Scientific Research Publishing

Health, 2024, 16, 204-217
https://www.scirp.org/journal/health
ISSN Online: 1949-5005
ISSN Print: 1949-4998

Prevalence of Work-Aggravated Asthma among Bakery Workers in Abidjan (Cote d'Ivoire)

Loukou Leandre Konan[1,2], Esme Marie Laure Essis[1*], Brou Michel Kouassi[3], Marius Kedote[2], Julius Fobil[4], William Yavo[1,5], Ossey Bernard Yapo[6], Issaka Tiembre[3,7]

[1]National Institute of Public Health, Abidjan, Cote d'Ivoire
[2]Interuniversity Doctoral Program, Cotonou, Benin
[3]Medical Sciences Training and Research Unit, Department of Public Health and Biostatistics, Felix Houphouet Boigny University, Abidjan, Côte d'Ivoire
[4]Global Environmental Occupational Health (GEOHealth), Accra, Ghana
[5]UFR of Pharmaceutical and Biological Sciences, Department of Public Health, Felix Houphouët Boigny University, Abidjan, Cote d'Ivoire
[6]Nangui Abrogoua University, Abidjan, Côte d'Ivoire
[7]National Institute of Public Hygiene, Abidjan, Côte d'Ivoire
Email: *essismarie2007@yahoo.fr

How to cite this paper: Konan, L.L., Essis, E.M.L., Kouassi, B.M., Kedote, M., Fobil, J., Yavo, W., Yapo, O.B. and Tiembre, I. (2024) Prevalence of Work-Aggravated Asthma among Bakery Workers in Abidjan (Cote d'Ivoire). *Health*, **16**, 204-217.
https://doi.org/10.4236/health.2024.163017

Received: February 1, 2024
Accepted: March 24, 2024
Published: March 27, 2024

Abstract

Introduction: Work-aggravated asthma is pre-existing or concomitant asthma whose symptoms are aggravated by the work environment. The aim of this study was to determine the prevalence of this pathology and its associated factors among bakery workers in Abidjan. **Materials and Methods**: This descriptive and analytical cross-sectional study was conducted over a period of four (4) months from 18 December 2019 to 18 April 2020. Two questionnaires were used, one on employees and the other on the indoor environment of bakeries. In addition, a spirometry test was performed on all bakery workers. Statistical analysis was performed using stata 15.1 software. **Results**: A total of 599 bakery employees, including bakers (59.73%), sales assistants/cashiers (23.52%), cleaners (6.34%) and administrative staff (10.18%), were investigated. The mean age was 30.8 ± 8 years, with a sex ratio (M/F) = 2.2. Asthma symptoms were found in 95 (15.86%) employees, of whom 74 (77.9%) had work-related asthma and 11 (14.9%) had asthma aggravated by work. The factors associated with work-aggravated asthma were personal or family history of allergy or atopy [ORa = 3.75; CI95%: 1.56 - 8.93; p = 0.003], exposure to dust [ORa = 5.01; CI95%: 1.43 - 7.50; p = 0.011] and humidity level (60% - 70%) [ORa = 1.80; CI 95%: 0.99 - 3.28; p = 0.05]. **Conclusion:** Work-aggravated asthma is a reality in bakeries in Abidjan, with an estimated prevalence of 14.9%. Two of the three factors associated with this condition suggest a link with indoor air pollution. Combating air pollution in these

establishments must therefore be a priority for the relevant authorities, in order to provide employees with a working environment that protects their health.

Keywords

Work-Aggravated Asthma, Occupational Asthma, Work-Related Asthma, Bakeries, Abidjan, Ivory Coast

1. Introduction

Asthma is a common disease, affecting around 15% of adults of working age [1]. Asthma is considered "work-related" when there is a relationship between asthma symptoms and the workplace. Work-related asthma encompasses both occupational asthma, which is asthma induced by the work environment, and work-aggravated asthma, which is pre-existing or concomitant asthma whose symptoms are aggravated by the work environment [2] [3] [4]. Work-aggravated asthma can significantly disrupt working life and has personal, prescribing, quality of life, healthcare, financial and societal costs [5] [6] [7] [8]. In addition, this condition can arise as a result of exposure to a number of factors, including flour, which is the main raw material used to make bread in bakeries [9] [10].

Côte d'Ivoire has a large number of bakeries due to the high consumption of bread, which is a staple food. Over the last decade, however, the number of bakeries has risen sharply. There are currently more than 2000 bakeries throughout Côte d'Ivoire, over 1000 of which are located in the city of Abidjan [11]. The bakery sector is a dynamic one, employing twice as many people as the entire agri-food sector. From an economic point of view, this is a good thing, as it helps to reduce youth unemployment, which was estimated at 12.5% by the World Bank in 2015 [12]. However, there is a health problem. The exposure of large numbers of employees to the indoor environment of bakeries is likely to lead to respiratory diseases, including work-related asthma. Studies on this condition in general, and in Côte d'Ivoire in particular, focus on occupational asthma to the detriment of work-aggravated asthma, which appears to be the most common, given their respective prevalences of 16% and 21.5% [8].

The aim of this study was to determine the prevalence of work-aggravated asthma and the associated factors in bakeries in Abidjan, in order to prevent this condition in the long term among employees of these establishments.

2. Materials and Methods

2.1. Scope of the Study

Abidjan, the economic capital of Côte d'Ivoire, covers an area of 2119 km² and comprises thirteen communes. Its population is estimated at 4,707,404 or 20.8% of the total Ivorian population, according to the latest General Census of Popu-

lation and Housing [13]. Economically, the District of Abidjan is home to the country's largest industrial zone, accounting for 60% of its Gross Domestic Product. The boom in the bakery sector since 2015 has led to a rapid increase in the number of bakeries in the district, with a number of new brands. Because of the similarity between the bakeries, we randomly selected bakeries grouped together in eight districts, mostly in the working-class neighbourhoods of Abobo, Adjamé, Koumassi, Marcory, Port-Bouet, Treichville and Yopougon, as well as the upmarket neighbourhoods of Cocody.

2.2. Type of Study and Study Period

This was a descriptive and analytical cross-sectional study conducted over a four-month period from 18 December 2019 to 18 April 2020.

2.3. Study Population

The study focused on bakery employees due, on the one hand, to the dynamism of this sector of activity in terms of job creation (top 10 job-creating industrial sectors) and, on the other hand, to the very young population (60% young people aged 15 to 34) that they employ [12].

Our study is part of the Ecohealth Chair project on air pollution and non-communicable respiratory diseases in West Africa. It is part of a thesis on bakeries and workers in Abidjan.

2.4. Sample Size of Bakery Workers to Be Investigated

The sample size of bakery workers was calculated using Schwartz formula [14].

$$\frac{Z^2 * p(1-p)}{d^2}$$

Z: standard normal variance (at 5% type I error) (1.96);

p: expected proportion in the population according to previous studies (15%) [15];

d: absolute error (0.03).

Using the Schwartz formula, we obtained a sample size of 544 employees.

For the purposes of the study, we added 55 (corresponding to 10% of 544) other employees to our sample size of 544 to avoid the risk of employees dropping out or being lost to the surveys, which could affect the size of our final sample. Thus, for this survey, the sample size was 599 employees.

Inclusion criteria

The employees who participated in this study were all at least 18 years old (age of civil majority in Côte d'Ivoire).

Employees who were present during the interviews and lung examinations and who had given their consent to the study.

Non-inclusion criteria

Employees who were absent or ill (unable to perform the spirometry test) during the course of our study.

2.5. Data Collection

"Two interviewers, all medical students, were recruited and given two days' in-class training on the research protocol and the various data collection tools and media. This training enabled them to check their understanding of the research procedures (recruitment, consent and follow-up). In addition, a pre-test of the data collection form was carried out in bakeries in Abobo and Adjamé, enabling the various shortcomings to be corrected. In addition, spirometry was carried out by a team consisting of a nurse and a doctor, both specialists in functional exploration and both very experienced".

Data available in the literature were used to select the variables included in this analysis. The dependent variable was asthma aggravated by work, obtained from the question: "Do your symptoms get worse at work and better outside work?"

The independent variables were socio-demographic and occupational characteristics, and the physical and environmental characteristics of the bakeries.

Data was collected in two phases. In the first phase, two questionnaires were used. The first questionnaire, from the Institut National de la Santé et de la Recherche Médicale (INSRM), enabled us to collect information on the socio-demographic characteristics of the employees (gender, qualifications, position in the bakery, number of hours worked per day, length of service, monthly salary and smoking status). The second questionnaire, derived from the American Thoracic Society (ATS) questionnaire, sought information on asthma symptoms (wheezing, dyspnoea, chest tightness and cough), the evolution of symptoms in the workplace, a history of asthma, confirmation of the diagnosis of asthma by a doctor, the dates of the first and last asthma attacks, the frequency of asthma attacks over the last 12 months and factors likely to exacerbate asthma symptoms.

The second phase involved respiratory function testing using a portable Winspiro Pro 6.5 MIR (Médical International Research) spirometer.

Each employee's personal data were entered in accordance with the manufacturer's manual. The parameters measured were forced vital capacity (FVC), forced expiratory volume in one second (FEV1), Tiffeneau index (FEV1/FVC) and peak expiratory flow (PEF). All spirometry tests were performed in the seated position and repeated 3 times for each person. For employees with abnormal lung function, the spirometry test was followed by a reversibility test after inhalation of Salbutamol. The test was performed by a trained healthcare professional (nurse) in accordance with the guidelines of the American Thoracic Society (ATS) and the European Respiratory Society (ERS) [3]. The results were interpreted by an experienced physiologist in accordance with the ATS and ERS [16].

2.6. Operational Definitions

Asthma symptoms: the symptoms considered in this study were the cardinal symptoms of asthma: dyspnoea, wheezing, chest tightness and cough [3].

Reversible obstructive pulmonary disease: it was defined by comparing the ratio of forced expiratory volume in one second (FEV1) and vital capacity (VC) to the lower limit of normal. Significant reversibility was diagnosed by an in-

crease in FEV1 ≥ 12% and 200 ml in absolute value. The extrapolations that have been proposed derive from the African standards that were used to determine the theoretical values [3].

Asthma confirmed:

- The diagnosis was made in a symptomatic worker with a reversible obstructive disorder [3].
- The asthma reported by the worker has been confirmed by a doctor or healthcare staff.

Probable occupational asthma: A worker who has:

a) Reported never having had symptoms of asthma before starting to work in a bakery;

b) Began to show symptoms of asthma during working hours;

c) Symptoms improved during holidays or outside the workplace [4].

Asthma probably aggravated by work: A worker who reported:

a) A history of asthma before starting work in a bakery;

b) A worsening of symptoms during working hours in a bakery;

c) An improvement in symptoms during holidays or away from the workplace [17].

Probable work-related asthma: a combination of occupational and work-aggravated asthma [17].

Probable work-related asthma in bakeries: A combination of work-related and non-work-related asthma.

2.7. Data Processing

Statistical Analysis

Statistical analysis was performed using Stata version 15.1. Descriptive statistics were carried out for four groups of workers: i) bakers, ii) sales assistants, iii) cleaners and (iv) administrative staff. The first analysis consisted of finding the means and standard deviations. The Chi-2 test was used to compare frequencies between two independent variables. When the number of variables was less than 5, the Fisher test was used. The one-factor Anova test was used.

Multiple linear regression models were then used to assess any correlation between the dependent and independent variables, with $p < 0.20$ being considered statistically significant.

Multiple linear regression models were required to show any relationship between work-aggravated asthma and socio-demographic characteristics of bakery workers, $p < 0.05$ was considered statistically significant.

2.8. Ethical Considerations

This study is part of the Ecosanté Chair's major study, which included the protocols of the doctoral students in the Interuniversity Doctoral Programme submitted to and approved by the National Research Ethics Committee (CNER) under number 026-18/MSHP/CNER-kp. In addition, this study was submitted to and authorised by the office of the Fédération des Patrones de Boulangeries de

Côte d'Ivoire and the Centre Ivoirien Anti-Pollution (CIAPOL).

At the measurement sites, the participants (bakery employees and bakery owners) were briefed on the content and various phases of the study. Emphasis was placed on confidentiality of identity and bakeries.

3. Results

3.1. Characteristics of Bakery Employees in 2020

The investigations covered 599 bakery employees, with no exclusion of occupational categories. There were 353 bakers (59.73%), 139 sales assistants/cashiers (23.52%), 38 cleaners (6.34%) and 61 administrative staff (10.18%).

The average age of the employees was 30.8 ± 8 years. The proportion of men (68.61%) was greater than that of women (31.39%) ($p = 0.000$), giving a sex ratio of 2.2. This trend was more marked in the bakers/pastry cooks occupational category, where the proportion of men was 92.35% compared with 7.65% for women ($p = 0.000$), *i.e.* a sex ratio of 12.07. On the other hand, in the salesperson occupation, women (9.09%) were more represented than men (7.91%) ($p = 0.000$). The majority of workers (88.32%) had attended school. On the other hand, more than 85% of these workers had been trained on the job in the bakeries. Most of them were unemployed (25.21%) or pupils/students (21.49%) at the start of their professional careers in the bakeries.

More than half of these workers (63%) had been in their jobs for less than 5 years and most of them were non-smokers (76%).

3.2. General Characteristics of the Bakeries Investigated

Almost all the bakeries (82.50%) were single rooms (30%) or partially separate rooms (52.50%). The surface areas of the premises varied between 17.5 and 1445 m^2. Controlled mechanical ventilation (CMV) was available in six bakeries (15%). Almost all of the dough mixers (92%) had no airtight protection (without protection or fitted with grids).

3.3. Diagnosis of Work-Aggravated Asthma and Estimation of Its Prevalence

The main steps in the diagnosis of work-aggravated asthma or work-exacerbated asthma are summarised in Table 1. The prevalence of work-aggravated asthma is estimated at 14.9%.

3.4. Results of Spirometry Performed on Bakery Employees in 2020

Lung function tests confirmed the diagnosis of asthma in only one of the 11 employees with work-aggravated asthma (Table 2).

3.5. Characteristics of Bakery Workers with Work-Aggravated Asthma

Women (81.82%) had more work-aggravated asthma than men (18.18%) p =

Table 1. Aggravated asthma in bakeries in Abidjan in 2020.

	Staff	(%)
1. Reported asthma (RA) or history of asthma (HA)		
No	582	97.2
Yes	17	2.8
2. Reported asthma (RA) or history of asthma (HA)		
No	02	11.8
Yes	15	88.2
3. Asthma attack in the last 12 months		
No	02	13.3
Yes	13	86.7
4. Frequency of asthma attacks in the last 12 months		
≤12	10	76.9
>12	03	23.1
5. Worsening of symptoms at work and improvement outside work		
No	04	26.7
Yes	**11**	73.3
6. Asthma in bakeries (AB)		
No	504	84.14
Yes	95	15.86

Table 2. Asthma aggravated by work confirmed by spirometry in bakeries in Abidjan in 2020.

Spirometry results	Asthma aggravated by work N (%)			
	No	Yes	Total	p
Normal	475 (80.78)	7 (63.64)	482 (80.47)	0.175
Asthma	17 (2.89)	1 (9.09)	18 (3.01)	
Bronchial obstruction	57 (9.69)	3 (27.27)	60 (10.02)	
Bronchial restriction	34 (5.78)	0 (00.00)	34 (5.68)	
Mixed syndrome	5 (0.85)	0 (00.00)	5 (0.83)	
Total	588 (98.16)	11 (1.84)	599 (100)	

Fisher test.

0.001. In addition, the occupational categories that developed work-aggravated asthma were bakers (27.27%) and sales assistants (73.73%), p = 0.007 (Table 3).

3.6. Factors Associated with Work-Aggravated Asthma in Bakery Workers

Factors associated with work-aggravated asthma in bakery workers are presented in Table 4. Attécoubé Lagune residents with a family or personal history of atopy had a 3.75 fold risk of developing work-aggravated asthma. In addition, employees exposed to dust were 5.01 times more likely to develop work-aggravated asthma than those who were not. Employees exposed to humidity levels of between 60% and 70% were 1.80 times more likely to have work-aggravated asthma than those who were not. However, no link was found between work-aggravated asthma and smoking in our study.

Table 3. Description of work-aggravated asthma in bakery workers.

	Asthma aggravated by work N (%)			
	No	**Yes**	**Total**	**p**
Gender				
Woman	179 (30.97)	9 (81.82)	188 (31.92)	**0.001 ***
Men	409 (69.03)	2 (18.18)	411 (68.08)	
Age group (years)				
[18 - 35[	447 (76.02)	11 (100)	458 (76.46)	**0.262 ****
[35 - 45[	109 (18.54)	0 (00.00)	109 (18.20)	
[45 - 64]	32 (5.44)	0 (00.00)	32 (5.34)	
Professional categories				
Administrative	62 (10.54)	0 (00.00)	62 (10.35)	**0.007 ****
Bakers	354 (60.20)	3 (27.27)	357 (59.60)	
Tech surface	40 (6.80)	0 (00.00)	40 (6.68)	
Saleswomen	132 (22.45)	8 (73.73)	140 (23.37)	
Professional seniority (years)				
5 ≤	372 (68.27)	9 (81.82)	381 (63.61)	**0.579 ****
]5 - 15]	156 (26.53)	2 (18.18)	158 (26.38)	
≥15	60 (10.20)	0 (00.00)	60 (10.02)	
Professional qualifications				
No	502 (85.37)	9 (81.82)	511 (85.31)	**0.669 ***
Yes	86 (14.63)	2 (18.18)	88 (14.69)	

*Chi^2/**Fisher.

Table 4. Factors associated with work-aggravated asthma among bakery workers.

Asthma made worse by work	**OR**	**p**	**ORa**	**IC95**	**p**
Dust					
No	1		1		
Yes	**2.04**	**0.000**	**5.01**	**1.43 - 7.50**	**0.011**
Vapor/Gas					
No	1		1		
Yes	0.14	0.588	1.26	0.72 - 2.20	0.417
Atopy or allergy					
No	1		1		
Yes	**1.38**	**0.000**	**3.75**	**1.56 - 8.93**	**0.003**
Humidity in sales area					
< 60	1		1		
[60 - 70]	**0.74**	**0.006**	**1.80**	**0.99 - 3.28**	**0.050**
> 70	0.30	0.504	1.08	0.39 - 2.94	0.879
CO_2 sales area					
≤1000 ppm	1		1		
>1000 ppm	0.46	0.196	1.72	0.80 -3.71	0.161

Continued

Tobacco					
No	1		1		
Yes	2.4	0.009	4.02	0.50 - 13.74	0. 187
Gender					
Female	1		1		
Male	0.09	0.003	1.4	0.75 - 2.56	0. 290

4. Discussion

The present study was conducted to determine the prevalence of work-aggravated asthma and the factors associated with it among employees of bakeries in Abidjan. A total of 599 bakery employees classified into 4 occupational categories were investigated. Unlike some studies that focused on specific groups [18] [19], our study included all employees. Symptoms suggestive of asthma (dyspnoea, wheezing, chest tightness and cough) were reported by 15.86% of the employees investigated, 14.9% of whom had asthma symptoms that worsened at work and improved outside work. In fact, this description of symptoms in these employees suggested occupational asthma [20]. Only seventeen (2.8%) of these employees had a history of asthma before starting to work in the bakeries. However, fifteen employees (88.2%) had physician-confirmed asthma, eleven of whom (73.3%) had reported worsening symptoms in the workplace, in accordance with the recommendations of the American Thoracic Society [20]. In these patients, the diagnosis of work-aggravated asthma was made, as in most epidemiological studies [20] [21]. The prevalence of work-aggravated asthma can be obtained from all asthmatics or from all asthmatics working in bakeries [20]. The prevalence of work-aggravated asthma in this study was 14.9%. In addition, several authors have established that the prevalence of work-aggravated asthma varied between 13% and 58%, with an average of 21.5% (8) [20] [22].

Our value of 14.9% is certainly within this range, but it is well below the average value of 21.5%.

This finding could be justified by the fact that subjects with work-aggravated asthma are generally exposed to irritants such as paints, solvent or acid vapours and ammonia, and less often to sensitisers such as isocyanates or wheat flour [23]. In our study, employees were exposed to flour, which is more of a sensitiser than an irritant. This finding could also be justified by the definitions adopted in the various studies. In addition, we noted a predominance of women (81.82%) among the workers with work-aggravated asthma, and this difference was statistically significant ($p = 0.001$). The two occupational categories affected by this condition were bakers and saleswomen ($p = 0.007$). However, female sales assistants are the most affected. This finding could be explained by the fact that the sales sector is one of the occupations or sectors at risk of developing work-aggravated asthma [2]. In fact, according to the work of Tarlo SM (2016) on work-aggravated asthma, the three sectors that were highlighted as providers of work-aggravated asthma were the administrative sector, the healthcare sector and the

sales sector [2]. Goe SK *et al.* (2004) also reported in the USA that, according to occupation, cases of work-aggravated asthma were most often found among employees in technical, commercial and administrative support occupations [24]. It follows that the sales sector is one of the three sectors at risk of work-aggravated asthma. However, the bakery sales sector employs exclusively women, hence the predominance of women in our study. In addition, the particular architecture of bakeries could explain the high exposure of these women. In fact, almost all the bakeries (82.50%) consisted of a single room (30%) or partially separate rooms (52.50%). As a result, the flour dust circulated easily from the bread production area to the sales area, causing the women to inhale it continuously throughout the day.

In terms of risk factors for work-aggravated asthma, investigations revealed a history of allergy or atopy [ORa = 3.75; 95% CI: 1.56 - 8.93; p = 0.003], exposure to dust and aerosols [ORa = 5.01; 95% CI: 1.43 - 7.50; p = 0.011] and humidity level (60% - 70%) [ORa = 1.80; 95% CI: 0.99 - 3.28; p = 0.05]. It should be noted that there are many differences in the risk factors associated with atopy. For some authors, atopy was not a risk factor for work-aggravated asthma [9] [25]. The type of definition adopted for the diagnosis of work-aggravated asthma may be at the root of this discrepancy. Epidemiological cases are based on the existence of pre-existing asthma, whereas clinical cases are based on objective criteria using spirometry. Pre-existing asthma suggests an allergy. This is the case in our study, where the cases are epidemiological. This explains why atopy is a risk factor in our work, as it is in some authors [26] [27]. On the other hand, it is clearly established that dust is a risk factor for work-aggravated asthma. Tarlo *et al.* (2016) reported in Ontario that cases of work-aggravated asthma were associated with dusts and second-hand smoke (2). The same is true for Goe SK *et al.*, who also revealed an association of work-aggravated asthma with mineral and inorganic dusts [23]. Employees exposed to dusts were 5.01 times more likely to develop work-aggravated asthma than those who were not [OR = 5.01; 95% CI: 1.43 - 7.50; p = 0.011]. It is also clearly established that excess humidity encourages the development of bacteria, fungi and moulds [28] [29] which can in turn produce spores, cell fragments and volatile organic compounds that will spread into the ambient air. Excessive humidity is observed when the level exceeds 60% [30]. This was the case in our study, where the humidity levels in the sales areas were between 60% and 70%. The consequence is that employees in the sales area have a 1.80 greater risk of developing work-aggravated asthma than other employees working outside this area [ORa = 1.80; 95% CI: 0.99 - 3.28; p = 0.05].

Furthermore, in our study, smoking was not associated with work-aggravated asthma, probably due to the low proportion of smokers or smokers among bakery workers. Saarinen K *et al.* (2003) in Finland also found in their study that smoking did not affect the symptoms of work-aggravated asthma [31].

The limitations of the study were, on the one hand, that the Beta 2 mimetic test was not performed on all employees due to the refusal of certain employers and, on the other hand, that the bronchial provocation test was not routinely

available to refine the detection of cases of work-aggravated asthma.

5. Conclusion

Work-aggravated asthma is pre-existing or concomitant asthma whose symptoms are aggravated by the work environment. This respiratory condition is a reality in bakeries in Abidjan, with an estimated prevalence of 14.9%. Exposure to dust was the risk factor most strongly associated with this condition. This situation highlights the contribution of air pollution to the occurrence of work-aggravated asthma in bakeries in Abidjan. This work, which is the very first in the bakery sector in Côte d'Ivoire, is a wake-up call and paves the way for future research aimed at improving the working environment and the well-being and health of workers.

Acknowledgements

This study would not have been possible without the support of the Centre Ivoirien Antipollution (CIAPOL) and the Federation of Bakery Owners of Côte d'Ivoire [Fédération des Patrons de Boulangeries de Côte d'Ivoire (FPB-CI)]. These two organizations each provided us with a list of bakeries, the compilation of which gave us a single database of bakeries that was used to randomly select the bakeries in our study. They also sent letters to these structures to give us easy access to their workspaces. We would like to thank the CIAPOL management and the president of the Federation of Bakery Owners of Côte d'Ivoire for their effective involvement in the realization of this study. We would also like to thank the bakery owners who opened their doors to us, not forgetting the bakery employees who agreed to take part in this study.

Declaration

Authors' Contribution

LLK wrote the study protocol and collected the data. He analyzed and interpreted the data then wrote the manuscript. EMLE made critical revision of the manuscript for important intellectual content.OBY and IT approved the study protocol. BMK, MK, JF, WY, OBY 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

This study is part of the Ecosanté Chair's major study, which included the protocols of the doctoral students in the Interuniversity Doctoral Program submitted to and approved by the National Research Ethics Committee (CNER) under number 026-18/MSHP/CNER-kp. In addition, this study was submitted to and

authorised by the office of the Fédération des Patrones de Boulangeries de Côte d'Ivoire and the Centre Ivoirien Anti-Pollution (CIAPOL). At the measurement sites, the participants (bakery employees and bakery owners) were briefed on the content and various phases of the study.

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.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Mével, H., Demange, V., Penven, E., Trontin, C., Wild, P. and Paris, C. (2016) Assessment of Work-Related Asthma Prevalence, Control and Severity: Protocol of a Field Study. *BMC Public Health*, **16**, Article No. 1164. https://doi.org/10.1186/s12889-016-3824-0

[2] Tarlo, S.M. (2016) Update on Work-Exacerbated Asthma. *International Journal of Occupational Medicine and Environmental Health*, **29**, 369-374. https://doi.org/10.13075/ijomeh.1896.00676

[3] Lemiere, C. and Cartier, A. (2016) Asthme Professionnel Avec et Sans Période de Latence.

[4] Mevel, H. (2019) Contribution to Improving Knowledge of Work-Related Asthma. These, Biologie-Santé-Environnement, Universite de Lorraine, Lorraine. https://hal.univ-lorraine.fr/tel-02460677/document

[5] Cannon, J., Cullinan, P. and Taylor, A.N. (1995) Consequences of Occupational Asthma. *BMJ*, **311**, 602-603. https://doi.org/10.1136/bmj.311.7005.602

[6] Lowery, E.P., Henneberger, P.K., Rosiello, R., Sama, S.R., Preusse, P., and Milton, D.K. (2007) Quality of Life of Adults with Workplace Exacerbation of Asthma. *Quality of Life Research*, **16**, 1605-1613. https://doi.org/10.1007/s11136-007-9274-5

[7] Mazurek, J.M., Knoeller, G.E. and Moorman, J.E. (2012) Effect of Current Depression on the Association of Work-Related Asthma with Adverse Asthma Outcomes: A Cross-Sectional Study Using the Behavioral Risk Factor Surveillance System. *Journal of Affective Disorders*, **136**, 1135-1142. https://doi.org/10.1016/j.jad.2011.09.045

[8] Bradshaw, L., Sumner, J., Delic, J., Henneberger, P. and Fishwick, D. (2018) Work

Aggravated Asthma in Great Britain: A Cross-Sectional Postal Survey. *Primary Health Care Research & Development*, **19**, 561-569. https://doi.org/10.1017/S1463423618000063

[9] Baatjies, R., Lopata, A.L., Sander, I., Raulf-Heimsoth, M., Batemane, E.D., Meijster, T., *et al*. (2009) Determinants of Asthma Phenotypes in Supermarket Bakery Workers. *European Respiratory Journal*, **34**, 825-833. https://doi.org/10.1183/09031936.00164408

[10] Dubini, M., Marraccini, P., Brass, D.M., Patrini, L. and Riboldi, L. (2020) Occupational Asthma and Rhinitis Due to Wheat Flour: Sublingual Specific Immunotherapy Treatment. *Medicina del Lavoro*, **111**, 203-209.

[11] Faustin, E. (2021) Bakery and Pastry Sector: The Government Is Encouraging Investment in This Sector. https://www.fratmat.info/article/211267/conomie/filiere-boulangeriepatisserie-le-gouvernement-encourage-l039investissement-dans-ce-secteur-d039activite

[12] World Bank (2015) Study on the Competitiveness of the Ivorian Manufacturing Industry. This Report Is Commissioned by the World Bank. The Views Expressed in This Report Are Those of the Consultant and Do Not Represent Those of the World Bank or Its Board of Directors. https://documents1.worldbank.org/curated/en/480881468189533348/pdf/97221-revised-wp-p148295-ouo-9-box391473b-acs.pdf

[13] Republique De Cote D'Ivoire (2015) General Population and Housing Census 2014. Institut National De La Statistique. http://www.ins.ci/n/index.php?limitstart=5

[14] Soglohoun, N. and Degla, P. (2023) Determinants of Credit Demand by Agricultural Farms in Cotton Area in Benin. *Revue Internationale des Sciences de Gestion*, **6**, 352-375.

[15] Tarlo, S.M. and Lemiere, C. (2014) Occupational Asthma. *The New England Journal of Medicine*, **370**, 640-649. https://doi.org/10.1056/NEJMra1301758

[16] Krüll, G., *et al*. (2016) Asthme Professionnel. *Revue Médicale Suisse*, **12**, 1972-1975. https://www.revmed.ch/revue-medicale-suisse/2016/revue-medicale-suisse-539/asthme-professionnel

[17] Tarlo, S.M. and Lau, A. (2019) Update on the Management of Occupational Asthma and Work-Exacerbated Asthma. *Allergy, Asthma and Immunology Research*, **11**, 188-200. https://doi.org/10.4168/aair.2019.11.2.188

[18] Fahim, A.E. and El-Prince, M. (2013) Pulmonary Function Impairment and Airway Allergy among Workers in Traditional Bakeries. *International Journal of Occupational Medicine and Environmental Health*, **26**, 214-219. https://doi.org/10.2478/s13382-013-0082-6

[19] Al Badri, F.M., Baatjies, R. and Jeebhay, M.F. (2020) Assessing the Health Impact of Interventions for Baker's Allergy and Asthma in Supermarket Bakeries: A Group Randomised Trial. *The International Archives of Occupational and Environmental Health*, **93**, 589-599. https://doi.org/10.1007/s00420-019-01511-7

[20] Henneberger, P.K., Redlich, C.A., Callahan, D.B., Harber, P., Lemiere, C., Martin, J., *et al*. (2011) An Official American Thoracic Society Statement: Work-Exacerbated Asthma. *American Journal of Respiratory and Critical Care Medicine*, **184**, 368-378. https://doi.org/10.1164/rccm.812011ST

[21] Baur, X., Aasen, T.B., Sherwood, B.P., Heederik, D., Henneberger, P.K., Maestrellie, P., *et al*. (2012) The Management of Work-Related Asthma Guidelines: A Broader Perspective. *European Respiratory Review*, **21**, 125-139. https://doi.org/10.1183/09059180.00004711

[22] Paris, C. (2015) Occupational Allergy-Pneumology. Work-Aggravated Asthma. Inrs. Dec, 113-125.

[23] Roio, L.C., Del Mizutani, R.F., Pinto, R.C., Terra-Filho, M. and Santos, U.P. (2021) Work-Related Asthma. *Jornal Brasileiro de Pneumologia*, **47**. https://doi.org/10.36416/1806-3756/e20200577

[24] Goe, S.K., Henneberger, P.K., Reilly, M.J., Rosenman, K.D., Schill, D.P., Valiante, D., *et al*. (2004) A Descriptive Study of Work Aggravated Asthma. *Occupational and Environmental Medicine*, **61**, 512-517. https://doi.org/10.1136/oem.2003.008177

[25] Muñoz, X., Cruz, M.J., Bustamante, V., Lopez-Campos, J.L. and Barreiro, E. (2014) Work-Related Asthma: Diagnosis and Prognosis of Immunological Occupational Asthma and Work-Exacerbated Asthma. *The Journal of Investigational Allergology and Clinical Immunology*, **24**, 396-405.

[26] Karvala, K., Nordman, H., Luukkonen, R. and Uitti, J. (2014) Asthma Related to Workplace Dampness and Impaired Work Ability. *The International Archives of Occupational and Environmental Health*, **87**, 1-11. https://doi.org/10.1007/s00420-012-0830-0

[27] Lemiere, C., Bégin, D., Camus, M., Forget, A., Boulet, L.P. and Gérin, M. (2012) Occupational Risk Factors Associated with Work-Exacerbated Asthma in Quebec. *Occupational and Environmental Medicine*, **69**, 901-907. https://doi.org/10.1136/oemed-2012-100663

[28] World Health Organisation (2009) WHO Guidelines for Indoor Air Quality: Moisture and Moulds. http://www.euro.who.int/pubrequest?language=french

[29] Cai, J., Li, B., Yu, W., Wang, H., Du, C., Zhang, Y., *et al*. (2019) Household Dampness-Related Exposures in Relation to Childhood Asthma and Rhinitis in China: A Multicentre Observational Study. *Environment International*, **126**, 735-746. https://doi.org/10.1016/j.envint.2019.03.013

[30] Conseil De La Santé Publique H. (2019) Factors Contributing to Healthy Housing—Current State of Knowledge and Recommendations for Public Policies for Healthy Housing.

[31] Saarinen, K., Karjalainen, A., Martikainen, R., Uitti, J., Tammilehto, L., Klaukka, T., *et al*. (2003) Prevalence of Work-Aggravated Symptoms in Clinically Established Asthma. *European Respiratory Journal*, **22**, 305-309. https://doi.org/10.1183/09031936.03.00100102