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QUALIDADE DO AR INTERIOR EM GINÁSIOS - ESTUDO DE CASO NO MUNICÍPIO DE COIMBRA

INDOOR AIR QUALITY IN GYMS - A CASE STUDY IN THE COUNTY OF COIMBRA

CALIDAD DEL AIRE INTERIOR EN LOS GIMNASIOS - ESTUDIO DE CASO EN EL MUNICIPIO DE COIMBRA

Fábio Monteiro[1]
Ana Ferreira[1]
Fernando Moreira[1]

[1]Instituto Politécnico de Coimbra, Escola Superior de Tecnologias da Saúde, Coimbra, Portugal

Fábio Monteiro - fabio_alexandre_93@hotmail.com | Ana Ferreira - anaferreira@estescoimbra.pt | Fernando Moreira - fernando.moreira@estescoimbra.pt

Autor Correspondente
Fábio Monteiro
Instituto Politécnico de Coimbra,
Escola Superior de Tecnologias da Saúde, Coimbra, Portugal
Rua 5 de Outubro, 3046-854 Coimbra
fabio_alexandre_93@hotmail.com

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RESUMO

Introdução: o aparecimento da qualidade do ar interior (IAQ) como ciência aparece nos anos 70 devido à crise energética com a consequente construção de prédios particulares. Esta visão só ganhou alívio mundial devido à descoberta de que uma diminuição nas taxas de troca de ar neste tipo de edifícios foi a principal causa de aumento da concentração de poluentes no ar interior.

Métodos: O presente estudo caracteriza-se por ser de coorte de nível II, observacional e transversal.
A amostra foi constituída por 3 ginásios de Coimbra e por 7 trabalhadores /. Para atingir esse objetivo, houve uma avaliação analítica dos parâmetros físicos e químicos e preenchimento de questionários pelos trabalhadores.

Resultados: Em relação aos resultados obtidos dos parâmetros avaliados, é possível concluir que os PM 10 (Diâmetro de Partículas de 10 mg / m3), os VOCs (Compostos Orgânicos Voláteis) e a Umidade Relativa apresentaram valores de risco relativos à saúde dos trabalhadores.

Conclusões: Os dados coletados, mostram a relevância dos estudos sobre a qualidade do ar para garantir no futuro ações preventivas de uma melhor qualidade de vida para todos.

Palavras-chave: Qualidade do Ar Interior; Parâmetros ambientais físico-químicos; Saúde pública.

ABSTRACT

Introduction: The appearance of the Indoor Air Quality (IAQ) as a Science appear in the 70's due to the energy crisis with consequent construction of private buildings. This vision only gained worldwide relief because of the discovery that a decrease in rates of air exchange in this type of buildings was the main cause for air increased pollutant concentration in the indoor air.

Objetives: To evaluate the IAQ regarding the applicable legislation in gyms.

Methods: The present study is characterized by being of level II, observational and cross-sectional cohort.
The sample consisted of 3 gyms Coimbra and by 7 workers/. In order to achieve this objective, there was an analytical assessment of both physical and chemical parameters and filling questionnaires by the workers.

Results: Regarding the obtained results of the evaluated parameters, it is possible to conclude that the PM_{10} (Particulate Matter diameter of 10 mg/m^3), the VOC's (Volatile Organic Compounds) and Relative Humidity presented risk values concerning workers health.

Conclusions: The data collected it was possible to verify the importance and relevance of the studies in the future to ensure a better quality of life for all.

Keywords: Indoor Air Quality; Physical-Chemical Environmental Parameters; Public Health.

RESUMEN

Introducción: La aparición de la Calidad del Aire Interior (IAQ) como Ciencia aparece en los años 70 debido a la crisis energética con la consecuente construcción de edificios privados. Esta visión sólo obtuvo un alivio mundial debido al descubrimiento de que una disminución en las tasas de intercambio de aire en este tipo de edificios fue la principal causa de aire aumentado la concentración de contaminantes en el aire interior.

Objetivos: Evaluar la IAQ sobre la legislación aplicable en los gimnasios.

Métodos: El presente estudio se caracteriza por ser de nivel II, observacional y transversal.
La muestra consistió en 3 gyms Coimbra y en 7 trabajadores /. Para lograr este objetivo, se realizó una evaluación analítica de los parámetros físicos y químicos y de los cuestionarios de los trabajadores.

Resultados: Respecto a los resultados obtenidos de los parámetros evaluados, se puede concluir que los PM 10 (Diámetro de Partículas de 10 mg / m3), los COV (Compuestos Orgánicos Volátiles) y la Humedad Relativa presentan valores de riesgo para la salud de los trabajadores.

Conclusiones: Los datos recogidos muestran la importancia y relevancia de los estudios para asegurar en el futuro una mejor calidad de vida para todos.

Palavras-clave: Calidad del Aire Interior; Parámetros físico-químicos ambientales; Salud pública.

INTRODUCTION

In the past, the purpose of building a habitation was only to provide necessary conditions for man, so that he could develop activities of their daily life. However, time has changed and knowledge concerning the structure of buildings has been improved, in particular themes such as safety, comfort, protection from natural causes, among others. However with this trend, new challenges have emerged regarding energy consumption, subsequently causing the Indoor Air Quality (IAQ) to be placed aside Carmo & Prado 1999).
This study aimed to evaluate the IAQ regarding chemical parameters such as CO (carbon monoxide), CO_2 (carbon dioxide), $PM_{2.5}$ (Particulate Matter diameter 2.5 mg/m3), PM_{10}, VOC's , HCHO (Formaldehyde) and physical parameters such as the Relative Humidity (%) and Air Temperature (°C) in 3 gymnasiums located in the district of Coimbra.

1 - THEORETICAL FRAMEWORK

Today, although many challenges are still being confronted, environmental concern has been growing and the impact that IAQ has on health and well-being of people has become a subject of study in the field of Public Health (Costa & Costa, 2006).
In this sense and according to the World Health Organization (WHO), an acceptable IAQ presumes that *"the physical nature and air chemistry that is breathed by the occupants of a building produces a complete well-being, mental, physical and social and cannot cause absenteeism, illness or infirmities"* (Marques, 2013).
Nowadays there is a continuous increase of scientific evidence that the contaminated air which is present inside a building may be more danger that the contaminated air presented outside of that same building, even in industrialized areas (Ramos, 2013). This information becomes extremely important due to the fact that a large number of people (80% to 90%) spend most of their time in buildings and consequently exposed to various existing pollutants (Schirmer, Pian, Sílvia, Szymanski, & Gauer, 2011).
Environments showing a low IAQ are characterized by having a high concentration of pollutants that are harmful to the occupant's health, which are inserted into chemical parameters. These environments combined with an increase in humidity and temperature (physical parameters) can lead to the appearance of a large number of fungi and bacteria (biological parameters) (Fraga et al., 2008).
These parameters have become a study base regarding the IAQ since these can be found, for example in cleaning products, materials and/or damaged equipment and polluted, due to human presence, their activities and poor conditions of ventilation and air renewal (Schirmer et al., 2011); (Alves, 2012).
Due to the multiple pollutants that can be found in a building, the WHO has classified *"Sick Building Syndrome"* (SBS) as a danger to public health. SED is used to mention situations in which the residents of a building show symptoms harmful to health and comfort. These symptoms arise associated with the residence time of an individual inside the building, but no pathology or effect can be identified. Symptoms such as headache; dizziness; nausea; apathy; somnolence; tiredness and/or weakness; among others, depend on the concentration and exposure to short or long term to a given pollutant (Marques, 2013), (Brickus, & Neto, 1999); (Madureira et al., 2015).
The IAQ is directly related to the ventilation conditions in buildings. In this way, a verification and/or repair of the ventilation system is required, consequently improving the quality of air in any type of building (Robertson, 2016).
With regard to the IAQ in sports facilities, few studies are known which implies greater attention in these establishments, since these areas are frequented by many people regardless of their age and purpose for which they train. Staying in these locations can differ from a few hours to every day in the case of the monitors (Marques, 2013). In this sense it is imperative to carry out a continuous assessment of these areas, in order to ensure the best possible conditions for the occupants of these spaces.

2 - METHODS

This study was conducted in the academic year 2015/2016 and the data collection was performed between days 21 December 2015 until 20 January 2016. It was conducted in three gyms located in the county of Coimbra, which were close to transport routes. This study was presented as Level II, observational type and cross-sectional cohort type.

2.1 – Data Collection Instruments and Procedures

This study was based on data collection inside and outside the gym, having collected 9 samples in each, along with the preparation of a questionnaire given to the workers of each establishment. With this in mind, the study showed two moments of investigation. Initially referring the collection of values for the CO, CO2, $PM_{2.5}$, PM_{10}, COV's, HCHO, Relative Humidity and Air Temperature; A second stage which involved the collection of information regarding the health of workers in each establishment by completing a questionnaire.
In particular, the study sample consists of three gyms located in the county of Coimbra and the monitors that showed willingness to participate in this study. Regarding the fulfillment of the questionnaire, the sample was represented by 7 employees.

The total area was recorded, the type of ventilation, and other characteristics of critical areas, with regard to the building conditions of each gym. For these rooms, the gym A has an area of 70 m^3 and 0 ventilation equipment, gym B has an area of 370 m^3 and 0 of ventilation equipment and gym C has an area of 50 m^3 and 3 ventilation equipment.
According to the first moment of evaluation, the parameters mentioned above were evaluated according to an analytical data collection respecting all procedures for a good assessment of the site under study. Each measurement was carried out using four monitoring equipment of Air Quality (Formaldemeter - Model HTV-M - Formaldehyde, Lighthouse - Model 3016 - $PM_{2.5}$ and PM_{10}, Q-Track - Model 8554 - CO, CO_2, Relative Humidity and Air temperature; PhotoVac - Model 2020 Combo Pro - COV's). The place where data collection was performed was based on the worst possible conditions present, according to time and room that presented a greater number of people, and its exterior allowing the collection of variations regarding the concentrations of pollutants in the study.
The measurement of chemical parameters varied regarding the duration of the measurement, since we used two different devices (Lighthouse - Model 3016, Q-Track - Model 8554). To assess CO, CO_2, humidity and air temperature an average of 5 minutes was spent and to evaluate PM_{10} and $PM_{2.5}$ about 15 minutes, both inside and outside. Note that all measurements were done outside after performing the evaluation inside each gym.
As discussed above, an assessment was conducted on the outside and inside the rooms where a larger number of people were presented (in the evening) in all gymnasiums. The devices were placed in an area where the environment presented being more unfavorable for the people, in the area around their airways (between 1m and 1.5m height at least 1m apart walls). In the case of the Outdoor Air Quality (OAQ), the devices were placed near the entrance of the gyms and on the basis of the same height and distance of the inner walls.
According to Decree No. 353-A/2013 of December 4th, the maximum concentration of each pollutant presents a protection threshold. In the case of CO, a limit of 10 mg/m3 (9 ppm), CO_2 of 2250 mg/m^3 (1250 ppm), $PM_{2.5}$ of 25 ug/m^3, PM_{10} of 50 ug/m^3, VOCs 's of 600 ug/m^3 and the formaldehyde of 100 ug/m^3 (0,08 ppm) (Portugal, 2013).
In the case of physical parameters, the protection threshold for the air temperature varies according to the season. Since this study was conducted in winter, the reference value is 20ºC. Regarding Relative Humidity normal values are between thresholds of 30% and 70%.
All data collected, whether interior or exterior, was recorded by hand in a notebook, due to the fact that some equipment lacked any way to store the values obtained.
At the second assessment, the delivered questionnaires are related to the health of the respondents, with questions concerning the number of years in the said profession, the workload, rating their level of work (between monotonous and stimulating), health conditions (had any symptoms or diseases that could be related to the activity performed) and finally concerning their smoking habits, whether or not they presented it. Finally it should be noted that all data collected for the present statistical study were based on curricular and academic purposes and not for profit, without any economic or commercial interest associated. The measurements made and the questionnaires carried out had the consent of the directors of each gym after being informed about the study's objectives, always keeping anonymous the data and any references to the gym.

2.2 – Statiscal analysis

Statistical analysis of the data collected was performed using the IBM SPSS Statistic software version 23.0 for Windows 8.1. Using this software it was possible to use descriptive statistics, such as location measures (mean) and dispersion (standard deviation). The tests used were the t-Student test for independent samples, t-Student test for one sample, Kruskal-Wallis test and the Independence X^2 test. For statistical inference it was possible to establish a 95% confidence level for a random error less or equal to 5%.

3 - RESULTS

Regarding the presented sample, 3 gyms were located in the county of Coimbra, where it was performed various sport activities, such as cycling, zumba, fitness, among others, in a room where all participants could train.
Due to the contribution of workers, it was found that, of the seven individuals who completed the questionnaire, 42.9% were male (3 subjects) and 57.1% were female (4 individuals). With regard to the age of respondents, the average was 28 years (standard deviation = 4.756), the maximum age was 36 years and the minimum age is 21 years. In the case of qualifications it was possible to point out that 71.4% of respondents had a bachelor degree (5 subjects).
After data collection and statistical analysis, it was possible to proceed to compare the mean values estimated from concentrations obtained from both chemical and physical parameters of the air from gyms in study with the protection thresholds indicated in the Decree mentioned above (Table 1).

Table 1: Results of the chemical air parameters

	N	Mean	Standard Deviation	Protection Threshold	Mean Difference	p-*value*
CO (mg/m^3)	18	9,300	14,618	10 mg/m^3	-0,700	0,841
CO_2 (mg/m^3)	18	1232,722	1561,164	2250 mg/m^3	-1017,278	0,013
PM $_{2.5}$ (ug/m^3)	18	24,351	8,566	25 ug/m^3	-0,649	0,752
PM $_{10}$ (ug/m^3)	18	83,027	41,616	50 ug/m^3	33,027	0,004
COV´s (ug/m^3)	18	616,111	259,686	600 ug/m^3	16,111	0,769
Formaldehyde (ppmv)	18	0,064	0,259	0,08 ppmv	-0,016	0,802
Maximum Formaldehyde (ppmv)	18	0,082	0,329	0,08 ppmv	0,002	0,978
Relative Humidity (%)	18	85,039	11,473	30%-70%	15,039	<0,0001
Air Temperature (ºC)	18	13,344	2,747	20ºC	-6,656	<0,0001

Test: t-Student for 1 sample

In the pollutants, it was found that the average concentrations of CO, CO_2, PM $_{2.5}$, Formaldehyde and Air Temperature were presented below the danger threshold for the users of gymnasiums.

Certain parameters showed values higher than the limit threshold stipulated by law, such the case of PM $_{10}$, VOC's and Relative Humidity, whose difference presents a risk to the health of the participants during their physical activity in gyms of the study. Among the parameters with a high significant impact on the health of occupants of gyms, it was the pollutant PM $_{10}$ ($p = 0.004$) which demonstrated a greater discrepancy in which the values exceeded on average 33.027 ppm over the limit established by law, which was 50 ug/m^3.

It was then performed an analytical evaluation for the internal and external environment in order to check which one presented a higher concentration of pollutants studied (Table 2).

Table 2: Results of the chemical indoor and outdoor air parameters

N=9	Measurement Place (Indoor and Outdoor)	Mean	Standard Deviation	p-*value*
CO (mg/m^3)	Indoor	11,322	16,202	0,595
	Outdoor	7,278	13,503	
CO_2 (mg/m^3)	Indoor	2222,778	1723,737	<0,0001
	Outdoor	242,667	48,757	
PM $_{2.5}$ (ug/m^3)	Indoor	25,101	11,074	0,930
	Outdoor	23,600	5,659	
PM $_{10}$ (ug/m^3)	Indoor	89,899	34,903	0,070
	Outdoor	76,154	48,537	
COV´s (ug/m^3)	Indoor	563,333	291,595	0,507
	Outdoor	668,889	228,169	
Formaldehyde (ug/m^3)	Indoor	0,129	0,365	0,146
	Outdoor	0,000	0,000	
Maximum Formaldehyde (ug/m^3)	Indoor	0,164	0,464	0,146
	Outdoor	0,000	0,000	
Relative Humidity (%)	Indoor	85,100	16,134	0,093
	Outdoor	84,978	4,406	
Air Temperature (ºC)	Indoor	15,133	2,055	0,007
	Outdoor	11,556	2,148	

Test: t-Student for independent samples

With these results it was found that there were significant differences in CO_2 and air temperature. However, although it was not observed differences between the place (inside/outside) with respect to PM $_{10}$ ($p = 0,07$), it was possible to state that the indoor revealed, on average, higher values marginally significant when compared to exterior locations.
From the average of CO_2, this has a much higher concentration in the indoor environment compared to measurements outside the gyms. In the other parameters it was not possible to verify significant differences.
Then it was intended to evaluate the pollutants from the spaces (indoor and outdoor) and verify if these varied depending on the various gyms (Table 3).

Table 3: Results of the chemical air parameters in gyms

N=6	Gym A		Gym B		Gym C		Total		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
CO (mg/m^3)	2,400	0,486	3,767	1,446	21,733	21,090	9,300	14,618	0,086
CO_2 (mg/m^3)	485,500	252,969	977,833	839,944	2234,833	2358,824	1232,722	1561,164	0,573
PM $_{2.5}$ (ug/m3)	25,425	7,066	21,293	6,132	26,333	12,026	24,351	8,56	0,434
PM $_{10}$ (ug/m3)	72,362	24,628	87,335	51,684	89,383	49,026	83,027	41,616	0,834
COV´s (ug/m3)	786,667	203,928	693,333	2,262	368,333	144,141	616,111	259,686	0,003
Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,193	0,445	0,064	0,259	0,120
Maximum Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,247	0,566	0,082	0,329	0,120
Relative Humidity (%)	86,200	3,501	80,183	18,706	88,733	6,251	85,039	11,473	0,567
Air Temperature (ºC)	11,483	2,272	14,050	2,933	14,500	2,353	13,344	2,747	0,141

Test: t-Student for independent samples

It was found that regarding the assessment by gyms, these didn´t present significant differences in the parameters studied except for one, the VOC's, which showed different values being higher in gyms A and B and lower in the gym C relative to the limit. However it is also important to note that CO_2 has values close to those stipulated by the legislation in the gym C.
However it is noteworthy that although there may be differences when compared each gym relative to environment (indoor and outdoor), it may not be the same when separating each environment. With this in mind a separation of each environment and an analysis was proceeded to see if those same differences existed (Table 4).

Table 4: Results of chemical parameters of indoor air in each gym

N=3	Gym A		Gym B		Gym C		Total		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation	
CO (mg/m^3)	2,233	0,208	4,433	1,050	27,300	21,700	11,322	16,202	0,061
CO_2 (mg/m^3)	711,000	11,358	1719,000	339,080	4238,333	1366,522	2222,778	1723,737	0,027
$PM_{2.5}$ (ug/m3)	26,117	7,764	17,400	4,918	31,787	15,764	25,101	11,074	0,193
PM_{10} (ug/m3)	90,000	22,805	68,450	2,948	111,247	54,502	89,899	34,903	0,430
COV´s (ug/m3)	826,667	2,715	603,333	73,711	260,000	1,277	563,333	291,505	0,032
Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,387	0,618	0,129	0,365	0,105
Maximum Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,493	0,786	0,164	0,464	0,105
Relative Humidity (%)	84,933	0,924	76,233	28,205	94,133	2,108	85,100	16,134	0,097
Air Temperature (ºC)	12,700	1,044	16,100	1,473	16,600	0,346	15,133	2,055	0,064

Test: t-Student for independent samples

When comparing gyms indoor environment it was found that almost all the parameters showed no significant differences with the exception of CO2 and VOC's, however some are close to present significant differences such as CO, air temperature and relative humidity (Table 5).

Table 5: Results of chemical parameters of outdoor air in each gym

N=3	Ginásio A		Ginásio B		Ginásio C		Total		p-value
	Mean	Standard Deviation	Mean	Standard Deviation	Média	Standard Deviation	Média	Standard Deviation	
CO (mg/m^3)	2,567	0,681	3,100	1,670	16,167	23,412	7,278	13,503	0,871
CO_2 (mg/m^3)	260,000	85,458	236,667	28,361	231,333	26,539	242,667	48,757	0,967
$PM_{2.5}$ (ug/m3)	24,733	7,945	25,187	4,934	20,880	4,880	23,600	5,659	0,587
PM_{10} (ug/m3)	54,723	7,931	106,220	74,829	67,520	40,054	76,154	48,537	0,288
COV´s (ug/m3)	746,667	159,478	783,333	313,422	476,667	20,817	668,889	228,169	0,088
Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000
Maximum Formaldehyde (ug/m^3)	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	1,000
Relative Humidity (%)	87,467	4,997	84,133	5,698	83,333	2,401	84,978	4,405	0,430
Air Temperature (ºC)	10,267	2,715	12,000	2,594	12,400	0,700	11,556	2,148	0,561

Test: t-Student for independent samples

On the outside environment it was possible to verify that all parameters did not show significant differences, however one of the parameters is close to show significant differences, in particular VOC's.
Regarding the health of the workers an analysis was made in order to verify if the malaise that workers had could be related to the fact that they carry out activities outside the gym or not.

4 - DISCUSSION

Improving the quality of life of a population/community it is increasingly becoming a factor aggregated to the air quality levels that each person breathes. Thus the air quality can affect our well-being, influencing our present and future thus becoming one of the main risk factors for public health (Santos, 2008); (Ferreira & Cardoso, 2013).
After analyzing the results it was possible to verify that in the average values, obtained in 3 gyms concerning chemical and physical parameters of IAQ, most of the parameters were not excessive when compared to the threshold values, except three parameters PM_{10}, VOC's and Relative humidity, which exceeded the limit (50 ug/m3 600 ug/m3, a range of 30% -70% respectively).
Given that a large percentage of people spend most of the time indoors, the IAQ is fundamental to the health of those same people. Interior spaces usually have little air exchange rate when comparing with the outside environment, thus there is a tendency to accumulate harmful pollutants. Due to this trend, it is important to monitor the indoor air quality with respect to maintenance, inspection and possible recovery of IAQ (Barbosa, 2012).
Nowadays people are more sensitized regarding IAQ, associating some discomforts that can be felt to the poor indoor air quality. It is known that the presence of living beings (humans and animals), all types of equipment (ventilation) and materials (curtains, furniture, etc.) which are in the buildings may be possible sources of contamination (Sodré, Tórtora, & Corrêa, 2014).
According to the analysis presented in Table 2 it is possible to see that the indoor air has higher values than the air outside. Regarding the parameters that had values above the limit threshold set by legislation, they become harmful and have many complications.
Although CO_2 did not show a mean higher than the protection limits, it is important to refer its properties because of its potential both as a way to evaluate IAQ as of dangerous.
Carbon dioxide, being at room temperature, is characterized by being colorless, odorless and non-flammable resulting from metabolism of building occupants and other sources such as combustion appliances (oven, fireplaces, boilers, etc.). Thus CO_2 is recognized as an indicator of ventilation rates and own assessment of IAQ. When performing minor tasks, people release about 0,3L/min of CO_2, varying the concentration depending on the size of the space, the time of day and also depending on the level of physical activity, leading to a minimum ventilation rate per person 10L/s in order to ensure good IAQ in buildings recommended by the ASHRAE Standard 62-1989. Very low concentration levels of CO_2 don´t present any kind of danger, but when it exceeds 30 000 ppmv, it can cause headaches, dizziness and even nausea (Santos, 2008); (Sodré et al., 2014).
The particulate material consists of condensed particles that are classified by diameter feature. It is known that the density, shape and particle size are harmful factors when they reach the lungs. The smaller it is the more dangerous it becomes to health. They can be found in many places such as in smoke of cars, the type of pipes isolation, carpets and in the ventilation system filters. High levels can cause symptoms such as allergy, irritation to the eyes and nose, coughing and breathing difficulties, bearing in mind that most dangerous particles may eventually cause asthma and/or bronchitis (Sodré et al., 2014); (Matos & Andrade, 2013).
The VOC's can contribute to tropospheric ozone formation and the destruction of the stratospheric ozone layer, which can be found in various sources inside a building such as carpets, paints and varnishes, cleaning agents, photocopiers, among others. Depending on the exposed concentration it can be more or less damaging, in other words, concentrations between 0.3 and 3 mg/m^3 may cause irritation, discomfort, and even stress. Amounts exceeding $25mg/m^3$ can cause other more dangerous symptoms such as respiratory irritation (Santos, 2008); (Sodré et al., 2014).
Regarding the relative humidity, this may result due to a poor control of the moisture levels, the amount of equipment, occupational density and also the possible inability of the building in terms of air exchange rates. High humidity values can lead to proliferation of microorganisms and even worse pollutant concentration. Symptoms that can be associated with moisture are the thermal discomfort, increased irritability, and further lead to loss of concentration of the occupants (Sodré et al., 2014).
Although the values found are above the threshold values, it is important to note that in all the studied areas there were means that could provide exchanges between the indoor and outdoor air.
The use of ventilation systems aims to renew air, consequently removal of pollutants and/or harmful particles generated by human activities or from used machinery and equipment. This measure has other advantages, such as ensuring good hygiene and good health to the building occupants favoring the comfort of the same, increasing the oxygen rate and still control the

humidity and temperature levels, contributing to the improvement of indoor air quality. However it should only be performed when the outdoor environment has good air quality (Schossler, Santana, & Spinelli, 2015; Barros, 2013).
Given the values found in respect of the parameters evaluated it can be seen that there is a possibility of risk to the health of occupants in gyms relative to the concentrations of PM_{10}, VOC's and Relative humidity.
When conducting physical activity it is necessary to pay attention to the type of exercise performed, frequency, time and even the intensity of it. These factors are directly related to energy expenditure in the body. Other associated aspects that can be highlighted are the type of diet, physical condition and morphology of the athlete. All these conditions influence the effort recovery time, the performance and concentration in which the activity is performed, especially if the exercise is of short duration and high intensity (Ramos, 2013; (Ferreira & Cardoso, 2013).
Information gathered from surveys has shown that most workers had symptoms such as fatigue, stress and perturbations of sleep/insomnia.
When the evaluation in gyms was performed, it was possible to observe some situations that can be improved, though they may be already legally enforceable. Thus, some recommendations are given.
In order to prevent the appearance of high pollutant concentrations, a good ventilation of spaces should be performed, thus creating a form of daily-ventilated either through mechanical ventilation equipment (insert clean air) or air conditioning equipment filtering the outside air when it has good air quality, either by opening windows and doors of the building, in order to ensure air changes.
Another measure goes through the habit of performing a proper cleaning of the space and maintenance of HVAC equipment in order to control the pollution parameters of indoor air. Taking this information into account it would be essential to prevent or eliminate, if possible, the appearance of signs regarding moisture and clean fixed surfaces and furniture so that there is no possibility of the dust.

CONCLUSIONS

In short, with the analysis carried out it is possible to verify that three of all parameters were indicated with values above the protection threshold, namely PM_{10}, VOC's and Relative humidity, therefore conclude that existed at the time of data collection a poor air ventilation, which caused an air saturation in the area. However other types of ventilation should be adopted to improve filtration and air cleaning that may eventually come from the outside contaminated air, or from the place itself and the people who attend it.
It should be noted that the study was conducted in winter and in a few days it was raining. Another important limitation is the small number of surveys conducted since each gym had few permanent workers.
Thus it is relevant the need for more studies in this area, regardless of the county, with a larger sample and respectively more employees willingly to respond more simple and direct questionnaires regarding their perception of the air they breathe indoors.
However it would be interesting to compare data collected in different seasons of the year in order to make the study more representative and the sample more significant thus making a most comprehensive study.
The development of IAQ area becomes, therefore, very important for environmental health because it includes the various professionals involved in this area that perform the most various activities. Thus it is necessary to intervene to prevent problems associated with IAQ in buildings, in order to contribute to a better level of comfort, well-being and health of its occupants, whether workers or people who attend this type of establishment.

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