levels. A descriptive analysis of these parameters is presented in Table 2. Carbon dioxide concentrations and air temperature values were higher indoors than outdoors. Higher values for RH were found outdoors.

Airborne Fungi Concentrations

Airborne fungi levels were determined for both indoor and outdoor environments. Table 2 reveals a wide range of fungi concentrations, namely, for indoor air samples. Concentrations ranged from 16 to 1686 CFU/m³ indoors,

TABLE 1. School Building Characteristics ($n = 73$ Classrooms)

Characteristics	n (%)	Mean $\pm$ SD	Minimum	Maximum
Floor area/classroom (m^2)	—	50.6 ± 5.6	43.4	70.2
Floor covering				
PVC/linoleum	48 (64.9)	—	—	—
Parquet	26 (35.1)	—	—	—
Damp stains ^a	14 (18.9)	—	—	—
Visible mold ^a	21 (28.4)	—	—	—
Number of students/classroom	—	21 ± 3	15	27
Density of occupation (m^2 /student)	—	2.3 ± 0.4	1.3	3.5

Note. SD, standard deviation.

^aVisible damp stains or mold on walls, floors, and ceilings.

TABLE 2. Indoor and Outdoor Concentrations of Airborne Fungi, CO₂ Levels, Temperature, and Relative Humidity in 20 Schools

	Indoor				Outdoor			
	Mean $\pm$ SD	Median	Minimum	Maximum	Mean $\pm$ SD	Median	Minimum	Maximum
Airborne fungi (CFU/ m^3)	332 ± 274	251	16	1686	224 ± 127	200	53	590
CO ₂ (ppm)	1126 ± 762	859	231	4991	428 ± 109	404	235	1587
Temperature ($^{\circ}C$)	19.2 ± 2.8	19.1	10.3	32.1	13.2 ± 3.8	13.2	2.0	36.8
Relative humidity (%)	55 ± 11	55	11	84	67 ± 14	68	12	95

Note. SD, Standard deviation.

and from 53 to 590 CFU/ m^3 outdoors (mean values of 332 ± 274 CFU/ m^3 and 224 ± 127 CFU/ m^3 , respectively). Concentrations of fungi levels indoors were higher than outdoors ($I/O = 1.5$), but observed difference was not significant.

Spearman's rank correlation was used to test for concordances between airborne fungi levels and CO₂ concentration, temperature, and RH, as well as with particular school building characteristics. As shown in Table 3, correlation indices were not strong; although some of the observed differences were sufficiently consistent to reach statistical significance. Significant correlations were achieved with indoor airborne fungi concentrations and indoor and outdoor temperature ($r_s = .453$ and $r_s = .644$) and with damp stains ($r_s = -.311$). Relative humidity, CO₂ levels, and school characteristics such as mold stains in buildings, year of construction, type of floor covering, floor area, and number of students were not significantly correlated with measured levels of indoor viable airborne fungi. Outdoor environmental parameters were not significantly associated with total fungal concentrations outdoors.

TABLE 3. Spearman Rank Correlation Coefficients Between Airborne Fungi Levels, Environmental Parameters, and School Characteristics

	Airborne fungi	
	Indoor	Outdoor
Indoor		
CO ₂	-0.427	—
Temperature	0.453*	—
Relative humidity	-0.048	—
Outdoor		
CO ₂	0.243	-0.478
Temperature	0.644*	0.096
Relative humidity	-0.165	0.130
Year of construction	-0.144	—
Damp stains	-0.311*	—
Visible mold	-0.085	—
Floor area/classroom	0.054	—
Type of floor covering	0.021	—
Number of students	0.052	—

Note. Significant correlations are marked in bold; * $p < .05$.

Fungi Identification

Nineteen different genera and three fungi species were identified. The prevalence of the identified fungi is displayed in Figure 1. There was a concordance between fungi found indoors and outdoors, but still there were some differences regarding

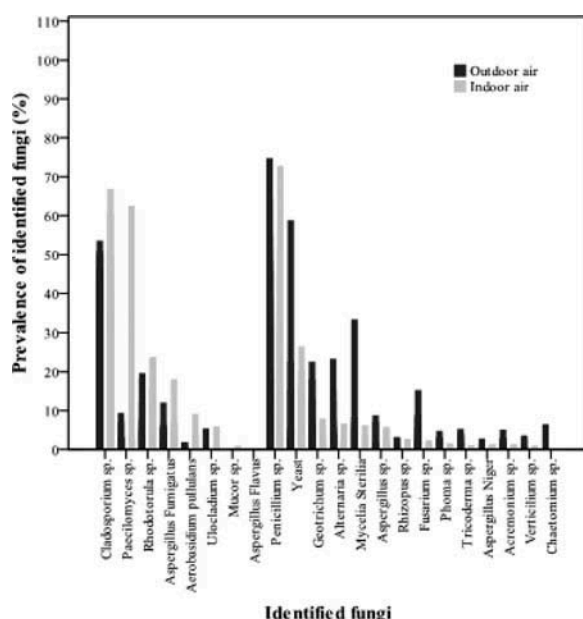


FIGURE 1. Most prevalent fungi genera and species identified in 20 schools.

prevalence of *Cladosporium* sp., *Paecilomyces* sp., *Rhodotorula* sp., *Aspergillus fumigatus* and *Aureobasidium pullulans*, which were recovered from more indoor sampling sites than outdoors. Conversely, in outdoor sampling, *Penicillium* sp., yeast, *Geotrichum* sp., *Alternaria* sp., mycelia sterilia, *Fusarium* sp., *Phoma* sp., *Trichoderma* sp., *Aspergillus niger*, *Acremonium* sp., and *Verticillium* sp. were more frequently found than indoors.

The most prevalent culturable fungal type found indoors was *Penicillium* sp. (>70%), followed by *Cladosporium* sp., *Paecilomyces* sp., yeast, and *Rhodotorula* sp. Other genera occurred in frequencies below 20%, and *Chaetomium* sp. was not found indoors. In the outdoor environment, *Penicillium* sp. was the prevalent type, followed by yeast, *Cladosporium* sp., and mycelia sterilia. In outdoor air samples, *Aspergillus flavus* and *Mucor* sp. were not found.

Spearman's correlations between the most prevalent culturable fungal types (frequency greater than 20%), some environmental parameters and school characteristics were examined (Table 4). Indoor yeast and *Rhodotorula* sp. were significantly correlated (positive)

with indoor CO₂ concentration. A significant positive correlation was noted between *Paecilomyces* sp. and indoor temperature and between yeast and RH.

Regarding the school characteristics, the presence of damp stains was associated with a decreased prevalence of *Geotrichum* sp. The presence of visible mold was associated with lower prevalence of *Alternaria* sp. In contrast, *Geotrichum* sp. was associated with increased prevalence of yeast. Indoor *Geotrichum* sp. and *Paecilomyces* sp. were positively correlated with floor area. The type of floor covering was significantly, positively correlated with indoor prevalence of *Alternaria* sp. ($r_s = .278$), *Geotrichum* sp. ($r_s = .469$), and *Rhodotorula* sp. ($r_s = .361$) but, inversely correlated with mycelia sterilia ($r_s = -0.322$). *Geotrichum* sp. prevalence indoors was positively correlated with the number of students ($r_s = .259$).

DISCUSSION

Estimation of fungal exposures is of increasing importance in assessing IAQ. In fact, Cabral (2010) indicated that fungi may be useful bio-indicators of IAQ. The average indoor fungi concentration obtained in our study was higher than in other studies conducted in similar places (Grisoli et al., 2012; Kim et al., 2007; Mentese et al., 2009; Roda et al., 2011) that reported mean values for fungi concentration between 35 and 120 CFU/m³. In addition, Jo and Seo (2005), in their study conducted during winter season in schools from Daegu, the third largest city of Korea, found fungi concentration levels ranging from 281 to 501

CFU/m³ lower than obtained in this study (range: 16–1686 CFU/m³). In a study conducted in elementary schools in Lisbon, Portugal, Pegas et al. (2011) noted higher levels of indoor fungi concentration mean values above 1802 CFU/m³ compared to this study. Indoor fungal growth is mainly affected by factors such as temperature, RH, and the type of building/furnishing materials. These factors may influence the variation reported between different geographic locations, seasons, and

TABLE 4. Spearman Rank Correlation Coefficients Between Genera/Fungi, Environmental Parameters, and School Characteristics

	CO ₂	Temperature	Relative humidity	Damp stains	Visible mold	Floor area	Type of floor covering	Number of students
Indoor								
<i>Alternaria</i> sp.	-0.293	0.155	-0.149	-0.063	-0.316*	0.159	0.278*	0.139
<i>Cladosporium</i> sp.	-0.284	0.272	-0.129	0.175	0.122	0.103	0.008	-0.048
<i>Geotrichum</i> sp.	0.089	0.230	0.228	-0.253*	-0.354*	0.301*	0.469*	0.259*
Yeast	0.604*	-0.345	0.614*	-0.036	0.290*	-0.154	-0.053	-0.026
<i>Mycelia sterilia</i>	0.172	0.201	0.343	-0.118	-0.195	-0.078	-0.322*	0.144
<i>Paecilomyces</i> sp.	-0.277	0.448*	-0.224	-0.021	-0.148	0.338*	0.085	-0.075
<i>Penicillium</i> sp.	0.244	-0.379	0.050	-0.106	0.074	-0.191	0.054	0.203
<i>Rhodotorula</i> sp.	0.536*	-0.134	0.363	-0.130	-0.178	0.049	0.361*	0.083

Note. Significant correlations are marked in bold; * $p < .05$.

building particular characteristics (Chao et al., 2002; Meng et al., 2012).

While no Europe-wide guideline values exist with respect to biological contaminants indoors, recommendations, guidance, or guidelines have been formulated to protect health and identify health risks by defining indicators of a safe indoor environment (WHO, 2009). Each country has its own set of guideline values, in some cases imposed as legislation. The legal values of fungal bioaerosol in Portugal and guidelines for Canada and the United States for indoor environments are 500, 150, and 1000 CFU/m³, respectively. The standards reach 10,000 CFU/m³ in Germany (Mandal and Brandl, 2011). In this study, 14 classrooms (19% of the total) had airborne fungi concentrations above the maximal value (500 CFU/m³) defined by Portuguese legislation (DL 79/2006).

In healthy buildings, the ratio of indoor/outdoor fungi concentration is lower than or slightly higher than 1, as the majority of fungi present indoors originate from outdoor sources. Conversely, troubled buildings display ratios higher than 1 (Cabral 2010). In this study, indoor air presented higher airborne fungi concentrations than outdoors in a ratio of I/O = 1.5 (median values of 251 CFU/m³ and 200 CFU/m³, respectively). Other studies reported lower or identical ratios (Kalwasinska et al., 2012; Mentese et al., 2009). The concentrations of culturable fungi in outdoor air varied over time in relation to many factors,

including temperature, RH, precipitation, and season.

As our measurements were taken during the heating season (November 2011 to March 2012, and November to December 2012), weather conditions of winter season such as temperature (median = 13.2°C) and heavier precipitation levels might explain our findings and also the basis for I/O ratio higher than 1. In addition, during the winter season occupants spend more time indoors, windows are more often closed, and ventilation, in particular natural ventilation, tends to be poor; thus, higher indoor temperature and RH become suitable for fungal growth indoors. According to the results of Spearman's correlation coefficient test, there was a positive correlation between indoor concentration of airborne fungi and indoor temperature, which is consistent with the fact that optimal temperature ranges for fungal growth were achieved. This mirrors a numerical rise in bioaerosol concentrations with increase of indoor temperature in classrooms.

This study identified *Penicillium*, *Cladosporium*, and *Paecilomyces* species as some of the most frequently detected viable fungi in schools. This is similar to results from other studies (Aydogdu and Asan, 2008; Celtik et al., 2011; Meklin et al., 2005; Roda et al., 2011; Simoni et al., 2011; Zuraimi et al., 2009). Compared to the reported studies, fungi genera distribution observed in our study seemed to be the usual distribution in indoor

air of school buildings. However, differences in some fungi genera prevalence may be attributed to geographic location, season, cultural procedures, different experimental and sampling approaches, RH, and building characteristics.

The differences found between the most abundant fungal genera identified indoors and outdoors may also be related with the individual ability to grow inside buildings or to persist indoors for a longer time after penetration into the building (Meng et al., 2012). A higher prevalence of *Penicillium* sp. was found indoors. Typically, higher concentrations of *Penicillium* have been observed in buildings with moisture damage or with visible mold growth (Garrett et al., 1998; Haas et al., 2007). Garrett et al. (1998) studied association between house dampness, airborne fungal spore levels, and health outcomes in 149 children from 80 households in Australia. These investigators found an association between several conditions of damp housing, including musty odor, water intrusion, high humidity, limited ventilation, and indoor fungal concentrations. Daisey et al. (2003) and Meklin et al. (2005) also noted that water damage in a building often leads to the growth of molds. However, it is noteworthy that these fungi, due to their xerophily, also commonly grow in dust in buildings without obvious moisture problems and are detected indoors at levels greater than those detected outdoors (Chew et al., 2003; Godwin and Batterman, 2007; Jones et al., 2011), as illustrated by the results of this study.

Data imply that not all subjective indicators of dampness can serve as surrogates for the presence of indoor fungi. This was demonstrated in a study by Rosenbaum et al. (2010), who found that airborne molds were significantly associated with wheeze but that visual indicators of mold and dampness were not. Ren et al. (2001) and Denning et al. (2006) suggested that home characteristics and visual assessments of dampness cannot reliably predict the presence of indoor mold. In our study, the correlation between damp stain and visible mold with indoor fungi concentration was not significant. Nevertheless, these signs suggest

potential exposure to fungi, as these factors may produce high levels of air contamination by fungal fragments, which are not detected by culturable methods but still have the ability to penetrate the respiratory system and exert respiratory symptoms (Cabral 2010).

Although *Cladosporium* sp. was reported to be a predominant outdoor species (Cabral, 2010; Ren et al., 1999), our results indicated that this fungus was found at higher concentration indoors. The fact that measurements in this study were taken during the heating season might reduce the impact of outdoor air on IAQ. Evidence suggests that *Cladosporium* may grow inside schools or persist longer indoors and account for a certain portion of *Cladosporium* exposure.

In our study a positive correlation between yeast and RH was observed, similar to results reported by Chao et al. (2002). High RH levels in homes have been associated with several specific genera, including *Cladosporium* and *Penicillium* (Jacob et al., 2002). Similar associations between RH and indoor fungal levels were noted from a multicity survey of asthmatic children in urban areas across the United States, which found that RH was positively associated with high indoor airborne fungal concentrations and with elevated levels of specific fungi (O'Connor et al., 2004). The lack of a consistent association between high RH and some of the fungi identified in our study might be due to variations in the determinants of growth related to RH or the cross-sectional nature of the RH measure, which may not reflect the necessary conditions for mold growth.

Regarding indoor CO₂ levels, a positive correlation between yeasts and *Rhodotorula* was found. Similar results were obtained by Ramachandran et al. (2005), who found a positive significant effect of CO₂ on culturable airborne fungi and on the increase of fungal levels. The flooring material may exert an effect on airborne fungal concentrations. In no-problem schools, airborne fungal concentrations were threefold higher over tiled floors than over carpet (Foarde and Berry 2004), although the concentrations measured in dust

did not differ between these flooring materials. A significant correlation was found between type of floor and *Alternaria* sp., *Geotrichum* sp., and *Rhodotorula* sp. prevalence indoors. Prevalence of these three genera was higher in schools with PVC floor material. This floor material might serve as a substrate for fungal growth and thereby provide a contribution to total and specific genera in indoor air. Low levels of other genera or groups of fungi were also identified. While this study was performed in a temperate climate location and during a rainy season, moisture-indicator fungi, including *Chaetomium*, and *Ulocladium* species were nearly absent in all samples, particularly in those collected indoors.

As previously indicated, it is not easy to compare results from concentration measurements between different studies. Results may vary depending on the sampling used and methodology analysis, season of year for the measurements, region where the measurements were conducted, climate, and living condition (Chew et al., 2003; Hyvarinen et al., 2001; Ren et al., 2001). There are also data indicating that different places in the world have different kinds of moisture-related problems. The lack of insulation also increases the risk of condensation on indoor surfaces with low surface temperature and therefore allows moisture accumulation and fungal growth. It is also difficult to assess the impact of microbial agents indoors as there are no standardized and valid exposure assessment methods established yet, and the method selected for exposure assessment may significantly impact the interpretation of study findings (Tischer and Heinrich, 2013). Nevertheless, counting culturable microorganisms is potentially a reliable, sensitive technique, allowing the identification of many different species (EN 13098, 2000; WHO, 2009).

Identification and quantification of fungi in schools assume particular importance considering that some of identified airborne fungi are associated with health problems, particularly asthma and respiratory problems. The potential role of *Cladosporium* in asthma was previously noted (Daisey et al., 2003). Stark

et al. (2003) reported higher levels of indoor airborne *Cladosporium* as a risk factor for lower respiratory illnesses in a prospectively evaluated Massachusetts birth cohort. According to Rid et al. (2008) and Vijay et al. (2005), *Penicillium* and *Aspergillus* are the most frequently fungi associated with asthma. Katayama et al. (2008) and Vesper et al. (2008) *Aspergillus* species are known allergens that contribute to a variety of respiratory disease processes, including asthma. Our results also demonstrated that concurrent exposure to multiple fungal genera occurred in these studied schools, which might play a role in increased asthma risk.

CONCLUSIONS

To our knowledge, this is the first study in Portugal that investigated the levels and distribution characteristics of airborne fungi in indoor air in public primary schools. Data showed that fungi levels varied over a large range and indoor concentrations were higher than outdoors. The most prevalent fungi found indoors were *Penicillium* sp. and *Cladosporium* sp., which are associated with asthma and respiratory problems. Further, knowledge regarding airborne fungal species allows us to better understand the prevalence and ecology of indoor airborne fungi, which may be useful in the management and prevention of long- and short-term health problems for children and teachers. In addition, data demonstrated that indoor temperature levels were correlated with indoor fungi levels. The results obtained may serve as a reference for future assessments and provide a useful contribution to (1) review of policies, (2) implementing of public health prevention programs, and (3) formulating of recommendations aimed at providing healthier school environments.

FUNDING

This work is supported by the Portuguese Foundation for Science and Technology (FCT) through GERIA project (PTDC/SAU-SAP/

116563/2010) and ARIA project (PTDC/DTP-SAP/1522/2012).

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