ANALYSIS OF THE PREVALENCE OF RESPIRATORY SYMPTOMS IN PEOPLE PRACTITIONING PHYSICAL EXERCISE IN SANTOS

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ABSTRACT
Objective. To analyze the prevalence of respiratory symptoms among exercise practitioners in Santos. Methods. A cross-sectional study was carried out through the registration of two self-administered questionnaires, one of which was a sociodemographic data questionnaire and the other a validated European Community Respiratory Health Survey (ECRHS) questionnaire for the evaluation of respiratory symptoms. Descriptive analyses of all variables, univariate and multiple logistic regression models to assess the risk of exposure, and analysis of spatial dynamics were performed. The significance level was 5%. Results. Exposure to moldy humidity (OR = 2.38; 95% CI: 1.31; 4.30), and higher education (OR = 6.96; 95% CI: 2.21; 21.45) were jointly significant factors for rhinitis. Regarding the responses to the ECRHS questionnaire, we can see that those who live in Ponta da Praia have a 2.43 (95% CI: 1.05; 5.64) times greater chance of having wheezing than those who live in other regions of Santos. The analysis of spatial dynamics shows a higher prevalence of respiratory symptoms in residents of Ponta da Praia. Conclusion. Exposure to air pollution plays an important role in respiratory symptoms such as rhinitis and wheezing among those who practice physical exercise in the region of the Rebouças Sports and Recreation Complex, Ponta da Praia, in the city of Santos.

Keywords: Cross-sectional study. Air pollution. Physical exercise. Respiratory symptoms. Rhinitis.

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INTRODUCTION

According to the World Health Organization (WHO), air pollution is a critical environmental problem that affects human health and quality of life. Sources of air pollution include emissions from vehicles, industries, and the burning of fossil fuels. Recent studies indicate that exposure to air pollutants, such as fine particulate matter (PM2.5), nitrogen dioxide (NO2), and ozone (O3), is associated with an increased risk of respiratory and cardiovascular diseases (WHO, 2022).

Approximately 99% of the world's population lives in places where air pollutant levels exceed acceptable air quality limits, exposing the population to their deleterious effects, and is considered a global public health concern by the Pan American Health Organization (PAHO, 2022).

The damage caused by air pollution is increasingly worrying, as described by PAHO (2022). Polluted air is considered one of the main environmental risks to health and is a serious problem that needs to be discussed on several fronts, and few cities have adequate air quality. Air pollution is an invisible threat to health and, in addition, generates a major economic impact. The Ministry of Health (MS) states that the benefits of practicing physical exercise are numerous and, as it improves aerobic capacity and physical function, it also reinforces the improvement of cardiorespiratory fitness, but when performed in places with high levels of exposure to pollution, it can cause harm to health (BRASIL, 2022). As the Ministry of the Environment (MMA) points out, air quality is fundamental to the well-being of the entire society and, since 2019, it has been a priority for the MMA to take care of air quality and the health of more than 80% of Brazilians, who are currently concentrated in urban centers. If air quality in large cities continues to worsen, cardiovascular and respiratory diseases will increase, even among healthy people who exercise (MMA, 2020).

Air quality is directly influenced by the distribution and intensity of atmospheric pollutant emissions, topography, land use, and meteorological conditions that hinder the dispersion of pollutants, causing an increase in their concentration levels, which can be observed by air quality monitoring networks, according to the National Environmental Council (CONAMA, 2022).

RAE KIM et al., (2021) state that together with aerobic training, it improves blood vessel compliance and reactivity, systemic immune function, and cardiac output. However, air pollution is an obstacle to active exercise, and many individuals who exercise in places with high concentrations of pollutants run the risk of having their respiratory and cardiovascular health compromised.

For the same authors, the impacts of exposure to air pollution can be aggravated during periods of faster or deeper breathing, for example, during physical exercise, because when there is a higher rate of air exchange and, consequently, an increase in the volume of inhaled air, pollutants penetrate the respiratory tract with greater intensity, not to mention the notable negative impact on the quality of life of those who practice physical exercise.

The impacts of exposure can be aggravated during periods of faster or deeper breathing, for example, during physical exercise, because when there is a higher rate of air exchange and, consequently, an increase in the volume of inhaled air, SO2 penetrates the respiratory tract with greater intensity (CETESB, 2023).

The main objective of this study is to analyze the respiratory health of those who practice physical activity and live in the Ponta da Praia neighborhood, a neighborhood very close to the port, where practitioners are exposed to a region with high levels of air pollutants.

MATERIALS AND METHODS

A cross-sectional study was carried out by recording two self-administered questionnaires, one of which was a sociodemographic data questionnaire and the other a validated European Community Respiratory Health Survey (ECRHS) questionnaire for the assessment of respiratory symptoms. The study was approved by the research ethics committee of the Catholic University of Santos (UNISANTOS).

It was carried out in the city of Santos, São Paulo - Brazil. The total area of the city is 281,033 km², the island area is 39.4 km², and the continental area is 231.6 km², with a total population of 414,029 thousand inhabitants, according to the Brazilian Institute of Geography and Statistics (IBGE, 2022).

The city of Santos has the largest port in Latin America, is responsible for the transshipment of more than a quarter of Brazil's trade balance, has an area of 3,700,000 m² on the right bank (Santos) and 4,000,000 m² on the left bank (Guarujá), totaling a pier extension of 13 kilometers (PORTO DE SANTOS, 2021).

The Rebouç Sports and Recreational Complex is located in the Ponta da Praia neighborhood, in the municipality of Santos and close to the port of Santos, with a pier extension of 16 km and a total useful area of 7.8 million m² (EMBRAPA, 2020).

The sample was calculated based on the prevalence of respiratory diseases in the Brazilian population of 20% (J. BRAS. PNEUMOL, 2006; MINISTRY OF HEALTH, 2010), with a power of 80%, a significance level of 5% and a delta of 5%, that is, the prevalence can vary between 15% and 25%, considering a total of 2,000 people practicing physical exercise at the Rebouças Sports and Recreational Complex, adding 20% due to possible losses, a total sample of n = 240 individuals was reached.

Adults over 18 years of age, of both sexes, who practiced physical exercise and had been living in the city of Santos for at least 1 year, at the Rebouças Sports and Recreation Complex, were selected.

Participants answered the questionnaire via email, Google Forms, WhatsApp, and in person, after signing the informed consent form. Individuals who had 4 or more positive responses to the ECRHS questions, according to tested and validated criteria, were considered asthmatics. Those who answered “Yes” to the question “Do you have any allergies in your nose or allergic rhinitis?” were considered to have rhinitis or nasal allergies.

In this study, the dependent variables were rhinitis, asthma, and respiratory symptoms. The independent variables were sociodemographic, allergen block, health block, physical exercise block, post-pandemic physical exercise block, and respiratory symptoms. A descriptive analysis was performed on all study variables, transformed into qualitative variables, and presented in terms of their absolute and relative values (CALLEGARI-JACQUES, 2009).

To assess the risk of exposure, the univariate and multiple logistic regression model and spatial dynamics analysis were used. Univariate and multiple logistic regression analysis was performed by blocks, where the variables were grouped by similar characteristics.

In the univariate model of each block, the variables that presented a significance level of less than 20% ($p<0.20$) were tested in the multiple model by block, leaving only the variables that presented a significance level of 5% ($p<0.05$) in the final model.

The multiple logistic regression analysis was performed using the Stepwise method (KLEINBAUM, KUPPER, NIZAM, 2008). The significance level was 5% and the statistical package used was Statistical Package for the Social Sciences (SPSS version 24.0) for Windows.

The spatial dynamics analysis was performed by Quantum GIS (QGIS), an Open Source Geographic Information System (GIS) licensed under the General Public License, and its function is to create, edit, visualize, analyze, and publish geospatial data and health determinants and problems that can be used, in addition to detection, to eliminate problematic situations (MINISTRY OF HEALTH, 2006).

The significance level adopted was 5% and the packages used were SPSS version 24.0 for Windows and Qgis 14.

Since this is a study using secondary and public domain data, this study was approved by the Research Ethics Committee of the Catholic University of Santos (UNISANTOS), Opinion Number: 4,362,920, in accordance with Resolution No. 466/12 and 510/16 of the National Health Council (CNS).

RESULTS

Table 1 presents the descriptive analysis of the variables age group, local group, gender, education level, and profession. It can be seen that most of the participants who live in Ponta da Praia, are adults, female, white, have higher education, have partners, and are active.

TABLE 01: Descriptive Analysis of Sociodemographic Data of Physical Exercise Practitioners, Santos, 2022

Variable	N	%
Local Group		
Ponta da Praia	171	71.5
Others	69	28.5
Age Group		
Adults (18 to 59 years)	148	61.7
Elderly (60 years and older)	92	38.3
Gender		
Female	138	57.5
Male	102	42.5
Ethnicity		
Yellow/Oriental	2	0.8
Indigenous	2	0.8
Black	15	6.3
Mixed-race	58	24.2
Education Level		
Elementary School	29	12.1
High School	64	26.7
Higher Education	108	45.0
Postgraduate	39	16.3
Occupation		
Homemaker	15	6.3
Retired	55	22.9
Employed	170	70.8
Current Marital Status		
With Partner	142	59.2
Without Partner	98	40.8

The table presents risk factors and confidence intervals for rhinitis in physical exercise practitioners using the univariate model. It is observed that exposure to dust increases the likelihood of rhinitis symptoms by **1.99** (95%CI: **1.13-3.47**), and exposure to humidity/mold increases the likelihood by **2.11** (95%CI: **1.22-3.64**).

TABLE 02. Logistic Regression Analysis of Allergenic Materials in Physical Exercise Practitioners Related to Rhinitis Symptoms

Rhinitis	Univariate		
	OR	95% CI (Lower)	95% CI (Upper)
Dust			
No	1.00	___	___
Yes	1.99	1.13	3.47
Animal			
No	1.00	___	___
Yes	1.46	0.87	2.46
Humidity/Mold			
No	1.00	___	___
Yes	2.11	1.22	3.64

This table presents risk factors and confidence intervals for rhinitis in physical exercise practitioners using multiple models. It is observed that **exposure to humidity/mold** increases the likelihood of rhinitis by **2.38** (95%CI: **1.31-4.30**), and **higher education** increases the likelihood by **6.96** (95%CI: **2.21-21.45**), making them jointly significant factors for rhinitis.

TABLE 03: Multiple Logistic Regression Analysis of Significant Variables Related to Rhinitis Symptoms (Humidity/Mold and Education Level)

Rhinitis	Multiple		
	OR	95% CI (Lower)	95% CI (Upper)
Gender			
Male	1.00	___	___
Female	0.50	0.29	0.89
Humidity/Mold			
No	1.00	___	___
Yes	2.38	1.31	4.30
Education Level			
Elementary School	1.00	___	___
Higher Education	6.96	2.21	21.45

In the univariate logistic regression analysis for respiratory symptoms (Table 4), it is observed that **smoking** increases the likelihood of wheezing by **3.53** (95%CI: **1.02-12.16**) compared to non-smokers. Additionally, individuals living in **Ponta da Praia (Port)** have **2.32** (95%CI: **1.01-5.34**) times higher chances of experiencing wheezing compared to those who do not live there.

TABLE 04: Univariate Logistic Regression Analysis of Wheezing and Whistling Symptoms in the Last 12 Months

Wheezing	Univariate		
	OR	95% CI (Lower)	95% CI (Upper)
Glue/Adhesives			
No	1.00	___	___
Yes	1.88	0.76	4.60
Do you smoke?			
No	1.00	___	___
Yes	3.53	1.02	12.16

Local Group			
Other districts	1.00	___	___
Ponta da Praia	2.32	1.01	5.34

The multiple logistic regression model demonstrated that **living in Ponta da Praia (Port), having carpets/rugs at home, and smoking** are jointly associated risk factors for wheezing symptoms.

- **Living in Ponta da Praia** increases the chance of wheezing by **2.43** (95%CI: **1.04-5.65**) compared to those living in other areas.
- **Having carpets/rugs at home** increases the chance of wheezing by **2.81** (95%CI: **1.00-7.86**) compared to those without carpets/rugs.
- **Smoking** increases the likelihood of wheezing by **4.07** (95%CI: **1.12-14.80**) compared to non-smokers.

TABLE 05: Multiple Logistic Regression Analysis of Wheezing Symptoms

Wheezing	Multiple OR	95% CI (Lower)	95% CI (Upper)
Local Group			
Other districts	1.00	___	___
Ponta da Praia	2.43	1.04	5.65
Carpet/Rug			
No	1.00	___	___
Yes	2.81	1.00	7.86
Do you smoke?			
No	1.00	___	___
Yes	4.07	1.12	14.80

The use of spatial analysis of health data was an important strategy for understanding the dynamics of the prevalence of respiratory symptoms among exercise practitioners at the Rebouças Sports and Recreation Complex in the city of Santos, comparing the neighborhoods of Ponta da Praia and others.

The outcomes for rhinitis and wheezing and their distribution in the Ponta da Praia neighborhood in relation to other neighborhoods were considered.

Among the study participants, the following were identified:

- 92 with rhinitis in the Ponta da Praia neighborhood
- 27 with wheezing symptoms in the Ponta da Praia neighborhood
- 119 with rhinitis and wheezing symptoms in the Ponta da Praia neighborhood and others

Georeferencing of participants with rhinitis and wheezing in the Ponta da Praia neighborhood and others (KERNEL) (Figure 1).

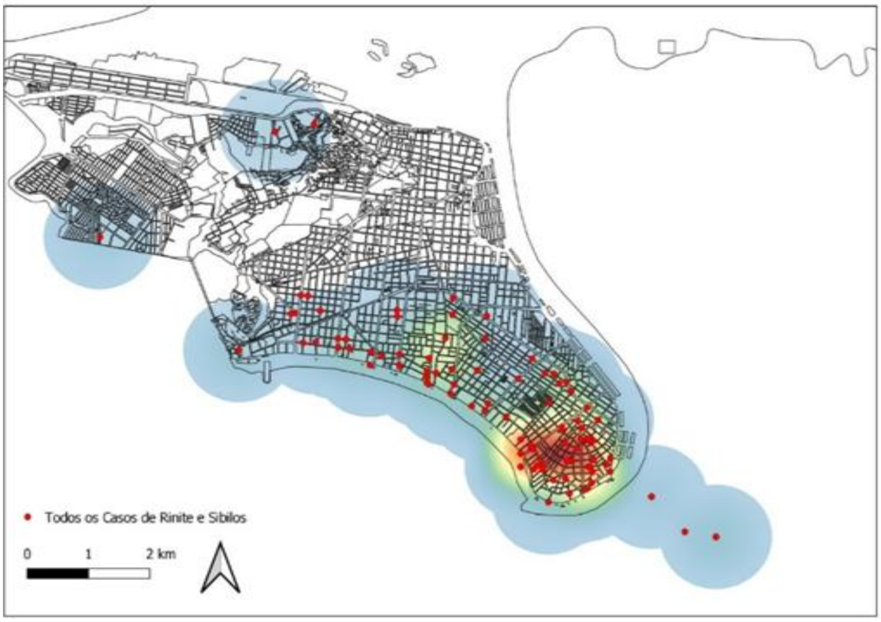
When applying the spatial autocorrelation test, positive values were detected, that is, there is a dependence between the analysis units that influence the pattern of respiratory diseases such as rhinitis and wheezing, and air pollution in a dynamic way, indicating that it is somehow associated with the practice of physical exercise and its location due to its proximity to the port.

The highest prevalences were found in the Ponta da Praia neighborhood for rhinitis and wheezing symptoms, associated with higher concentrations for the Ponta da Praia neighborhood, due to its proximity to the port of Santos.

The Kernel density map (Figure 1) or heat map, within Qgis, is used in the health area to show, through point data, where it is more concentrated and more dispersed and also shows the density of points within a radius of coverage.

The vector file of points, which are the limits of the neighborhoods of Santos, SIRGAS 2000, UTM by the Municipal Government of Santos.

FIGURE 01: Georeferencing of participants with rhinitis and wheezing, in the Ponta da Praia and other neighborhoods (kernel).



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It can be seen that those in red represent those with neighborhoods with high respiratory diseases (rhinitis and wheezing). In the white neighborhoods, there is a low concentration of rhinitis and wheezing. In the neighborhoods in blue, there is an average concentration of rhinitis and wheezing.

DISCUSSION

The data obtained in the present study demonstrate that the majority of participants who live in Ponta da Praia are adults, female, white, with higher education, with partners, and active. The present study showed that in the period evaluated, from March 2022 to July 2022, there was a significant association between exposure to air pollution and respiratory diseases such as rhinitis and wheezing in physical exercise practitioners at the Rebouças Sports and Recreational Complex located in Ponta da Praia.

Regarding the results obtained, possible discrepancies can be explained by geographical differences, as the studies differ in terms of sampled populations, age groups, case and exposure definitions, and analytical techniques used. Air pollutants continue to be a contributing factor to the increase in cases of rhinitis and wheezing.

The present study had some limitations; the first is inherent to the project itself, as it was a cross-sectional study and, therefore, used primary data that serves to quickly assess the results through questionnaires via Google Forms, WhatsApp, and in person.

Understanding the relationship between the effect of air pollution on respiratory diseases such as rhinitis and wheezing in exercise practitioners at the Rebouças Sports Complex is an advance in knowledge that enables differentiated intervention policies for all practitioners in the location and in neighborhoods that are also close to the city's port region.

Similar results to ours were found in other studies conducted by SHI AND SUN (2022), where they systematically evaluated the effect of exposure to air pollutants on the lung function of exercise practitioners. The meta-analysis showed that exposure to air pollutants has no significant effect on forced expiratory vital capacity (FVC), forced expiratory volume in the first few seconds (FEV1), and peak expiratory flow (PEF) of exercisers ($p>0.05$); but it can significantly increase the level of iron nitrate (FeNo) of exercisers.

Exposure to air pollutants can cause allergic inflammation of the airways, increasing FeNo levels in exercised populations and adversely affecting human health. Practicing physical exercise in environments with high concentrations of pollutants can pose significant health risks.

According to a review of studies, exposure to pollutants during exercise can exacerbate the adverse effects of these pollutants, since physical activity increases the ventilation rate and, consequently, the amount of pollutants inhaled (TAINIO et al., 2021).

Another study considers air pollution to be an environmental priority in the European port sector. Therefore, there are many concerns about the adverse health and pollution outcomes that occur due to air exposure related to the operations of large ports in Europe, which have a significant environmental impact, often not assessed or measured due to budgetary constraints (SIROKA et al. 2021).

Air pollutants increase the presence of free radicals that are not neutralized by antioxidant defenses and increase the inflammatory response with the release of inflammatory cells and mediators (cytokines, chemokines, and adhesion molecules) that reach the systemic circulation, leading to subclinical inflammation with repercussions not only on the respiratory system but also causing systemic effects (SANTOS et al., 2021).

In the research by QIN et. al, (2019), the authors explain that through their study where the objective was to evaluate the influence of exposure to air pollution and outdoor exercise. Estimates of the combined effect of exposure to air pollution and outdoor exercise were calculated in the meta-analysis.

Six studies addressed exposure to O^3 and ten to exposure to PM; seven studies reported that exposure to air pollution during physical exercise was associated with an increased risk of airway inflammation and decreased lung function. Six studies demonstrated that exposure to traffic pollution or high PM during exercise may contribute to changes in blood pressure, systemic function of the ductus artery, and microvascular function.

FINAL CONSIDERATIONS

Despite efforts to reduce pollutant emission levels in recent decades in the city of Santos, the pollutant concentrations analyzed in the period studied showed that the effects of air pollution on the respiratory health of those practicing physical exercise are still measurable and significant.

Therefore, it is recommended that efforts be intensified in the search for the lowest levels of PM concentration. Air pollution to minimize the adverse effects of exposure to atmospheric pollutants on those who practice physical exercise at the Rebouças Sports and Recreation Complex (Ponta da Praia). The presence of materials considered allergenic in the homes of the participants was observed, with an association between exposure to dust and physical exercise. There was also an association between having a stuffed toy and physical exercise, with a greater predominance in female individuals.

Evaluating the Georeferencing (Figure 1), the spatial dynamics demonstrate that cases of rhinitis and wheezing among those who practice physical exercise are concentrated within the Ponta da Praia neighborhood, in locations close to the port region. Considering that the present study was carried out with data from the CETESB Monitoring

Station located next to the Rebouças Sports Complex, it allowed for the official and targeted capture of information on the pollutants present in the atmospheric plume.

It is crucial that public policies are implemented to improve air quality and that people are informed about the potential risks of exercising in highly polluted areas. Measures such as creating low-level zones can help reduce exposure to air pollution.

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