Scientific Research Publishing

Health, 2023, 15, 871-882
https://www.scirp.org/journal/health
ISSN Online: 1949-5005
ISSN Print: 1949-4998

Prevalence of Ventilatory Function Abnormalities in Residents of Attecoube Lagune, Abidjan (Côte d'Ivoire)

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How to cite this paper: Wognin, A.S., Konan, L.L., Essis, E.M.L., Otshudi'a Ndjekaoma, J.B., Yapo, O.B. and Tiembre, I. (2023) Prevalence of Ventilatory Function Abnormalities in Residents of Attecoube Lagune, Abidjan (Côte d'Ivoire). *Health*, **15**, 871-882.
https://doi.org/10.4236/health.2023.158057

Received: June 28, 2023
Accepted: August 20, 2023
Published: August 23, 2023

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Abstract

Introduction: Studies of abnormal ventilatory function in Côte d'Ivoire have been carried out in the workplace and in schools. The objective of this study was to determine the prevalence of respiratory symptoms and ventilatory function abnormalities in the population of the lagoon district of Attécoubé in Abidjan. **Material and Methods:** A cross-sectional study was carried out on 170 people in the municipality of Attécoubé Lagune. A questionnaire was used to collect information on sociodemographic, clinical, and environmental characteristics. A basic spirometry and a beta mimetic test were carried out on all the subjects surveyed. Data analysis was done with the stata 15.1 software. **Results:** The study population was composed of 103 women and 67 men with a sex ratio (M/F) of 0.65. The average age was 35.92 ± 15.28 years. The most frequent respiratory symptoms were chest tightness (29.41%), dyspnea (28.82%), sneezing (22.94%) and cough (22.35%). The prevalence of ventilatory function abnormalities was 43.24% among residents of Attécoubé Lagune and the most frequent abnormality was ventilatory restriction (35.15%) followed by obstruction (4.85%). The risk factor for ventilatory function abnormalities was heavy pollution [OR = 2.66; IC: 1.053 - 6.743; P = 0.038]. **Conclusion:** Residents of the Attécoubé Lagune district had many respiratory symptoms and a high prevalence of ventilatory function abnormalities. Improving air quality is urgently needed in this municipality.

Keywords

Obstruction, Restriction, Ventilatory Function Abnormalities, Air Pollution, Attécoubé Lagune, Abidjan, Côte d'Ivoire

1. Introduction

Air pollution is a major health risk factor [1]. According to the World Health Organization (WHO), 7 million people die from air pollution every year. About 91% of these premature deaths occur in low- and middle-income countries [2]. 42% of premature deaths related to outdoor air pollution were due to acute and chronic lung diseases in 2016 [3]. Air pollution increases the risk of irritation, allergic sensitization, acute or chronic respiratory symptoms and illnesses and impaired lung function [4] [5]. Even relatively low levels of air pollution are a health risk. According to the number of people exposed, they cause a significant morbidity and mortality in all countries. Residents of disadvantaged areas, such as slums and those living near high-traffic roads or industrial sites, are often exposed to higher levels of ambient air pollution, which appears to be increasing in many cities.

In the megalopolis of Abidjan, which is subject to strong demographic pressure, the Dynamic Aerosol-Cloud-Chemistry Interaction in West Africa (DACCIWA) project found $PM_{2,5}$ concentrations of 32 µg/m^3 and 45 µg/m^3 respectively at a road traffic site and a fish smoking site [6]. As a result, the air quality in Abidjan, as in most large cities, is impaired. The majority of studies on air quality in relation to respiratory diseases in Côte d'Ivoire have focused on the professional sector and the school environment [7] [8] [9]. On the other hand, few studies have focused on the community environment, hence the interest of the present study whose objective was to determine the prevalence of respiratory symptoms and ventilatory function abnormalities among the residents of Attécoubé Lagune.

2. Materials and Methods

2.1. Framework of the Study

The municipality of Attécoubé, our study site, is one of the thirteen municipalities of the Autonomous District of Abidjan. It is located between the essentially commercial municipality of Adjamé and the highly industrialized municipality of Yopougon. The municipality of Attécoubé has 207,586 inhabitants and extends over 68.2 km^2. It is divided into two banks, right and left, and has 35 districts with 5 villages. The unbuilt space is proportionally greater than that offering an adequate living environment. Indeed, we can attribute 30% of built space, 50% of anarchic occupation zone and 20% of unbuilt zone. The economic life in Attécoubé is essentially dominated by trade and craft activities.

2.2. Type of Study

This was a cross-sectional study with descriptive and analytical purposes that took place over a period of two months, from February 15, 2022, to April 15, 2022, in the Attécoubé Lagune neighborhood.

2.3. Population

The study population consisted of the inhabitants of Attécoubé Lagune neighborhood residing between the Banco Bay and Peace Boulevard.

2.3.1. Inclusion Criteria

Residents who were at least 18 years old of age and who gave a favorable opinion were included in the study.

2.3.2. Non-Inclusion Criteria

Pregnant women, ill persons, non-consenting residents, and all those who were unable to perform the spirometry test were excluded from the study.

2.4. Sampling and Sample Size

Starting from the center of the neighborhood, the right side of the entrance of the Naval Training Center (NTC) was randomly selected as the starting point for data collection. The progression was made in the direction of the road interchange with a probing pitch equal to 2. We thus proceeded to the right and to the left side to visit the chosen dwellings; all individuals who fulfilled the inclusion criteria were exhaustively enrolled. The StatCalc program in Epi Info version 7.2.1 was used to calculate our minimum sample size. A minimum sample size of 153 was obtained. The components of the minimum size calculation were: the total population of the Attécoubé Lagune district = 2700 (Report of the Adjamé-Plateau-Attécoubé District, 2021).

- The prevalence of respiratory diseases in Attécoubé = 12%. (Adjamé-Plateau-Attécoubé District Report, 2021).
- The Alpha Risk = 5%.
- The confidence interval = 95%.

With a 10% increase, our final sample size was 168 people.

2.5. Data Collection

As part of this study, three students' investigators were trained for two days on the research protocol and the various data collection tools and media. This training allowed them to verify their understanding of the research procedures (recruitment, consent and monitoring). In addition, a pre-test of the data collection form was carried out on February 10, 2022, in the Attécoubé Sebroko sub-district and allowed for the correction of various shortcomings. In addition, spirometry was carried out by a team consisting of a doctor and a nurse, both specialist in functional exploration and highly experienced. Data collection took place in two phases.

The first phase consisted of filling out a questionnaire with each subject included in the study. The questionnaire collected information on sociodemographic characteristics, length of residence in the neighborhood, smoking status, degree of exposure to pollution, and health data.

The respiratory symptoms sought were those which evoked on the one hand asthma or chronic obstructive pulmonary disease (dry cough, wheezing, dyspnea, and chest tightness), and on the other hand rhino conjunctivitis (rhinorrhea, nasal obstruction, nasal tingling, sneezing, lacrimation, ocular redness). The second phase consisted in the realization of a pulmonary auscultation and a spirometry in each subject included in the study. Spirometry was performed using a portable Winspiro PRO6.5 MIR spirometer, followed by the reversibility test performed after inhalation of a 400-µg dose through an inhalation chamber. This test was performed according to the recommended guidelines of the American Thoracic Society (ATS).

The parameters measured were forced vital capacity (FVC) in liters, forced expiratory volume in one second (FEV1) in liters per second, Tiffeneau ratio (FEV1/FVC) expressed as a percentage, Maximum expiratory flow 25% - 75% (FEF 25% - 75%) and slow vital capacity (VC) in liters. The pathological threshold was defined by a fall of more than 20% in FEV1, FVC, FEF 25% - 75% and VC. The pathologic threshold for the Tiffeneau's ratio was defined by a fall of more than 12% (FEV1/FVC < 80% of predicted) according to the ATS/ERS Criteria.

The theoretical standard used is that of the African ethnic group incorporated in the spirometer software, which considers the sex, age, weight, and height of the subjects.

2.6. Operational Definition

Restrictive ventilatory disorder (RVD) is defined as VC < 80% and FEV1s/FVC > 80% Obstructive ventilatory disorder (OVD) is defined as FEV1/FVC ratio < 80% of predicted. Mixed syndrome is defined by VC < 80% and FEV1s/FVC < 80%. Small airway obstruction is defined by a FEV1s/FVC ratio > 80% and an FEF25% - 75% < 65% of the theoretical value.

The severity of the disorders is assessed from the FEV1s:

FEV1 > 80%: light;

FEV1 > 80%: mild;

FEV1 50 - 80%: moderate;

FEV1 30 - 50%: Severe;

FEV1 < 30%: very severe.

Reversibility of the obstruction: gain on FEV1 of more than 12% (relative value) and 200 ml (absolute value).

2.7. Data Analysis

A univariate analysis was performed for the description of the variables: age, sex,

height, weight, smoking, BMI, length of residence, professional activity, education level, school level, pollution exposure level, respiratory symptoms (cough, dyspnea, wheezing, chest tightness), rhinitis symptoms (sneezing, nasal obstruction, rhinorrhea, nasal pruritus), conjunctivitis, and family history of asthma.

The dependent variable: abnormalities in ventilatory function (bronchial obstruction or bronchial restriction or mixed syndrome) were obtained from the results of spirometry tests carried out on the inhabitants of Attecoubé Lagune.

A bivariate analysis was used to look for possible associations between the dependent variable (abnormal spirometry) and the independent variables (age, sex, smoking, length of residence, level of exposure, occupational activity, and education level). Independent variables that had a significance level $P \leq 0.20$ were included in the multivariate analysis.

Multiple linear regression models were constructed for the search for the relationship between the dependent variable and the selected independent variables. The top-down stepwise logistic regression method was adopted with ($P < 0.05$).

2.8. Ethical Considerations

Verbal and informed consent was obtained from the respondents prior to start the interviews. The questionnaire was administered only when consent was obtained. Anonymity and confidentiality were respected; initials were used instead of names. Interviews were conducted in French or local language and in private locations to ensure confidentiality. In addition, approval for the study was granted by the Internal Ethics Committee of the National Institute of Public Health (NIHP) and the Adjamé-Plateau-Attécoubé Health District.

3. Results

3.1. Socio-Demographic Characteristics

The study population consisted of 103 women and 67 men with a sex ratio (M/F) of 0.65. The average age was 35.92 ± 15.28 years. More than 41% of the population had a high school education and above. Regarding the duration of residence in Attécoubé Lagune, about 66% of the residents had lived in the neighborhood for more than 10 years. Smoking status was found in 5.30% of the residents and obesity in over 26.47% of the population (**Table 1**).

3.2. Prevalence of Respiratory Symptoms among Residents of Attécoubé Lagune in 2022

The most frequent respiratory symptoms were, in order of importance, chest tightness (29.41%), dyspnea (28.82%), sneezing (22.94%) and coughing (22.35%) (**Figure 1**).

3.3. Prevalence of Ventilatory Function Abnormalities among Residents of Attécoubé Lagune in 2022

The prevalence of ventilatory function abnormalities was 43.24% among residents

Table 1. Socio-demographic characteristics of Attécoubé Lagune residents in 2022.

	Number of people (N) = 170	Percentage (%)
Sex		
Male	67	39.40
Woman	103	60.60
Age range		
35 years ≤	96	56.50
35 years >	74	43.50
Study level		
No	61	35.90
Primary	38	22.30
High school and up	71	41.80
Duration of residence		
10 years ≤	58	34.10
10 years >	112	65.90
Smoking status		
No	161	94.70
Yes	9	5.30
Body mass index (BMI)		
Underweight	6	3.53
Normal weight	83	48.82
Overweight	36	21.18
Obesity	45	26.47

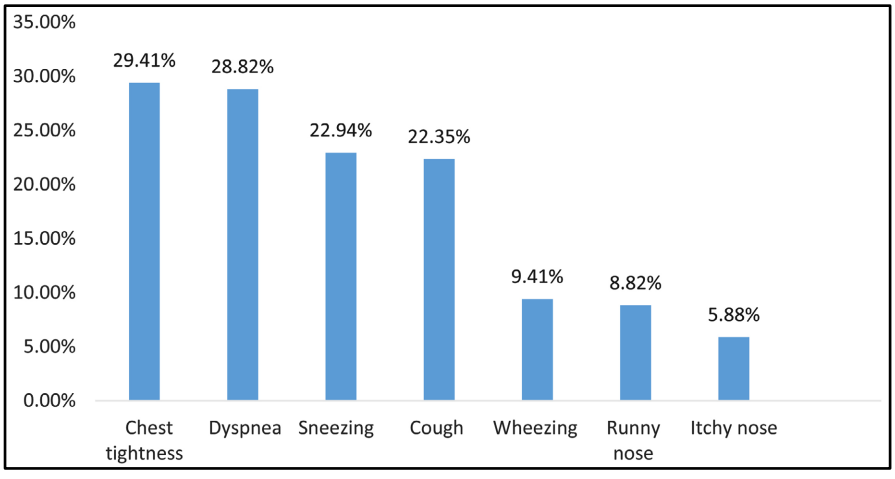

Figure 1. Respiratory symptoms in the population of Attécoubé Lagune.

of Attécoubé Lagune in 2022. The most frequent ventilatory function abnormality was ventilatory restriction (35.15%) followed by obstruction (4.85%) and mixed syndrome (4.42%) (**Figure 2**). The level of impairment of bronchial

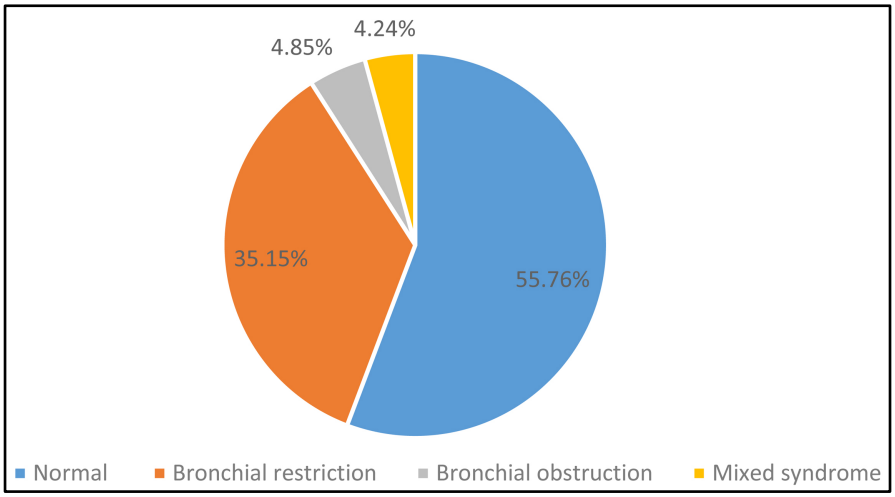

Figure 2. Prevalence of ventilatory function abnormalities among residents of Attécoubé Lagune in 2022.

Table 2. Risk factors for ventilatory function abnormalities in Attécoubé Lagune in 2022.

Ventilatory function abnormalities: (Bronchial obstruction or bronchial restriction or mixed syndrome)	OR	IC 95%	P
Age range			
<35 years	1		
[35 - 65 years]	0.601	0.286 - 1.264	0.180
>65 years	2.082	0.423 - 10.243	0.367
Level of exposure			
Low	1		
Medium	1.663	0.698 - 3.962	0.251
Strong	2.66	1.053 - 6.743	0.038**
Profession			
Other	1		
Trader	0,64	0.292 - 1.408	0.269
Gender			
Female	1		
Male	1.349	0.648 - 2.805	0.422
Tabacco			
No	1		
Yes	1.072	0.248 - 4.630	0.926
Level of education			
None	1		
Primary	0.743	0.301 - 1.832	0.520
Secondary	0.741	0.294 - 1.867	0.526
Higher	1.129	0.358 - 3.563	0.835

obstruction and bronchial restriction was of moderate type with proportions of 71.43% and 50% respectively.

The prevalence of ventilatory function abnormalities was higher in females (53.42%) than males (46.58%).

3.4. Risk Factors for Ventilatory Function Abnormalities in Attécoubé Lagune in 2022

The multivariate logistic regression allowed to highlight the high exposure as a risk factor of the anomalies of the ventilatory function [OR: 2.66; IC 95%: 1.05 - 6.74; P = 0.038]. Residents of Attecoubé Lagune who were exposed to prominent levels of pollution were 2.66 times more likely to have a ventilatory function abnormality (bronchial obstruction or bronchial restriction or mixed syndrome) than those who were not. Smoking was not associated with abnormal ventilatory function [OR: 1.072; IC 95%: 0.248 - 4.630; P = 0.926] (**Table 2**).

4. Discussion

The objective of this study was to determine the prevalence of respiratory symptoms and abnormalities of ventilatory function among residents of Attécoubé Lagune. Many respiratory symptoms were found in the present study but chest tightness (29.41%), dyspnea (28.82%), sneezing (22.94%) and cough (22.35%) had the highest prevalence. However, in some African studies from south of the Sahara, cough had the highest prevalence of respiratory symptoms [10] [11]. Our result could be explained by differences in pollution levels, exposure duration, exposure frequencies and seasons of the year.

The prevalence of ventilatory function abnormalities was 43.24% in our study. This result was higher than those of M'begnan *et al.* conducted in 2021 in a fish smoking site in Yopougon, Côte d'Ivoire [12] and Suneela conducted in 2022 in a community setting in New Delhi, India [13]. The prevalences of anomalies were respectively 25% for M'begnan and 34.35% for Suneela.

Nevertheless, our result was closer to Suneela's result obtained in community setting just like ours. The fish smoking activity would require healthy individuals which would explain the low prevalence of ventilatory function abnormalities in this study. The most frequent abnormality of ventilatory function among the inhabitants of the Attécoubé Lagune district was restriction (35.15%).

This result was higher than that of Suneela *et al.* estimated at 28.1% [13]. On the other hand, that of M'begnan *et al.* with a value of 89% was very high compared to ours [12]. In addition, the prevalence of restrictive respiratory disease in rural areas of northern Thailand (2022) was 6.3% in the general population [14]. This result was much lower than ours (35.15%) but it should be remembered that our study was conducted in an urban setting compared to the said Thai study. These differences in the study environment could explain these results, especially since the urban environment is more polluted than the rural environment. Our result could be justified by the fact that approximately 47.65% of

the inhabitants of Attécoubé Lagune were overweight or obese. The pathologies responsible for chronic restrictive syndromes are numerous and are generally classified as pulmonary pathologies, pleural pathologies, thoracic deformities and obesity [14]. In addition, the presence of a cement works two kilometers from the study site would be a source of deterioration in air quality due to the fine particles suspended from this industrial unit. These particles can lead to abnormalities in ventilatory function, including bronchial restriction, as shown in several studies [15] [16] [17].

Airway obstruction was found in only 4.85% of the subjects in our study. Similar results were observed by Suneela *et al*. (4.5%) (2022). In contrast, our results were higher than those found by Pitchayapa *et al*. (2022) in Thailand (2.4%) [18]. However, our results were relatively lower than those of M'begnan *et al*. (7.14%) but five times lower than those of Kumar *et al*. (2004) who conducted their study in a highly polluted area of Punjab state in northern India (24.90%) [19]. The prevalences of obstruction in Uganda (2015) and Cape Town (2007) in South Africa, were estimated to be 16.2% and 19.1% respectively [11] [20] [21]. These values were 3 and 4 times higher than ours, respectively. The air quality in these two study areas would likely be more impaired than ours.

Multivariate logistic regression had identified a risk factor that was heavy pollution [OR = 2.66; CI: 1.053 - 6.743; P = 0.038]. Residents of Attecoubé Lagune who were exposed to prominent levels of pollution were 2.66 times more likely to have a ventilatory function abnormality (bronchial obstruction or bronchial restriction or mixed syndrome) than those who were not.

The association between air pollution and the occurrence of function abnormalities has been widely demonstrated in previous studies [4] [5]. Furthermore, tobacco has been associated in some studies [22] [23] with abnormalities in ventilatory function, but in our case this association was not found. [OR: 1.072; IC 95%: 0.248 - 4.630; P = 0.926]. In our study, the risk factor was certainly high pollution, but it should be noted that even relatively low levels of air pollution would constitute a health risk because there is no threshold below which the risk is zero.

The major limitation of this study was the lack of air quality measurements taken during data collection at Attécoubé Lagune, our study site.

5. Conclusion

The population of the Attécoubé Lagune district presented several respiratory symptoms, the most frequent of which were chest tightness, dyspnea, sneezing and coughing. The prevalence of ventilatory function abnormalities was 43.24%, of which restrictive syndrome (35.15%) was the most frequent. However, only 4.85% of the population had an obstructive syndrome. The only objective risk factor was heavy pollution. Even though there is no threshold below which the risk is zero, it would be desirable that the competent authorities of the municipality of Attécoubé undertake actions to mitigate the level of pollution to offer

residents a better living environment.

Acknowledgements

This study would not have been possible without the support of the management of the Departmental Director of Health of the Adjame-Plateau-Attécoubé Health District and the National Institute of Public Health in Abidjan. We thank the management of the Departmental Director of Health of the Adjame-Plateau-Attécoubé Health District who accepted that our study take place in their structure. We are particularly grateful young people from the Attécoubé Lagune neighborhood who raised awareness and mobilized the population for this study. Our special thanks go to the local youth president for her involvement. We thank finally the population of Attécoubé Lagune who allowed us to collect their data.

Declaration

Authors' Contributions

SW wrote the study protocol and collected the data. LLK analyzed and interpreted the data then wrote the manuscript. EMLE made critical revision of the manuscript for important intellectual content. JBONO, BY and IT read and approved the final manuscript. Therefore, all the authors mentioned in this article contributed to the production of the work we are submitting, and the contents of the manuscript have never been published. They agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Ethical Considerations

Ethics approval was obtained from the *Internal Ethics Committee of the National Institute of Public Health* (*NIHP*) *Abidjan*, Côte d'Ivoire (N˚ 35). In addition, approval for the study was granted by the Adjamé-Plateau-Attécoubé Health District. The questionnaire was administered only when consent was obtained. Interviews were conducted in French or local language and in private locations to ensure confidentiality.

Consent to Participate

A written informed consent was obtained from all participants in the study. Participation was voluntary and participants were informed of their right to withdraw from the study when they wished to do so. All the participants were aware of the study's purpose, risks, and benefits.

Data were collected, managed, and analyzed in a way to ensure the confidentiality of study participants. All procedures performed in this study involving human participants were in accordance with the ethical standards of the national ethic review committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Availability of Data and Materials

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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