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Prevalence and risk factors allergic rhinitis in bakers in Douala, Cameroon

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ABSTRACT

Objective: To determine the prevalence and risk factors of allergic rhinitis among bakers in Douala.

Design: A cross-sectional study; The logistic regression model was use to find the risk factors of allergic rhinitis

Setting: The study was conducted in 42 bakeries randomly selected among a total of 151 in the Douala city.

Participants: All bakers who consented to participate from May 1st to July 31st 2013.

Outcome measures: Allergic rhinitis was the outcome of interest. It was defined as the presence of the following symptoms: itchy nose, rhinorrhea, nasal obstruction and sneezing.

Results: During the study period, a total of 273 bakers were invited to participate and finally 229 bakers agreed to participate in this study. Males were the most represented gender with 222 participants (96.9 %). The mean age of the participants was 36.29 ± 8.9 years. Smoking was found in 55 participants (24.5 %). The symptoms of allergic rhinitis were observed in 24.5% of participants. Nasal symptoms related to work were present in 15% of cases. Sensitization to wheat flour and alpha-amylase were found in 16.6% and 8.3% of participants respectively. Prick tests were positive for mites in 12.2% of participants. After multivariate analysis, sensitization to

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3 flour (OR 3.95, 95 % CI 1.85 - 8.47) and storage mites (OR 3.44, 95 % CI 1.45 - 8.18) were the
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5 factors independently associated with symptoms of allergic rhinitis.
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9 **Conclusion:** Allergic rhinitis is frequent among bakers in Cameroon. Implementation of
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11 preventive measures against inhalation of airborne allergens in bakeries and clinical monitoring
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13 of bakers sensitized to wheat flour and mites could help to reduce the prevalence of allergic
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15 rhinitis among bakers.
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18 19 20 21 22 **Strengths and limitations of this study** 23

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25 • This study is among the first in sub-Saharan Africa that have sought an association
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27 between workplace aeroallergens in bakers and the symptoms of allergic rhinitis.
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- 30
31 • The logistic regression, a pretty solid statistical method for the detection of associations
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33 between variables was used in this study.
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37 • The measurement of the exposure to dust in bakeries was not done.
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- 40
41 • The specific serum IgE antibodies measurements, a method with better specificity and
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43 sensitivity than that of skin tests, for the diagnosis of allergen sensitization were not
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45 performed.
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INTRODUCTION

Allergic rhinitis is a common condition in current medical practice. It is with asthma, the main manifestations of respiratory allergy. This condition is present in all parts of the world and its prevalence varies by regions. Most prevalence studies on rhinitis have used the methods of the International Study of Asthma and Allergies in Childhood (ISAAC). These prevalence ranges from 23 % to 30 % in Europe, 12 % to 30 % in the United States and 5.5% to 45.1 % in North America.¹ In Africa, it varies from 7.2% to 27.3 %.² Although it is not fatal, allergic rhinitis generates costs and has a negative impact on the quality of life of patients. It harmfully affects school and professional performances.³⁻⁵ The occurrence of allergic rhinitis is conditioned by the conjunction of several factors as atopy and many environmental factors, of which the leading factors are allergens and pollution. Amongst the allergens, pollens from plants and house dust mites are the most represented.⁶ Occupational allergens are involved in the onset of occupational allergic rhinitis. Flour and alpha-amylase used for the fermentation of yeast are the main risk factors in bakers' allergic rhinitis.^{7, 8} Storage mites present in the flour also contribute to the development of this condition.⁹ In sub-Saharan Africa, few studies have been carried out on allergic rhinitis, whereas this part of the world is increasingly being exposed to pollution and climatic conditions are more and more favorable to allergens such as dust mites and moulds.¹⁰ Bakery employees, apart from their usual exposure to aeroallergens are often in contact with specific aeroallergens of their workplace.

The objective of this study was to determine the prevalence of allergic rhinitis and associated factors in bakers in the city of Douala.

METHODS

Design and setting

This was a cross-sectional study conducted from May 1st to July 31st2013 in 42 randomly selected bakeries in the city of Douala in Cameroon. Douala is a sea neighboring city in central part of Africa located just above the equator. It is the economic capital of Cameroon, hosting many industries. The climate is hot and humid.

Participants: Bakery employees with regular contact with flour were included. Participants under 15 years, those with a non-allergic rhinitis or sinusitis and those declining to participate in the study were excluded.

Data collection and variables

Sociodemographic data, respiratory symptoms, medical history, family history of atopy, smoking status, and characteristics of exposure to flour were collected using a face to face administered questionnaire. Allergic rhinitis was defined by the presence of at least one of the following symptoms: itchy nose, sneezing, nasal obstruction and rhinorrhea. Work-related symptoms were those triggered in the workplace. Rhino-conjunctivitis was defined by the association of symptoms of allergic rhinitis, ocular itching or eye tearing. Skin prick tests to 13 aeroallergens were performed. Allergens used were those from ALK laboratories (Varenes in Argonne, France). Aeroallergens present in bakeries included wheat flour, alpha-amylase, 4 types of storage mites; and common aeroallergens included house dust mites, moulds, cat, dog, and German cockroach. When searching for risk factors of allergic rhinitis, aeroallergens were grouped as follows: sensitization to house dust mites was defined by positive skin tests to *Dermatophagoides farinae* and/or to *Dermatophagoides pteronyssinus*. Similarly, sensitization to storage mites was considered when a positive prick test to at least one the following type of mites was observed: *Lepidoglyphus destructor*, *Glycyphagus domesticus*, *Acarus siro*, *Tyroglyphus putrescentia*.

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3 Atopy was defined as positive skin test to at least one of the common aeroallergens. The positive
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5 control was histamine and the negative control was glycerol-saline solution. The test was read 15
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7 minutes after application of the allergen solution. The test was positive when the diameter of
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9 induration was greater than (or equal to) 3 mm, or greater than 50% of the positive control.

12 **Data analysis**

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14 Data were entered and analyzed using SPSS 20 for Windows. Descriptive statistics were used for
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16 general presentation of our sample. Univariate analysis was then performed, followed by logistic
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18 regression to identify risk factors of allergic rhinitis. Variables for which P was less than (or
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20 equal) to 0.2 were introduced in the final model for multivariate analysis. The odds ratio and
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22 confidence intervals of 95% were determined. Statistical tests were considered significant for a P
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24 value of less than 0.05.
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29 **Ethical clearance**

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31 The protocol was submitted to the National Ethics Committee and the recruitment started after
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33 obtaining ethical clearance as well as oral consent from each participant.
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36 **RESULTS**

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38 During the study period, a total of 273 bakers were invited to participate and finally 229 bakers
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40 agreed to participate in this study, giving a response rate of 83.8%. The general characteristics of
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42 the study population are shown in table 1.
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Table 1. General Characteristics of participants

Variables	Number	Percentage
Gender		
Male	222	96.9%
Female	7	3.1%
Age		
Mean \pm SD (Range)	36.29 \pm 8,9 (20 – 58 years)	
20-29 years	56	24.5%
30-39	99	43.2%
40-49	49	21.4%
50-59	25	10.9%
Exposure to flour (duration)		
Mean	11.7 \pm 7.3 (3 – 34 years)	
< 5 years	31	13.5%
5-9	81	35.4%
10-14	50	21.8%
15-19	27	11.8%
\geq 20 years	40	17.5%
Daily exposure (duration)		
Mean \pm SD (Range)	9.21 \pm 1.5 (6 – 12 hours)	
\leq 8 hours	104	45.4%
> 8 hours	125	54.6%
Smoking		
Yes	55	24%
Passive smoking	41	17.9%
Ex smoker	7	3.1%
No smoking	126	55%
Symptoms of asthma		
Cough during the night	59	
Ever wheezing	9	25.8%
Ever wheezing during exercise	8	3.9 %
Allergic rhinitis		3.5 %
Yes	56	24.5%
No	173	75.5%
Work related allergic rhinitis	35	15.3 %
Rhinoconjunctivitis	15	6.6 %

Males were the most represented gender with 222 participants (96.9 %). The average age was 36.29 \pm 8.9 years (range 20-58). The average length of stay in the profession was 11.7 \pm 7.3 years (range 3-34), while the average duration of daily exposure to flour dust was 9.21 \pm 1.5 hours

(range 6-12). Smoking was found in 55 participants (24.5 %). The symptoms of allergic rhinitis were observed in 56 participants (24.5%). These symptoms were associated with working 15.3% (35 participants). The prevalence of allergic rhino-conjunctivitis was 6.6% (15 participants). A notion of wheezing was observed in 3.9 % of participants. The skin tests were positive in 51.5% of cases (Figure 1).

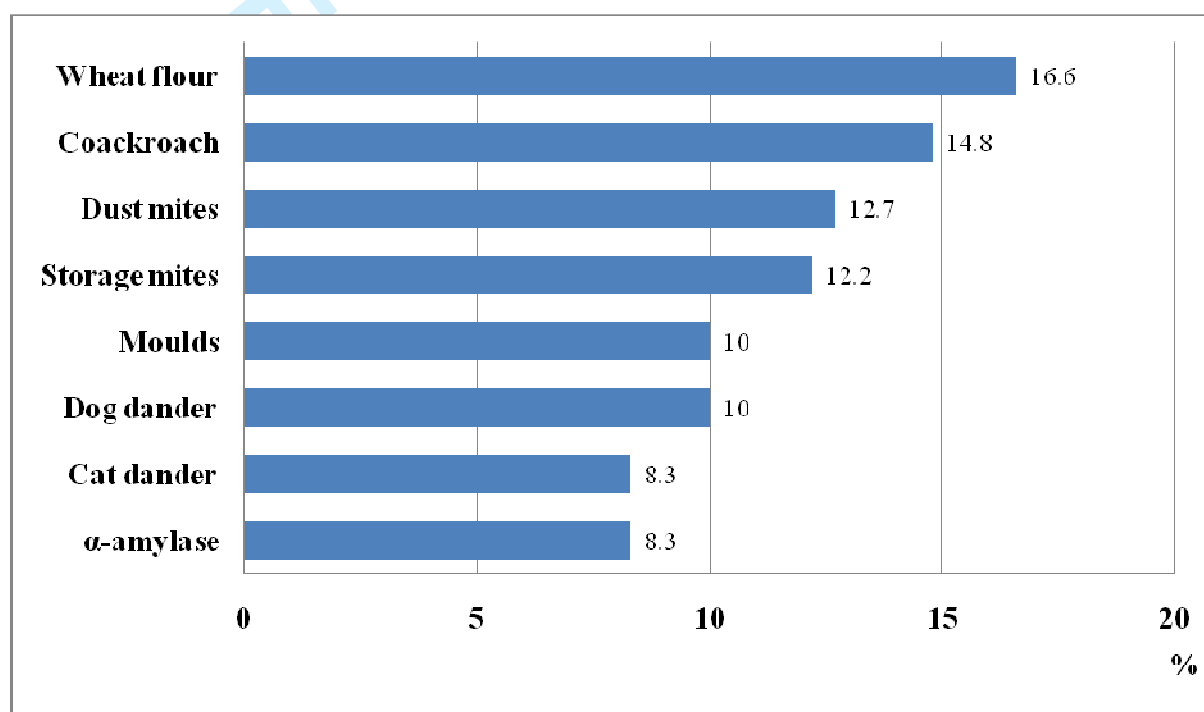


Figure 1. Prevalence of sensitization to aeroallergens

Sensitization to flour and alpha- amylase were observed respectively in 16.6 % and 8.3%. Sensitization to cockroach was found in 14.8 % of participants. Table 2 shows the results of univariate analysis of risk factors of allergic rhinitis in our study population.

Table 2. Univariate analysis of risk factors of allergic rhinitis

Variables	Allergic rhinitis		Crude OR (95 CI)	p value
	Yes	No		
Age				
≤ 30 years	12 (16.9%)	59 (83.1%)		
> 30 years	44 (27.8%)	114 (72.2%)	1.89 (0.93 – 3.86)	0.078
Smoking				
Yes	16 (29.1%)	39 (70.9%)	1.37 (0.89 – 2.71)	0.36
No	40 (23%)	134 (77%)		
Family atopy				
Yes	8 (34.8%)	15 (65.2%)	1.75 (0.70 – 4.39)	0.22
No	48 (23.3%)	158 (76.7%)		
Daily exposure to wheat flour				
≤ 8 hours	29 (27.9%)	75 (72.1%)		
> 8 hours	27 (21.6%)	98 (78.4%)	0.71 (0.38 – 1.30)	0.27
Exposure to wheat				
≤ 5 years	6 (12.8%)	41 (87.2%)		
6 – 10 years	21 (25.3%)	62 (74.7%)	2.31 (0.86 – 6.22)	0.096
> 10 years	29 (29.3%)	70 (70.7%)	2.83 (1.08 – 7.39)	0.034
wheat sensitization				
Yes	20 (52.6%)	18 (47.4%)	4.78 (2.29 – 9.95)	0.000
No	36 (18.8%)	155 (81.2%)		
α-amylase sensitization				
Yes	7 (36.8%)	12 (63.2%)	1.91 (0.71 – 5.13)	0.19
No	49 (23.3%)	161 (76.7%)		
Cockroach sensitization				
Yes	13 (38.2%)	21 (61.8%)	2.18 (1.01 – 4.72)	0.046
No	43 (22.1%)	152 (77.9%)		
Dog dander sensitization				
Yes	11 (47.8%)	12 (52.2%)	3.28 (1.35 – 7.92)	0.008
No	45 (21.8%)	161 (78.2%)		
Cat dander sensitization				
Yes	6 (31.6%)	13 (68.4%)	1.47 (0.53 – 4.08)	0.45
No	50 (23.8%)	160 (76.2%)		
Dust mite sensitization				
Yes	10 (34.5%)	19 (65.5%)	1.76 (0.76 – 4.05)	0.18
No	46 (23%)	154 (77%)		
Storage mite sensitization				
Yes	15 (53.6%)	13 (46.4%)	4.5 (1.98 – 10.20)	0.000
No	41 (20.4%)	160 (79.6%)		
Mould sensitization				
Yes	9 (39.1%)	14 (60.9%)	2.17 (0.88 – 5.34)	0.09
No	47 (22.8%)	159 (77.2%)		
Atopy				
Yes	29 (31.9)	62 (68.1%)	1.92 (1.04 – 3.53)	0.035
No	27 (19.6%)	111 (80.4%)		

Length of time spent in the profession, sensitization to wheat flour, to cockroach, to dog hair, to dust mites and to all common aeroallergens was associated with allergic rhinitis. The independent risk factors after multivariate analysis were sensitizations to flour and storage mites (Table 3).

Table 3. Multivariate analysis of risk factors of allergic rhinitis

Variables	Crude OR (95 CI)	P value
Exposure to wheat flour		
≤ 5 years		
6 – 10 years	2.17 (0.75 – 6.25)	0.15
> 10 years	2.19 (0.79 – 6.02)	0.12
Atopy		
Yes	0.69 (0.21 – 2.23)	0.54
No		
Dust mite sensitization		
Yes	1.52 (0.6 – 3.83)	0.37
No		
Mould sensitization		
Yes	1.80 (0.67 – 4.82)	0.24
No		
Cockroach sensitization		
Yes	1.85 (0.81 – 4.23)	0.14
No		
wheat sensitization		
Yes	3.95 (1.85 – 8.47)	0.000
No		
Storage mite sensitization		
Yes	3.44 (1.45 – 8.18)	0.005
No		

DISCUSSION

This study of allergic rhinitis in bakers shows a prevalence of 24.5 % of allergic rhinitis in this profession. It was work-related in 15.3%. Sensitization to flour, alpha- amylase and current aeroallergens were found respectively in 16.6 %, 8.3% and 39.7 %. As independent risk factors of allergic rhinitis, we found the flour and storage mite sensitization.

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3 From the 1980s, studies on prevalence of allergic rhinitis in bakers increased. In Europe, the
4 prevalence varies from 7% to 21 % depending to authors.¹¹ In Africa, studies on respiratory
5 allergy in the bakers are scarce. In Morocco, Alaoui Yazidi et al found that 33% of bakers had
6 allergic rhinitis.¹² As for allergic rhinitis related to work, Houba¹³ and Jacobs¹⁴ found
7 respectively 21% and 23% in the Netherlands. Other authors found higher prevalence of around
8 25% to 35%.^{15, 16} Our study found 15.3% of work-related allergic rhinitis. This disparity could be
9 explained by a different definition of allergic rhinitis in each study.
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21 With regards to risk factors of allergic rhinitis in our study, after adjustment, the sensitizations to
22 wheat flour and storage mites were associated with allergic rhinitis. Several studies in literature
23 have found a significant relationship between sensitization to wheat flour and allergic rhinitis.^{8, 14,}
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17, 18 Indeed, wheat flour is a complex mixture of polypeptide and polysaccharide substances,
many of which are potential allergens that can cause IgE dependent sensitization after inhalation.
The analysis of wheat flour shows more than 100 spots of IgE binding proteins and analysis of
bakers sensitized serum highlights not only several reactions to these antigens, but also a great
individual sensitization variability.¹⁹ Wheat flour consists in four classes of proteins including
albumin, globulins, gliadins and glutenins. The most important IgE reaction in bakers' respiratory
allergy is due to proteins of molecular weight between 12 and 17 kDa that are considered "major
allergens".²⁰

In this study, sensitization to storage mites was independently associated with allergic rhinitis.
This result corroborates that of Blainey et al²¹ who found an association between sensitization to
storage mites and respiratory allergy. However, De Zotti et al²² consider that storage mites are not
real occupational aeroallergens in bakers and would rather be a cause of immunological
cosensitizations.

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3 Univariate analyzes showed association between some factors and allergic rhinitis. These factors
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5 were no longer significantly associated in multivariate analysis. The named factor is length of
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7 time spent in the current profession of more than 10 years. Indeed, the latency period for the
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9 development of sensitization to aeroallergens in professional baker is short and longer for the
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11 occurrence of respiratory symptoms.^{23, 24} Atopy was associated with allergic rhinitis. While most
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13 studies show that it is a risk factor for workplace aeroallergen sensitization bakers,^{7, 8, 14, 16} its role
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15 as factor associated with the occurrence of respiratory symptoms in bakers was not found by all
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17 authors.^{15, 22, 25} In our study, after multivariate analysis, atopy was not associated with allergic
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19 rhinitis. This effect could have disappeared because of the significant sensitization association
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21 between storage mites and allergic rhinitis. Positive skin tests to storage mites in bakers would be
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23 more an indicator of atopy than being a real response to an occupational allergen.²⁶ As found by
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25 De Zotti et al²², age and smoking was not associated with allergic rhinitis.
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32 This study is among the first in sub-Saharan Africa that have sought an association between
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34 workplace aeroallergens in bakers and the symptoms of allergic rhinitis. The logistic regression, a
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36 pretty solid statistical method for the detection of associations between variables was used in this
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38 study. Despite these strengths, there are some weaknesses; the measurement of the exposure to
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40 dust in bakeries was not done. On the other hand, the specific serum IgE antibodies
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42 measurements, a method with better specificity and sensitivity than that of skin tests, for the
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44 diagnosis of allergen sensitization were not performed.
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49 CONCLUSION

50 This study on the respiratory allergy in bakers in Sub-Saharan Africa shows a high prevalence of
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52 allergic rhinitis and highlights the role of sensitization to wheat flour and dust mites as risk
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54 factors for allergic rhinitis in bakers. Implementing protective measures against these
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3 aeroallergens and clinical monitoring of sensitized workers towards occupational aeroallergens
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5 could reduce the prevalence of this condition which, though not life-threatening can significantly
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7 alter barkers quality of life.
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19 **Contribution of authors:**

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21 MNBH conceptualized the study, designed the protocol, analysed the data and drafted the
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23 manuscript. NE collected the data. AZE, NF and NLR revised the manuscript and MNY
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25 participated to administrative and technical support.
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28 **Competing of interests:** none
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31 **Data Sharing Statement:** No additional data
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Key words: wheat flour, bakeries, bakeries, Africa

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ABSTRACT

Objective: To determine the prevalence and risk factors of allergic rhinitis among bakers in Douala.

Design: A cross-sectional study; the logistic regression model was use to find the risk factors of allergic rhinitis

Setting: The study was conducted in 42 bakeries randomly selected among a total of 151 bakeries in the city of Douala.

Participants: All bakers who consented to participate in the study during from May 1st to July 31st 2013.

Outcome measures: Allergic rhinitis was the outcome of interest. It was defined as the presence of the following symptoms: itchy nose, rhinorrhea, nasal obstruction and sneezing.

Results: During the study period, a total of 273 bakers were invited to participate and 229 finally agreed to participate in this study. Males were the most represented gender with 222 (96.9%) participants. The mean age of the participants was 36.29 ± 8.9 years. Smoking was found in 55 participants (24.5 %). The symptoms of allergic rhinitis were observed in 24.5% of participants. Work related nasal symptoms were present in 15% of participants. Sensitization to wheat flour and alpha-amylase was found in 16.6% and 8.3% of participants respectively. The Prick test was positive for mites in 12.2% of participants. After multivariate analysis, sensitization to flour (OR

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3 3.95, 95 % CI 1.85 - 8.47) and storage mites (OR 3.44, 95 % CI 1.45 - 8.18) were the factors
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5 independently associated with symptoms of allergic rhinitis.
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9 **Conclusion:** Allergic rhinitis is frequent among bakers in Cameroon. Implementation of
10 preventive measures against inhalation of airborne allergens in bakeries and clinical monitoring
11 of bakers sensitized to wheat flour and mites could help to reduce the prevalence of allergic
12 rhinitis among bakers.
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18 19 20 21 22 **Strengths and limitations of this study** 23

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25 • This study is among the first studies carried out in sub-Saharan Africa that have sought an
26 association between workplace aeroallergens in bakers and the symptoms of allergic
27 rhinitis.
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- 29
30 • The logistic regression, which is a pretty solid statistical method for the detection of
31 associations between variables, was used in this study.
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34 • The measurement of the exposure to dust in bakeries was not done.
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37 • The specific serum IgE antibodies measurements, a method with better specificity and
38 sensitivity than that of skin tests, for the diagnosis of allergen sensitization were not
39 performed.
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INTRODUCTION

Allergic rhinitis is a common condition in current medical practice. It is with asthma, the main manifestations of respiratory allergy. This condition is present in all parts of the world and its prevalence varies with regions. Most prevalence studies on rhinitis have used the methods of the International Study of Asthma and Allergies in Childhood (ISAAC). These prevalence range from 23% to 30% in Europe, 12% to 30% in the United States of America and 5.5% to 45.1% in North America.¹ In Africa, it varies from 7.2% to 27.3%.² Although it is not fatal, allergic rhinitis generates costs and has a negative impact on the quality of life of patients. It harmfully affects school and professional performances.³⁻⁵ The occurrence of allergic rhinitis is conditioned by the conjunction of several factors such as atopy and several environmental factors, of which the leading factors are allergens and pollution. Amongst the allergens, pollens from plants and house dust mites are the most represented.⁶ Occupational allergens are involved in the onset of occupational allergic rhinitis. Flour and alpha-amylase used for the fermentation of yeast are the main risk factors in bakers' allergic rhinitis.^{7,8} Storage mites present in the flour also contribute to the development of this condition.⁹ In sub-Saharan Africa, few studies have been carried out on allergic rhinitis, whereas this part of the world is increasingly being exposed to pollution and climatic conditions are more and more favorable to allergens such as dust mites and moulds.¹⁰ Bakery employees, apart from their usual exposure to aeroallergens are often in contact with specific aeroallergens of their workplace.

The objective of this study was to determine the prevalence of allergic rhinitis and associated factors in bakers in the city of Douala.

METHODS

Design and setting

This was a cross-sectional study conducted from May 1st to July 31st 2013 in 42 randomly selected bakeries in the city of Douala in Cameroon. Douala is a sea neighboring city in the central part of Africa located just above the equator. It is the economic capital of Cameroon, hosting many industries. The climate is hot and humid most of the year.

Participants: Bakery employees with regular contact with flour were included. Participants under 15 years, those with a non-allergic rhinitis or sinusitis and those declining to participate in the study were excluded.

Data collection and variables

Sociodemographic data, respiratory symptoms, medical history, family history of atopy, smoking status, and characteristics of exposure to flour were collected using a face to face administered questionnaire. Allergic rhinitis was defined by the presence of at least one of the following symptoms: itchy nose, sneezing, nasal obstruction and rhinorrhea. Work-related symptoms were those triggered in the workplace. Rhino-conjunctivitis was defined by the association of symptoms of allergic rhinitis, ocular itching or eye tearing. Skin prick tests to 13 aeroallergens were performed. Allergens used were those from ALK laboratories (Varenes in Argonne, France). Aeroallergens present in bakeries included wheat flour, alpha-amylase, 4 types of storage mites; and common aeroallergens included house dust mites, moulds, cat, dog, and German cockroach. When searching for risk factors of allergic rhinitis, aeroallergens were grouped as follows: sensitization to house dust mites was defined by positive skin prick tests to *Dermatophagoides farinae* and/or to *Dermatophagoides pteronyssinus*. Similarly, sensitization to storage mites was considered when a positive prick test to at least one the following type of mites

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3 was observed: *Lepidoglyphus destructor*, *Glycyphagus domesticus*, *Acarus siro*, *Tyroglyphus*
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5 *putrescentia*.

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8 Atopy was defined as a positive skin prick test to at least one of the common aeroallergens. The
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10 positive control was histamine and the negative control was glycerol-saline solution. The test was
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12 read 15 minutes after application of the allergen solution. The test was positive when the
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14 diameter of induration was greater than (or equal to) 3mm, or greater than 50% of the positive
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16 control.

17 18 19 **Data analysis**

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22 Data was entered and analyzed using SPSS 20 for Windows. Descriptive statistics were used for
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24 general presentation of the sample. Univariate analysis was then performed, followed by logistic
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26 regression in order to identify risk factors of allergic rhinitis. Variables for which P was less than
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28 (or equal) to 0.2 were introduced in the final model for multivariate analysis. The odds ratio and
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30 confidence intervals of 95% were determined. Statistical tests were considered significant for a P
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32 value of less than 0.05.

33 34 35 **Ethical clearance**

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38 The protocol was submitted to the National Ethics Committee and the recruitment started after
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40 obtaining an ethical clearance as well as an oral consent from each participant.

41 42 43 **RESULTS**

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46 During the study period, a total of 273 bakers were invited to participate and finally 229 bakers
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48 agreed to participate in this study, giving a response rate of 83.8%. The general characteristics of
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50 the study population are shown in table I.

Table I. General Characteristics of participants

Variables	Number	Percentage
Gender		
Male	222	96.9%
Female	7	3.1%
Age		
Mean \pm SD (Range)	36.29 \pm 8.9 (20 – 58 years)	
20-29 years	56	24.5%
30-39	99	43.2%
40-49	49	21.4%
50-59	25	10.9%
Exposure to flour (duration)		
Mean	11.7 \pm 7.3 (3 – 34 years)	
< 5 years	31	13.5%
5-9	81	35.4%
10-14	50	21.8%
15-19	27	11.8%
\geq 20 years	40	17.5%
Daily exposure (duration)		
Mean \pm SD (Range)	9.21 \pm 1.5 (6 – 12 hours)	
\leq 8 hours	104	45.4%
> 8 hours	125	54.6%
Smoking		
Yes	55	24%
Passive smoking	41	17.9%
Ex-smoker	7	3.1%
No smoking	126	55%
Symptoms of asthma		
Cough at night	59	25.8%
Ever wheezing	9	3.9 %
Ever wheezing during exercise	8	3.5 %
Allergic rhinitis		
Yes	56	24.5%
No	173	75.5%
Work related allergic rhinitis	35	15.3 %
Rhinoconjunctivitis	15	6.6 %

Males were the most represented gender with 222 (96.9%) participants. The mean age was 36.29 \pm 8.9 years (range 20-58). The mean length of stay duration in the profession was 11.7 \pm 7.3 years (range 3-34), while the average duration of daily exposure to flour dust was 9.21 \pm 1.5

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3 hours (range 6-12). Smoking was found in 55 (24.5%) participants. The symptoms of allergic
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5 rhinitis were observed in 56 (24.5%) participants (24.5%). These symptoms were work related in
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7 15.3% (35 participants). The prevalence of allergic rhino-conjunctivitis was 6.6% (15
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9 participants) and the main symptoms of lower respiratory tract involvement being were cough
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11 (25.8%) and wheezing (3.9%). The skin prick tests were positive in 51.5% of participants cases
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13 (Figure 1).
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18 Sensitization to flour and alpha-amylase were observed in 16.6 % and 8.3% of participants
19
20 respectively. Sensitization to the German cockroach was found in 14.8 % of participants. Table II
21
22 shows the results of univariate analysis of risk factors of allergic rhinitis in the study population.
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Table II. Univariate analysis of risk factors of allergic rhinitis

Variables	Allergic rhinitis		Crude OR (95 CI)	p value
	Yes	No		
Age				
≤ 30 years	12 (16.9%)	59 (83.1%)		
> 30 years	44 (27.8%)	114 (72.2%)	1.89 (0.93 – 3.86)	0.078
Smoking				
Yes	16 (29.1%)	39 (70.9%)	1.37 (0.89 – 2.71)	0.36
No	40 (23%)	134 (77%)		
Family atopy				
Yes	8 (34.8%)	15 (65.2%)	1.75 (0.70 – 4.39)	0.22
No	48 (23.3%)	158 (76.7%)		
Daily exposure to wheat flour				
≤ 8 hours	29 (27.9%)	75 (72.1%)		
> 8 hours	27 (21.6%)	98 (78.4%)	0.71 (0.38 – 1.30)	0.27
Exposure to wheat				
≤ 5 years	6 (12.8%)	41 (87.2%)		
6 – 10 years	21 (25.3%)	62 (74.7%)	2.31 (0.86 – 6.22)	0.096
> 10 years	29 (29.3%)	70 (70.7%)	2.83 (1.08 – 7.39)	0.034
Wheat sensitization				
Yes	20 (52.6%)	18 (47.4%)	4.78 (2.29 – 9.95)	0.000
No	36 (18.8%)	155 (81.2%)		
α-amylase sensitization				
Yes	7 (36.8%)	12 (63.2%)	1.91 (0.71 – 5.13)	0.19
No	49 (23.3%)	161 (76.7%)		
Cockroach sensitization				
Yes	13 (38.2%)	21 (61.8%)	2.18 (1.01 – 4.72)	0.046
No	43 (22.1%)	152 (77.9%)		
Dog dander sensitization				
Yes	11 (47.8%)	12 (52.2%)	3.28 (1.35 – 7.92)	0.008
No	45 (21.8%)	161 (78.2%)		
Cat dander sensitization				
Yes	6 (31.6%)	13 (68.4%)	1.47 (0.53 – 4.08)	0.45
No	50 (23.8%)	160 (76.2%)		
Dust mite sensitization				
Yes	10 (34.5%)	19 (65.5%)	1.76 (0.76 – 4.05)	0.18
No	46 (23%)	154 (77%)		
Storage mite sensitization				
Yes	15 (53.6%)	13 (46.4%)	4.5 (1.98 – 10.20)	0.000
No	41 (20.4%)	160 (79.6%)		
Mould sensitization				
Yes	9 (39.1%)	14 (60.9%)	2.17 (0.88 – 5.34)	0.09
No	47 (22.8%)	159 (77.2%)		
Atopy				
Yes	29 (31.9)	62 (68.1%)	1.92 (1.04 – 3.53)	0.035
No	27 (19.6%)	111 (80.4%)		

Length of time spent in the profession, sensitization to wheat flour, to the German cockroach, to dog fur, to dust mites and to all common aeroallergens was associated with allergic rhinitis. The independent risk factors after multivariate analysis were sensitizations to flour and storage mites (Table III).

Table III. Multivariate analysis of risk factors of allergic rhinitis

Variables	Crude OR (95 CI)	P value
Exposure to wheat flour		
≤ 5 years		
6 – 10 years	2.17 (0.75 – 6.25)	0.15
> 10 years	2.19 (0.79 – 6.02)	0.12
Atopy		
Yes	0.69 (0.21 – 2.23)	0.54
No		
Dust mite sensitization		
Yes	1.52 (0.6 – 3.83)	0.37
No		
Mould sensitization		
Yes	1.80 (0.67 – 4.82)	0.24
No		
Cockroach sensitization		
Yes	1.85 (0.81 – 4.23)	0.14
No		
Wheat sensitization		
Yes	3.95 (1.85 – 8.47)	0.000
No		
Storage mite sensitization		
Yes	3.44 (1.45 – 8.18)	0.005
No		

DISCUSSION

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3 This study on of allergic rhinitis in bakers shows a prevalence of 24.5 % of allergic rhinitis in this
4 profession. It was work-related in 15.3%. Sensitization to flour, alpha- amylase and current
5 aeroallergens were found respectively in 16.6 %, 8.3% and 39.7 % of participants. As
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7 independent risk factors of allergic rhinitis, we found the flour and storage mite sensitization.
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9 From the 1980s, studies on the prevalence of allergic rhinitis in bakers increased. In Europe, the
10 prevalence varies from 7% to 21 % depending on the authors.¹¹ In Africa, studies on respiratory
11 allergies in the bakers are scarce. In Morocco, Alaoui Yazidi et al. found that 33% of bakers had
12 allergic rhinitis.¹² As for allergic rhinitis related to work, Houba¹³ and Jacobs¹⁴ reported
13 respectively 21% and 23% respectively in the Netherlands. Other authors reported higher
14 prevalence of around about 25% to 35%.^{15,16} This study had found 15.3% of work-related allergic
15 rhinitis. This disparity could be explained by the different definitions of allergic rhinitis used in
16 each study.
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32 With respect to risk factors of allergic rhinitis in this study, after adjustment, the sensitizations to
33 wheat flour and storage mites were associated with the presence of allergic rhinitis. Several
34 studies in literature have found a significant relationship between sensitization to wheat flour and
35 allergic rhinitis.^{8,14,17,18} Indeed, wheat flour is a complex mixture of polypeptide and
36 polysaccharide substances, many of which are potential allergens that can cause IgE dependent
37 sensitization after inhalation. The analysis of wheat flour shows more than 100 spots of IgE
38 binding proteins and analysis of bakers sensitized serum highlights not only several reactions to
39 these antigens, but also a great individual sensitization variability.¹⁹ Wheat flour consists of four
40 classes of proteins which are including albumin, ~~globulins~~, gliadins and glutenins. The most
41 important IgE reaction in bakers' respiratory allergy is due to proteins of molecular weight
42 ranging between 12 and 17 kDa that are considered "major allergens".²⁰
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3 In this study, sensitization to storage mites was independently associated with allergic rhinitis.
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5 This result corroborates that of Blainey et al²¹ who found an association between sensitization to
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7 storage mites and respiratory allergy. However, De Zotti et al²² consider that storage mites are not
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9 real occupational aeroallergens in bakers and would rather be a cause of immunological
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11 cosensitizations.
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16 Univariate analyzes showed association between some factors and allergic rhinitis. These factors
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18 were no longer significantly associated in multivariate analysis. The named factor is length of
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20 time spent in the current profession of more than 10 years. Indeed, the latency period for the
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22 development of sensitization to aeroallergens in professional baker is short and longer for the
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24 occurrence of respiratory symptoms.^{23,24} Atopy was associated with allergic rhinitis. While most
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26 studies show that it is a risk factor for workplace aeroallergen sensitization in bakers,^{7,8,14,16} its
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28 role as factor associated with the occurrence of respiratory symptoms in bakers was not found by
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30 all authors.^{15,22,25} In this study, after multivariate analysis, atopy was not associated with allergic
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32 rhinitis. The limited definition of atopy in this study could explain this finding. In addition, the
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34 effect of atopy could have disappeared because of the significant sensitization association
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36 between storage mites and allergic rhinitis and atopy has been demonstrated to be associated with
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38 sensitization to storage mites.²⁶ As found by De Zotti et al,²² age and smoking were was not
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40 associated with allergic rhinitis.
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48 This study is among the first in sub-Saharan Africa that has sought an association in between
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50 workplace aeroallergens in bakers and the symptoms of allergic rhinitis. The logistic regression,
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52 which is a pretty solid statistical method for the detection of associations between variables was
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54 used in this study. Despite these strengths, there are some weaknesses; the measurement of the
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56 exposure to dust in bakeries was not done. On the other hand, the specific serum IgE antibodies
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3 measurements, a method with better specificity and sensitivity than that of skin prick tests, for the
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5 diagnosis of allergen sensitization were not performed.
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8 9 **CONCLUSION**

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11 This study on respiratory allergies in bakers in Sub-Saharan Africa shows a high prevalence of
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13 allergic rhinitis and highlights the role of sensitization to wheat flour and dust mites as risk
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15 factors for allergic rhinitis in bakers. Implementing protective measures against these
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17 aeroallergens and clinical monitoring of sensitized workers towards occupational aeroallergens
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19 could reduce the prevalence of this condition which, though not life-threatening can significantly
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21 alter bakers quality of life.
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36 **Contribution of authors:**

37
38 MNBH conceptualized the study, designed the protocol, analysed the data and drafted the
39
40 manuscript. NE collected the data. AZE, NF and NLR revised the manuscript and MNY
41
42 participated to administrative and technical support.
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44

45 **Competing of interests:** none declared
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48 **Data Sharing Statement:** No additional data available
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Figure 1. Prevalence of sensitization to aeroallergens

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6 **Title:** Prevalence and risk factors allergic rhinitis in bakers in Douala, Cameroon
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3 **Key words:** wheat flour, bakeries, Allergy, Africa
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10 **ABSTRACT**

11 **Objective:** To determine the prevalence and risk factors of allergic rhinitis among bakers in
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16 Douala.

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19 **Design:** A cross-sectional study; the logistic regression model was use to find the risk factors of
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allergic rhinitis

Setting: The study was conducted in 42 bakeries randomly selected among a total of 151
bakeries in the city of Douala.

Participants: All bakers who consented to participate in the study during from May 1st to July
31st 2013.

Outcome measures: Allergic rhinitis was the outcome of interest. It was defined as the presence
of the following symptoms: itchy nose, rhinorrhea, nasal obstruction and sneezing.

Results: During the study period, a total of 273 bakers were invited to participate and 229 finally
agreed to participate in this study. Males were the most represented gender with 222 (96.9%)
participants. The mean age of the participants was 36.29 ± 8.9 years. Smoking was found in 55
participants (24.5 %). The symptoms of allergic rhinitis were observed in 24.5% of participants.
Work related nasal symptoms were present in 15% of participants. Sensitization to wheat flour
and alpha-amylase was found in 16.6% and 8.3% of participants respectively. The Prick test was
positive for mites in 12.2% of participants. After multivariate analysis, sensitization to flour (OR

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3 3.95, 95 % CI 1.85 - 8.47) and storage mites (OR 3.44, 95 % CI 1.45 - 8.18) were the factors
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5 independently associated with symptoms of allergic rhinitis.
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9 **Conclusion:** Allergic rhinitis is frequent among bakers in Cameroon. Implementation of
10 preventive measures against inhalation of airborne allergens in bakeries and clinical monitoring
11 of bakers sensitized to wheat flour and mites could help to reduce the prevalence of allergic
12 rhinitis among bakers.
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18 19 20 21 22 **Strengths and limitations of this study** 23

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25 • This study is among the first studies carried out in sub-Saharan Africa that have sought an
26 association between workplace aeroallergens in bakers and the symptoms of allergic
27 rhinitis.
28
- 29 • The logistic regression, which is a pretty solid statistical method for the detection of
30 associations between variables, was used in this study.
31
- 32 • The measurement of the exposure to dust in bakeries was not done.
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- 34 • The specific serum IgE antibodies measurements, a method with better specificity and
35 sensitivity than that of skin tests, for the diagnosis of allergen sensitization were not
36 performed.
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INTRODUCTION

Allergic rhinitis is a common condition in current medical practice. It is with asthma, the main manifestations of respiratory allergy. This condition is present in all parts of the world and its prevalence varies with regions. Most prevalence studies on rhinitis have used the methods of the International Study of Asthma and Allergies in Childhood (ISAAC). These prevalence range from 23% to 30% in Europe, 12% to 30% in the United States of America and 5.5% to 45.1% in North America.¹ In Africa, it varies from 7.2% to 27.3%.² Although it is not fatal, allergic rhinitis generates costs and has a negative impact on the quality of life of patients. It harmfully affects school and professional performances.³⁻⁵ The occurrence of allergic rhinitis is conditioned by the conjunction of several factors such as atopy and several environmental factors, of which the leading factors are allergens and pollution. Amongst the allergens, pollens from plants and house dust mites are the most represented.⁶ Occupational allergens are involved in the onset of occupational allergic rhinitis. Flour and alpha-amylase used for the fermentation of yeast are the main risk factors in bakers' allergic rhinitis.^{7,8} Storage mites present in the flour also contribute to the development of this condition.⁹ In sub-Saharan Africa, few studies have been carried out on allergic rhinitis, whereas this part of the world is increasingly being exposed to pollution and climatic conditions are more and more favorable to allergens such as dust mites and moulds.¹⁰ Bakery employees, apart from their usual exposure to aeroallergens are often in contact with specific aeroallergens of their workplace.

The objective of this study was to determine the prevalence of allergic rhinitis and associated factors in bakers in the city of Douala.

METHODS

Design and setting

This was a cross-sectional study conducted from May 1st to July 31st 2013 in 42 randomly selected bakeries in the city of Douala in Cameroon. Douala is a sea neighboring city in the central part of Africa located just above the equator. It is the economic capital of Cameroon, hosting many industries. The climate is hot and humid most of the year.

Participants: Bakery employees with regular contact with flour were included. Participants under 15 years, those with a non-allergic rhinitis or sinusitis and those declining to participate in the study were excluded.

Data collection and variables

Sociodemographic data, respiratory symptoms, medical history, family history of atopy, smoking status, and characteristics of exposure to flour were collected using a face to face administered questionnaire. Allergic rhinitis was defined by the presence of at least one of the following symptoms: itchy nose, sneezing, nasal obstruction and rhinorrhea. Work-related symptoms were those triggered in the workplace. Rhino-conjunctivitis was defined by the association of symptoms of allergic rhinitis, ocular itching or eye tearing. Skin prick tests to 13 aeroallergens were performed. Allergens used were those from ALK laboratories (Varenes in Argonne, France). Aeroallergens present in bakeries included wheat flour, alpha-amylase, 4 types of **storage mites**; and common aeroallergens included house dust mites, moulds, cat, dog, and German cockroach. When searching for risk factors of allergic rhinitis, aeroallergens were grouped as follows: sensitization to house dust mites was defined by positive skin prick tests to *Dermatophagoides farinae* and/or to *Dermatophagoides pteronyssinus*. Similarly, sensitization to storage mites was considered when a positive prick test to at least one the following type of mites

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3 was observed: *Lepidoglyphus destructor*, *Glycyphagus domesticus*, *Acarus siro*, *Tyroglyphus*
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5 *putrescentia*.

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8 Atopy was defined as a positive skin prick test to at least one of the common aeroallergens. The
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10 positive control was histamine and the negative control was glycerol-saline solution. The test was
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12 read 15 minutes after application of the allergen solution. The test was positive when the
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14 diameter of induration was greater than (or equal to) 3mm, or greater than 50% of the positive
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16 control.
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18 19 20 **Data analysis**

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22 Data was entered and analyzed using SPSS 20 for Windows. Descriptive statistics were used for
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24 general presentation of the sample. Univariate analysis was then performed, followed by logistic
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26 regression in order to identify risk factors of allergic rhinitis. Variables for which P was less than
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28 (or equal) to 0.2 were introduced in the final model for multivariate analysis. The odds ratio and
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30 confidence intervals of 95% were determined. Statistical tests were considered significant for a P
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32 value of less than 0.05.
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34 35 36 **Ethical clearance**

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38 The protocol was submitted to the National Ethics Committee and the recruitment started after
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40 obtaining an ethical clearance as well as an oral consent from each participant.
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43 44 **RESULTS**

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46 During the study period, a total of 273 bakers were invited to participate and finally 229 bakers
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48 agreed to participate in this study, giving a response rate of 83.8%. The general characteristics of
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50 the study population are shown in table I.
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Table I. General Characteristics of participants

Variables	Number	Percentage
Gender		
Male	222	96.9%
Female	7	3.1%
Age		
Mean \pm SD (Range)	36.29 \pm 8.9 (20 – 58 years)	
20-29 years	56	24.5%
30-39	99	43.2%
40-49	49	21.4%
50-59	25	10.9%
Exposure to flour (duration)		
Mean	11.7 \pm 7.3 (3 – 34 years)	
< 5 years	31	13.5%
5-9	81	35.4%
10-14	50	21.8%
15-19	27	11.8%
\geq 20 years	40	17.5%
Daily exposure (duration)		
Mean \pm SD (Range)	9.21 \pm 1.5 (6 – 12 hours)	
\leq 8 hours	104	45.4%
> 8 hours	125	54.6%
Smoking		
Yes	55	24%
Passive smoking	41	17.9%
Ex-smoker	7	3.1%
No smoking	126	55%
Symptoms of asthma		
Cough at night	59	25.8%
Ever wheezing	9	3.9 %
Ever wheezing during exercise	8	3.5 %
Allergic rhinitis		
Yes	56	24.5%
No	173	75.5%
Work related allergic rhinitis	35	15.3 %
Rhinoconjunctivitis	15	6.6 %

Males were the most represented gender with 222 (96.9%) participants. The mean age was 36.29 \pm 8.9 years (range 20-58). The mean length of stay duration in the profession was 11.7 \pm 7.3 years (range 3-34), while the average duration of daily exposure to flour dust was 9.21 \pm 1.5

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3 hours (range 6-12). Smoking was found in 55 (24.5%) participants. The symptoms of allergic
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5 rhinitis were observed in 56 (24.5%) participants (24.5%). These symptoms were work related in
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7 15.3% (35 participants). The prevalence of allergic rhino-conjunctivitis was 6.6% (15
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9 participants) and the main symptoms of lower respiratory tract involvement being were cough
10
11 (25.8%) and wheezing (3.9%). The skin prick tests were positive in 51.5% of participants cases
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13 (Figure 1).
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18 Sensitization to flour and alpha-amylase were observed in 16.6 % and 8.3% of participants
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20 respectively. Sensitization to the German cockroach was found in 14.8 % of participants. Table II
21
22 shows the results of univariate analysis of risk factors of allergic rhinitis in the study population.
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Table II. Univariate analysis of risk factors of allergic rhinitis

Variables	Allergic rhinitis		Crude OR (95 CI)	p value
	Yes	No		
Age				
≤ 30 years	12 (16.9%)	59 (83.1%)		
> 30 years	44 (27.8%)	114 (72.2%)	1.89 (0.93 – 3.86)	0.078
Smoking				
Yes	16 (29.1%)	39 (70.9%)	1.37 (0.89 – 2.71)	0.36
No	40 (23%)	134 (77%)		
Family atopy				
Yes	8 (34.8%)	15 (65.2%)	1.75 (0.70 – 4.39)	0.22
No	48 (23.3%)	158 (76.7%)		
Daily exposure to wheat flour				
≤ 8 hours	29 (27.9%)	75 (72.1%)		
> 8 hours	27 (21.6%)	98 (78.4%)	0.71 (0.38 – 1.30)	0.27
Exposure to wheat				
≤ 5 years	6 (12.8%)	41 (87.2%)		
6 – 10 years	21 (25.3%)	62 (74.7%)	2.31 (0.86 – 6.22)	0.096
> 10 years	29 (29.3%)	70 (70.7%)	2.83 (1.08 – 7.39)	0.034
Wheat sensitization				
Yes	20 (52.6%)	18 (47.4%)	4.78 (2.29 – 9.95)	0.000
No	36 (18.8%)	155 (81.2%)		
α-amylase sensitization				
Yes	7 (36.8%)	12 (63.2%)	1.91 (0.71 – 5.13)	0.19
No	49 (23.3%)	161 (76.7%)		
Cockroach sensitization				
Yes	13 (38.2%)	21 (61.8%)	2.18 (1.01 – 4.72)	0.046
No	43 (22.1%)	152 (77.9%)		
Dog dander sensitization				
Yes	11 (47.8%)	12 (52.2%)	3.28 (1.35 – 7.92)	0.008
No	45 (21.8%)	161 (78.2%)		
Cat dander sensitization				
Yes	6 (31.6%)	13 (68.4%)	1.47 (0.53 – 4.08)	0.45
No	50 (23.8%)	160 (76.2%)		
Dust mite sensitization				
Yes	10 (34.5%)	19 (65.5%)	1.76 (0.76 – 4.05)	0.18
No	46 (23%)	154 (77%)		
Storage mite sensitization				
Yes	15 (53.6%)	13 (46.4%)	4.5 (1.98 – 10.20)	0.000
No	41 (20.4%)	160 (79.6%)		
Mould sensitization				
Yes	9 (39.1%)	14 (60.9%)	2.17 (0.88 – 5.34)	0.09
No	47 (22.8%)	159 (77.2%)		
Atopy				
Yes	29 (31.9)	62 (68.1%)	1.92 (1.04 – 3.53)	0.035
No	27 (19.6%)	111 (80.4%)		

Length of time spent in the profession, sensitization to wheat flour, to the German cockroach, to dog fur, to dust mites and to all common aeroallergens was associated with allergic rhinitis. The independent risk factors after multivariate analysis were sensitizations to flour and storage mites (Table III).

Table III. Multivariate analysis of risk factors of allergic rhinitis

Variables	Crude OR (95 CI)	P value
Exposure to wheat flour		
≤ 5 years		
6 – 10 years	2.17 (0.75 – 6.25)	0.15
> 10 years	2.19 (0.79 – 6.02)	0.12
Atopy		
Yes	0.69 (0.21 – 2.23)	0.54
No		
Dust mite sensitization		
Yes	1.52 (0.6 – 3.83)	0.37
No		
Mould sensitization		
Yes	1.80 (0.67 – 4.82)	0.24
No		
Cockroach sensitization		
Yes	1.85 (0.81 – 4.23)	0.14
No		
Wheat sensitization		
Yes	3.95 (1.85 – 8.47)	0.000
No		
Storage mite sensitization		
Yes	3.44 (1.45 – 8.18)	0.005
No		

DISCUSSION

This study on of allergic rhinitis in bakers shows a prevalence of 24.5 % of allergic rhinitis in this profession. It was work-related in 15.3%. Sensitization to flour, alpha- amylase and current aeroallergens were found respectively in 16.6 %, 8.3% and 39.7 % of participants. As independent risk factors of allergic rhinitis, we found the flour and storage mite sensitization. From the 1980s, studies on the prevalence of allergic rhinitis in bakers increased. In Europe, the prevalence varies from 7% to 21 % depending on the authors.¹¹ In Africa, studies on respiratory allergies in the bakers are scarce. In Morocco, Alaoui Yazidi et al. found that 33% of bakers had allergic rhinitis.¹² As for allergic rhinitis related to work, Houba¹³ and Jacobs¹⁴ reported respectively 21% and 23% respectively in the Netherlands. Other authors reported higher prevalence of around about 25% to 35%.^{15,16} This study had found 15.3% of work-related allergic rhinitis. This disparity could be explained by the different definitions of allergic rhinitis used in each study.

With respect to risk factors of allergic rhinitis in this study, after adjustment, the sensitizations to wheat flour and storage mites were associated with the presence of allergic rhinitis. Several studies in literature have found a significant relationship between sensitization to wheat flour and allergic rhinitis.^{8,14,17,18} Indeed, wheat flour is a complex mixture of polypeptide and polysaccharide substances, many of which are potential allergens that can cause IgE dependent sensitization after inhalation. The analysis of wheat flour shows more than 100 spots of IgE binding proteins and analysis of bakers sensitized serum highlights not only several reactions to these antigens, but also a great individual sensitization variability.¹⁹ Wheat flour consists of four classes of proteins which are including albumin, ~~globulins~~, gliadins and glutenins. The most

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3 important IgE reaction in bakers' respiratory allergy is due to proteins of molecular weight
4 ranging between 12 and 17 kDa that are considered "major allergens".²⁰
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9 In this study, sensitization to storage mites was independently associated with allergic rhinitis.
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11 This result corroborates that of Blainey et al²¹ who found an association between sensitization to
12 storage mites and respiratory allergy. However, De Zotti et al²² consider that storage mites are not
13 real occupational aeroallergens in bakers and would rather be a cause of immunological
14 cosensitizations.
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21 Univariate analyzes showed association between some factors and allergic rhinitis. These factors
22 were no longer significantly associated in multivariate analysis. The named factor is length of
23 time spent in the current profession of more than 10 years. Indeed, the latency period for the
24 development of sensitization to aeroallergens in professional baker is short and longer for the
25 occurrence of respiratory symptoms.^{23,24} Atopy was associated with allergic rhinitis. While most
26 studies show that it is a risk factor for workplace aeroallergen sensitization in bakers,^{7,8,14,16} its
27 role as factor associated with the occurrence of respiratory symptoms in bakers was not found by
28 all authors.^{15,22,25} In this study, after multivariate analysis, atopy was not associated with allergic
29 rhinitis. **The limited definition of atopy in this study could explain this finding. In addition, the**
30 **effect of atopy** could have disappeared because of the significant sensitization association
31 between storage mites and allergic rhinitis **and atopy has been demonstrated to be associated with**
32 **sensitization to storage mites.**²⁶ As found by De Zotti et al,²² age and smoking were not
33 associated with allergic rhinitis.
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53 This study is among the first in sub-Saharan Africa that has sought an association in between
54 workplace aeroallergens in bakers and the symptoms of allergic rhinitis. The logistic regression,
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3 which is a pretty solid statistical method for the detection of associations between variables was
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5 used in this study. Despite these strengths, there are some weaknesses; the measurement of the
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7 exposure to dust in bakeries was not done. On the other hand, the specific serum IgE antibodies
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9 measurements, a method with better specificity and sensitivity than that of skin prick tests, for the
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11 diagnosis of allergen sensitization were not performed.
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14 15 16 **CONCLUSION**

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18 This study on respiratory allergies in bakers in Sub-Saharan Africa shows a high prevalence of
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20 allergic rhinitis and highlights the role of sensitization to wheat flour and dust mites as risk
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22 factors for allergic rhinitis in bakers. Implementing protective measures against these
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24 aeroallergens and clinical monitoring of sensitized workers towards occupational aeroallergens
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26 could reduce the prevalence of this condition which, though not life-threatening can significantly
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28 alter bakers quality of life.
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33 **Acknowledgements:** Many thanks to all the bakery employees who agreed to participate in this
34
35 study. The authors also thank the Pan African Thoracic Society MECOR course staff and the
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37 Douala Research Network for their suggestions during the preparation of the manuscript.
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40 41 **Contribution of authors:**

42
43 MNBH conceptualized the study, designed the protocol, analysed the data and drafted the
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45 manuscript. NE collected the data. AZE, NF and NLR revised the manuscript and MNY
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47 participated to administrative and technical support.
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51 **Competing of interests:** none declared
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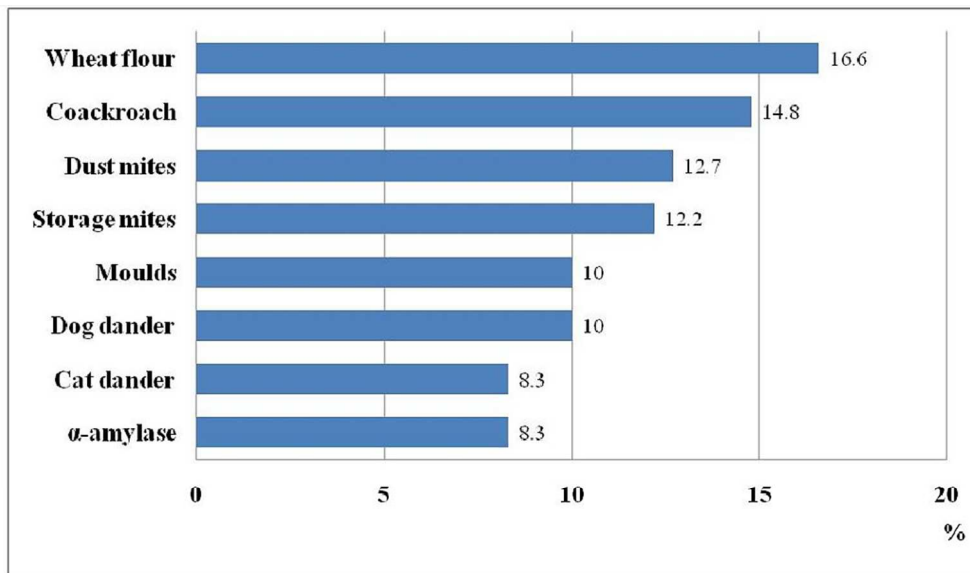
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55 **Figure 1.** Prevalence of sensitization to aeroallergens
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