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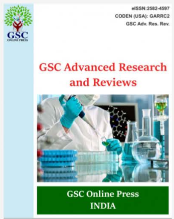

(Research Article)

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Respiratory effects of outdoor air pollution related to road traffic: Case of saleswomen working near Dantokpa's market highways in Cotonou, Benin

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Abstract

Introduction: Sales around roads, a common activity mainly carried out by women in African urban areas, exposes these professionals to outdoor air pollution (OAP). The study aimed to compare the frequency of respiratory symptoms and lung function in saleswomen exposed to OAP with controls.

Materials and Methods: In a quasi-experimental longitudinal study here-elsewhere, we compared 115 saleswomen exposed to OAP linked to heavy traffic, with 115 matched controls. The intensity of traffic on the two sites and the daily sales time of the saleswomen were assessed. Respiratory symptoms were collected by questionnaire and pulmonary function assessed by spirometry. Symptom-free survival over 12 months was described by Kaplan-Meier and the comparison by log rank.

Results: The two groups corresponded to the matching criteria. The saleswomen were exposed to higher levels of traffic intensity than the controls ($p<0.000$). Survival was better without cough, cold and sputum in controls. The spirometric parameters were more altered in saleswomen: FVC ($p<0.001$), FEV1 ($p<0.001$), DEP ($p=0.0001$), DEM 25-75 ($P<0.0001$). The latter reported longer durations of cough ($p<0.000$), cold ($p=0.012$), sputum ($p=0.002$) and dyspnea ($p=0.040$).

Conclusion: Saleswomen exposed to road traffic presented more spirometric alterations and respiratory symptoms. It is urgent to ensure the awareness of these professionals on the health risks of this exposure and actions to reduce the OAP linked to traffic. The reinforcement of the environmental police is necessary as well as intervention studies for risk mitigation. If nothing is done, the city will face worrying prevalence of chronic, preventable respiratory disorders.

Keywords: Sale near highways; Road traffic; Outdoor air pollution; Respiratory symptoms; Lung function; Benin

1. Introduction

Chronic respiratory diseases are heterogeneous disorders that affect the airways and other lung structures [1]. They include chronic bronchitis, emphysema, asthma, chronic obstructive pulmonary disease, unclassified chronic airway obstruction, lung cancer, tuberculosis, cystic fibrosis, respiratory distress syndrome and sleep apnea [1, 2]. These diseases are of great concern due to the increase in their prevalence, the mortality they cause and their economic burden

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[2]. Every year, chronic respiratory diseases affect hundreds of millions of people and cause 4.2 million deaths worldwide [2]. They thus pose a serious public health problem [2]. Chronic respiratory diseases manifest themselves through several symptoms, such as cough, sputum, rhinorrhea, dyspnea, wheezing and cause alterations in pulmonary function [3, 4]. These diseases have multifactorial, individual and environmental causes [5]. According to WHO, air pollution is the main environmental cause of respiratory diseases [6]. It is responsible for 43% of deaths due to chronic obstructive pulmonary disease and 29% of those linked to lung cancer [7]. Air pollution includes two categories: outdoor air pollution (OAP), the main subject of this work, and indoor air pollution [6]. OAP is the cause of a significant proportion of deaths due to air pollution [6]. According to research observations, some people are more exposed to OAP due to their professional activity [6, 8–11]. Studies carried out on people working close to traffic such as police officers who regulate traffic [3, 12] and taxi and motorcycle drivers [13, 14] have found in these exposed persons a high morbidity and mortality linked the health consequences of OAP. According to the International Labor Office (ILO), selling near roads is a preponderant activity in sub-Saharan Africa and mainly carried out by women [15]. These saleswomen spend several hours each day near highways and are exposed to OAP [10]. According to the findings of several studies, road traffic is the main source of OAP in major African cities [10, 14, 16–19]. In Cotonou, the share of the transport sector in the OAP reaches 80% [20]. Indeed, the transport sector is growing rapidly due to sustained population growth and the high rate of rural exodus [14, 19]. In addition, the transport system is poorly organized with the importation of machinery of all kinds, of advanced age associated with poor combustion efficiency and poor-quality fuel [14]. It is established that the fundamental mechanism of exposure to pollutants in humans is inhalation [9, 21]. As a result, the respiratory system becomes one of the prime targets for the adverse effects of OAP [22]. Despite their exposure, no study has been conducted in Benin on the respiratory effects of traffic-related OAP among saleswomen working near highways. Due to the severity of exposure to OAP and given that this occupational group is prevalent in African cities and other continents, it is necessary to figure out whether this occupational exposure is a source of additional respiratory effects in these saleswomen compared to the general population. A more specific answer to this question could help direct protective action to this occupational group.

The objective of this research work was to compare the respiratory symptoms and lung function in saleswomen selling near the roads of Dantokpa market and who are exposed to road traffic with those of matched control women.

2. Study framework and methods

2.1. Setting and type of study

This is a quasi-experimental longitudinal study here-elsewhere which took place in the communes of Cotonou and Abomey-Calavi (Figure no. 1). The saleswomen were chosen near the main roads of Dantokpa market in Cotonou (6° 22′ 23″ North, 2° 26′ 06″ East) over a distance of 1410m.

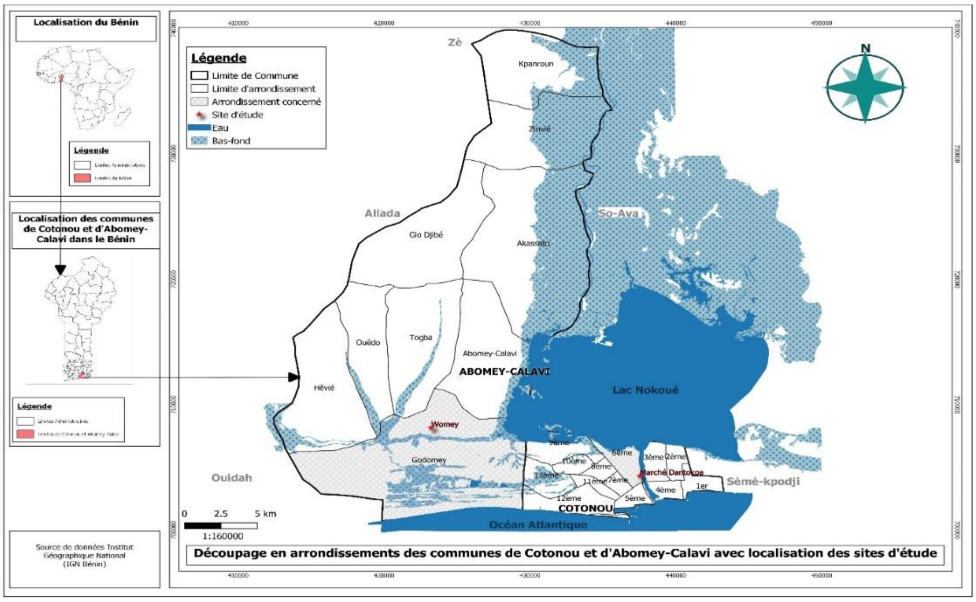

Figure 1 Overview of the study area

Cotonou is both the economic capital and the political and administrative center of Benin. The study took place on the edges of the main road axis of Dantokpa market, which is one of the largest markets in West Africa. This site was selected for the choice of saleswomen on the basis of the results of previous research having measured the concentration of traffic-related pollutants [11, 12, 18]. One of the studies carried out in 2013 showed that the concentration of pollutants such as CO and NO2 were high on the site, reaching 214.7 mg/m3 for CO for a national standard of 10 mg/m3 (over 8 hours) and 470 mg/m3 for NO2 for a national standard of 150 mg/m3 (over 24 hours) [16]. The second study that provided a time series of PM2.5 from February 2015 to March 2017 found a high concentration of PM2.5 [23]. Another research carried out as part of the Chair Pool project in 2018 during our data collection found PM2.5 concentrations reaching 500 mg/m3 in the vendor selection area for a national standard of 50 mg/m3 (over 24 hours) [17].

The controls were chosen in Womey (6° 24′ 42″ North, 2° 18′ 02″ East), a peri-urban locality, poor in road infrastructure and with low intensity of road traffic, located in the commune of Abomey-Calavi which is a community bordering Cotonou.

We carried out a quasi-experimental longitudinal study here-elsewhere over 12 months.

2.2. Sample size

The size was calculated from the formula adapted for analytical studies $T= [(P1Q1+P2Q2) \times (Z\alpha/2+Z1\text{-}ß)^2] / (P2\text{-}P1)2$ [24].

$Q1 = 1\text{-}P1$; P1 is the frequency of respiratory symptoms in saleswomen,

$Q2 = 1\text{-}P2$; P2 is the frequency of respiratory symptoms in controls,

$Z\alpha/2$, the value of the standard deviation is 1.96 at the α significance level of 5% and Z1-ß is 0.84 for a desired power of 80%.

In accordance with the results of a previous study, P1 = 0.38 and P2 = 0.21 [25].

With a non-response prediction, the size was increased by 10% to 115 subjects. We recruited 230 women, i.e. 115 saleswomen (exposed) and 115 controls.

2.3. Topic Selection Criteria

2.3.1. Inclusion criteria of saleswomen

The criteria for selecting the saleswomen were: 1) being a vendor near the main road axis of the Dantokpa market; 2) have a seniority of at least three years in the sale on the site; 3) be between 18 and 60 years old; 4) spend at least at least four days a week and eight hours a day on the site for sale.

2.3.2. Inclusion criteria of controls

The criteria for selecting the controls were: 1) living in the locality of Womey for at least 3 years and residing more than 200 meters from the main axis of the locality; 2) not to exercise a professional activity exposing to the OAP (not to be a saleswoman or near a road, or itinerant). The choice of this group of women as controls on the occupational level was based on the fact that their usual daily occupation would not be associated with exposure to OAP linked to road traffic as is the case for saleswomen exercising in the vicinity. Axes. They were selected on the basis of group pairing criteria with saleswomen, namely: a) age (the age of the control and that of the seller are in the same amplitude interval of 5 years); b) marital status; c) educational level; d) monthly income; e) fuel used for cooking and; f) type of accommodation.

2.3.3. Non-inclusion criteria for saleswomen and controls

Those with extra-occupational exposure to vapours, gases, dusts, fumes, other than that related to traffic (among the saleswomen) such as active or passive smoking (smoking of the spouse), exposure to smoke at a professional fish smoking site, exposure to dust through involvement in work as a "street sweeper".

2.3.4. Exclusion criteria for saleswomen and controls

Were excluded from the two study groups:

- those who could not perform an interpretable spirometry;
- those with cardiorespiratory pathologies previously diagnosed by a doctor or another health professional (tuberculosis, lung cancer, asthma, chronic bronchitis, chronic obstructive pulmonary disease, sinusitis, ischemic heart disease, myocardial infarction, stroke), or diabetes. The women included were those in good apparent health, asymptomatic of the exclusion pathologies mentioned above, verified during their selection through the interrogation which was conducted by a doctor.

2.4. Recruitment of women for the study

As a matter of convenience, we systematically selected along the two edges of the main road axis of Dantokpa market one out of every two saleswomen who retracted the criteria to obtain the sample size. We selected the first and left the second. Also, 115 control women were selected in Womey in Abomey-Calavi by reasoned choice in order to match them to the saleswomen in accordance with the defined matching criteria. Once in the center of the district, we drew lots for the direction to follow using a pencil thrown on the ground. The households were visited step by step for the selection of the 115 controls.

2.5. Data collection, variables, techniques and tools

2.5.1. Questionnaire data

The study used a validated questionnaire inspired by the main one of the BOLD study [26] which was administered to the respondents at their sales site (among the s saleswomen) or at their home (among the controls) by a doctor assisted by a medical assistant and a translator for the unschooled. It focused on socio-demographic and occupational characteristics and respiratory symptoms:

- Socio-demographic characteristics included age, monthly income, level of education, marital status, type of fuel used for cooking, type of housing, family size, presence of pets [12, 27].
- Professional characteristics related to seniority, employment status, number of days of sales per week, number of working hours per day, length of break during the working day and type of item sold.
- Five respiratory symptoms namely cough, cold, sputum, dyspnea and wheezing were assessed monthly for twelve months by their monthly duration. The questions on these symptoms were taken from the main questionnaire of the BOLD study [26].

Dyspnea was assessed according to Sadoul's 5-stage classification [28]. The presence of each of the five symptoms in each woman during each month was sought at the end of the month. When a symptom was present, its duration over the month was noted.

Transcriptions were provided by a professional translator.

A pilot survey was carried out at Pahou in the commune of Ouidah bordering Abomey-Calavi. Data collection took place from November 2017 to February 2019.

2.5.2. Anthropometric measurements

Anthropometric parameters such as weight (kg) and height (m) were measured according to standard World Health Organization protocols [29].

The body mass index (BMI) was obtained by the ratio: weight (kg) / height (m2). A BMI <18.5 was considered underweight, between 18.5 and 24.9: normal, between 25 and 29.9 overweight and ≥ 30: obese.

2.5.3. Exposure to outdoor air pollution related to road traffic

As part of this work, exposure to OAP related to road traffic was assessed using three indicators.

Saleswomen's daily duration for sale

The saleswomen included were those who spent at least eight hours a day and at least four days a week on the site for sale. A daily record of the duration of sales near the road axis was carried out for each saleswoman for one month. This made it possible to evaluate the average number of days per week as well as the average daily hours devoted to the activity.

Traffic intensity

It is defined by the number of vehicles that pass in one hour at a given point on a road axis [30, 31]. It was considered light up to 200 vehicles per hour and high from 1900 vehicles per hour [31]. Traffic intensity was assessed at the level of the main road axis of each site (Dantokpa market and locality of Womey). Measurements were taken at both sites on Mondays and Saturdays during the third week of each month for 12 months from 8:30 a.m. to 9:30 a.m. This time slot, which corresponded to the start of the sales activity by most of the saleswomen in Dantokpa, represents a peak hour of road traffic [12, 20]. The average of the traffic intensities of the two days was retained as the monthly value of the variable for each site.

Measurement of pollutants

In the context of this work, the level of pollutants found on the site of the saleswomen by previous research having measured the concentration of traffic-related pollutants was considered [11, 12, 18].

2.5.4. Spirometry

Spirometry was performed in all 230 women at the start of the study according to European Respiratory Society (ERS) guidelines [32]. Qualified personnel affiliated with the Cotonou Occupational Health and Environmental Education and Research Unit carried out spirometries in the morning between 9 and 12 a.m. for women in a seated position with a nose clip using a Mir Spirobank II spirometer (MIR Medical International Research, Rome, Italy). The procedure included at least three acceptable and reproducible forced vital capacity tests. All tests were interpreted by an external occupational health investigator and the best value was retained. The spirometric parameters studied for each woman were: Forced Expiratory Volume in one Second (FEV), Forced Vital Capacity (FVC), Tiffeneau Index (FEV / FVC), Peak Expiratory Flow (PEF) and Flow Expiratory from 25% to 75% of Vital Capacity (MED 25% - 75%). The definitions used were [33]:

- restrictive insufficiency: FVC < 80% and FEV / FVC > 70%;
- obstructive insufficiency: Normal FVC and FEV1 / FVC < 70%;
- mixed insufficiency: FVC < 80% and FEV1/FVC < 70%;
- beginning insufficiency with DEM 25-75 < 70% of the predictive value.

2.6. Data analysis

Data were entered with Cspro 7.1 software and analyzed with Stata14 software. Statistical analysis of quantitative variables used mean ± standard deviation while categorical variables were presented by their frequency. We checked the comparability of the two groups by matching criteria and compared the saleswomen and matched controls using a paired t test for continuous data and the McNemar test for categorical data. Frequency curves have been produced for traffic intensity. In order to analyze whether occupational exposure to traffic is a source of additional respiratory effects in saleswomen, we compared the duration of symptoms and lung function between saleswomen and controls. The Kaplan-Meier method was used to describe the 12-month survival of the two groups without the various respiratory symptoms. The log rank test was used to compare survival curves.

The significance level was set at 0.05.

3. Results

3.1. Socio-demographic and professional characteristics of the respondents

The matching between saleswomen and controls was successful on age (p=0.629), on income (p=0.242). The two groups were also comparable for household size (p=0.776). The means ± standard deviations of age (year), income (euros) and household size (persons per household) were 31.8±7.21, 88.79±49.08 and 4.71, respectively. ±1.67 among saleswomen and 31.35±6.91; 86.80±49.27 and 4.65±1.52 in controls. The two groups were also well matched with regard to the level of education (p=0.964), marital status (p=1), type of habitat (p= 0.587), cooking fuel (p= 0.748). The two groups were also comparable in terms of the presence of pets (p=0.776). There is a difference between the two groups of women regarding BMI (p=0.011). The saleswomen had an average professional seniority of 9.90±6.17 years and worked an average of 5.56±0.62 days per week and 8.92±0.87 hours per day. The items sold were foodstuffs in 72 (62.61%), clothing products in 15 (13.04%) (Table 1).

Table 1 Respondents' characteristics

Characteristics	**Saleswomen**		**Controls**		
	n	**%**	**n**	**%**	**P**
Ages (years)					
[18-23]	11	09.57	11	09.57	0.999
[23-28]	17	14.78	19	16.52	
[28-33]	41	35.65	41	35.65	
[33-38]	21	18.26	21	18.26	
[38-43]	17	14.78	17	14.78	
[43-48]	05	04.35	03	02.61	
[48-53]	01	00.87	01	00.87	
[53-58]	01	00.87	01	00.87	
[58-60]	01	00.87	01	00.87	
Moyenne ± écart-type	31.8±7.37		31.4±7.13		
BMI					
Lean : <18.5	07	06.09	10	08.70	0.011
Normal weight: 18.5 to 24.9	46	40.00	68	59,13	
Overweight: 25 to 29.9	33	28.69	20	17.39	
Obese : > 30	29	25.22	17	14.78	
Mean ± standard deviation	26.43±5.82		24.11±5.18		
Family size					
≤ 3	29	25,22	25	21,74	0.7760
> 3	86	74,78	90	78,26	
Mean ± standard deviation	4,71±1,67		4,65±1,52		
Educational level					
Unschooled	89	77.39	86	74.78	0.964
Primary	08	06.96	08	06.96	
Secondary	15	13.04	18	15.65	
University	03	02.61	03	02.61	
Marital status					
Married or cohabiting	115	100	115	100	
Type of habitat					
High and medium standing house	69	60.00	73	63.48	0.587
Low standing house	46	40.00	42	36.52	

Fuel for cooking					
Wood	06	05.22	08	06.96	0.748
Coals	92	80.00	93	80.87	
Gomestic gas	17	14.78	14	12.17	
Monthly income (Euro)					
≤ 61	66	57.39	56	48.70	0.242
]61 to 122]	32	27.83	44	38.26	
> 122	17	14.78	15	13.04	
Mean ± standard deviation	88.79±49.08		88.79±49.08		
Professional seniority (years)					
3	15	13.04			-
>3	100	86.96			
Mean ± standard deviation	9.90±6.17		9.90±6.17		
Status in the profession					
Goods owners	101	87.83			-
Sales assistants	14	12.17			
Number of days of sale per week					
<4	00	00			-
≥4	115	100			
Mean ± standard deviation	5.56±0.62		5.56±0.62		
Number of hours of sale per day					
<8	00	00			-
≥8	115	100.00			-
Mean ± standard deviation	8.92±0.87		8.92±0.87		
Items sold					
Foodstuffs	72	62.61			-
clothing products	15	13.04			
Various	28	24.35			
Pets (yes)	37	32.17	35	30.43	0.776

3.2. Exposure of saleswomen to outdoor air pollution related to road traffic

3.2.1. The daily duration of sales near the main road

Regarding the duration of their daily exposure to road traffic, saleswomen worked an average of 5.56±0.62 days per week and 8.92±0.87 hours per day (Table I).

3.2.2. Intensity of road traffic

The average ± standard deviation of traffic intensity to which saleswomen were exposed in Dantokpa was 7083 ± 709 compared to 258 ± 48 in Womey on the control site ($P < 0.0000$). Over the 12 months, the lowest values of road traffic intensity at the two sites were revealed in February at the Dantokpa market and in March at Womey and the highest values in December at the two sites (Figure 2**).**

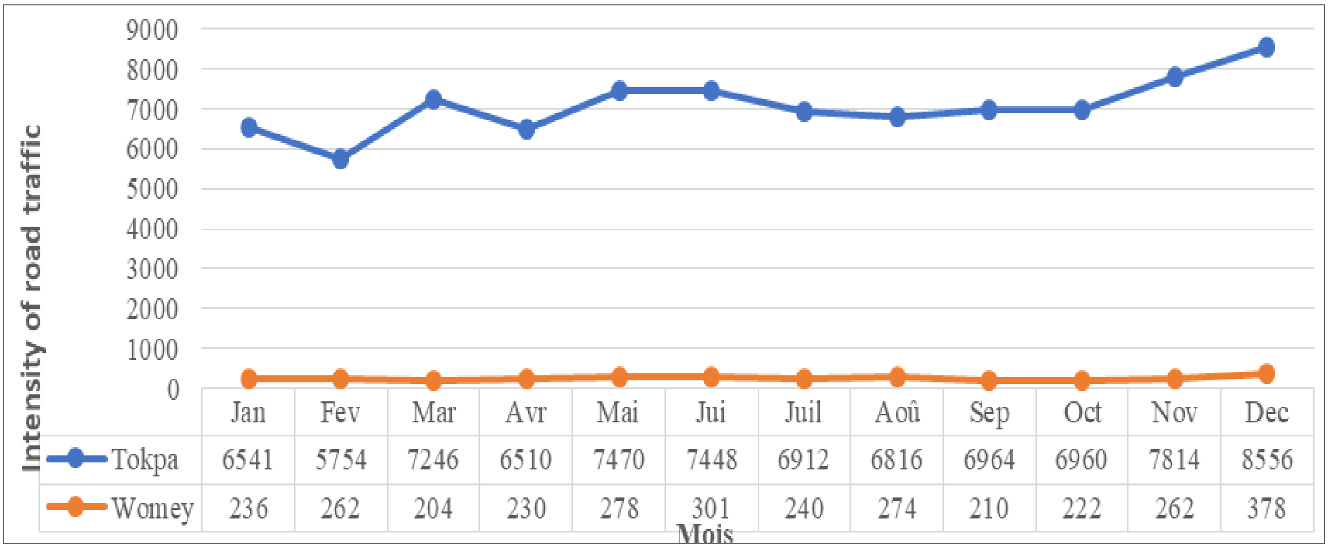

Figure 2 Intensity of road traffic at the level of the main axis of the two sites

3.3. Lung function of respondents

The means ± standard deviations of FVC (L), FEV1 (L), Tiffeneau coefficient (FEV1/FVC) (%), PEF (L/s) and FEF25-75 (%) were respectively 3 .11±0.75; 2.49±0.60; 79.89±5.34; 6.65±1.73; 60.68±18.43 among saleswomen and 3.74±1.01; 2.98±0.81; 80.08±4.03; 7.63±2.08 and 73.47±22.61 in controls. There is thus a significant difference between the two groups concerning the means of most of the spirometric parameters studied: FVC (p<0.001), FEV1 (p<0.001), DEP (p=0.0001), DEM 25-75 (P <0.0001). There is no difference between the two groups for the Tiffeneau coefficient (FEV/FVC) (P=0.761).

The two groups of women were comparable regarding obstructive and restrictive disorders. Indeed, one case (0.87%) of restrictive insufficiency was observed in each group. No cases of obstruction were observed in either group. However, the prevalence of early lung function impairment marked by a reduction in FED25-75 was higher among saleswomen (p<0.0001) (Table 2).

Table 2 Lung function of respondents (at the start of the study)

Lung function	**Saleswomen (n=115)**	**Controls (n=115)**	**P**
Spirometric parameters (mean ± standard deviation)			
FVC (L)	3.11±0.75	3.74±1.01	P<0.0001
FEV (L)	2.49±0.60	2.98±0.81	P<0.0001
FEV1/FVC (%)	79.89±5.34	80.08±4.03	0.761
DEP (L/s)	6.65±1.73	7.63±2.08	0.0001
DEM25-75 (L/s)	2.31±0.72	2.82±0.89	0.028
DEM25-75 (% predictive)	60.68±18.43	73.47±22.61	P<0.0001
Pulmonary function disorders among respondents (frequency and %)			
Restrictive deficiency	1 (0.87)	1 (0.87)	1
Obstructive insufficiency	0	0	-
Mixed insufficiency.	0	0	-
Insufficiency with DEM 25-75 <70% of the predictive value	84 (73.04)	56 (48.69)	P<0.0001

3.4. Survival of respiratory symptoms in both groups over 12 months

3.4.1. Cough-free survival

Cough-free survival in the controls (Womey site) was better than that of the saleswomen (Dantokpa site) (Figure 3). This difference observed graphically between the two study groups is significant at the 5% level (P-value log rank test=0.0003). We can therefore say that there is a statistically significant difference for the probability of cough-free survival between saleswomen and control women at the 5% level.

The table 3 summarizes the results of the log rank tests.

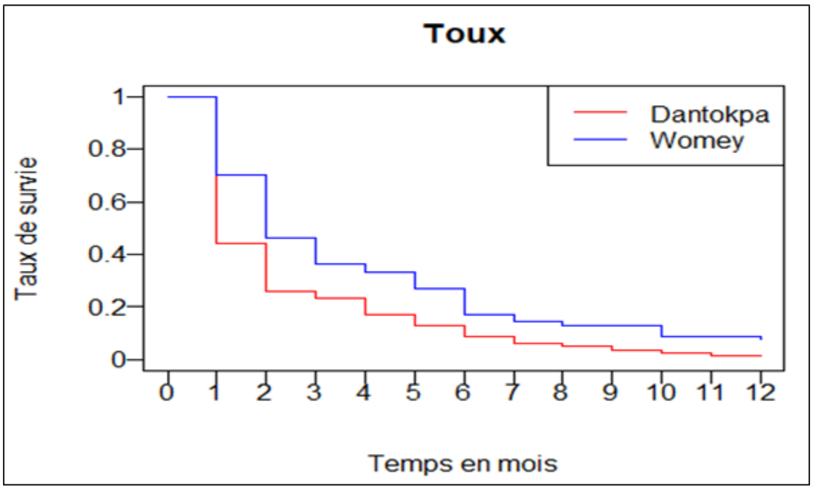

Figure 3 Cough-free survival as a function of time in the two groups

3.4.2. Common cold-free survival

The cold-free survival of the controls was better than that of the saleswomen between the first 5 months and then (January to May). There is a reversal of the trend between May and June. This rate is almost identical from June to December (Figure 4). The difference observed graphically between the two groups is not significant at the 5% level (P-value log rank test =0.8). We can therefore say that the probability of survival without the common cold is statistically identical to the threshold of 5% regardless of the observation site.

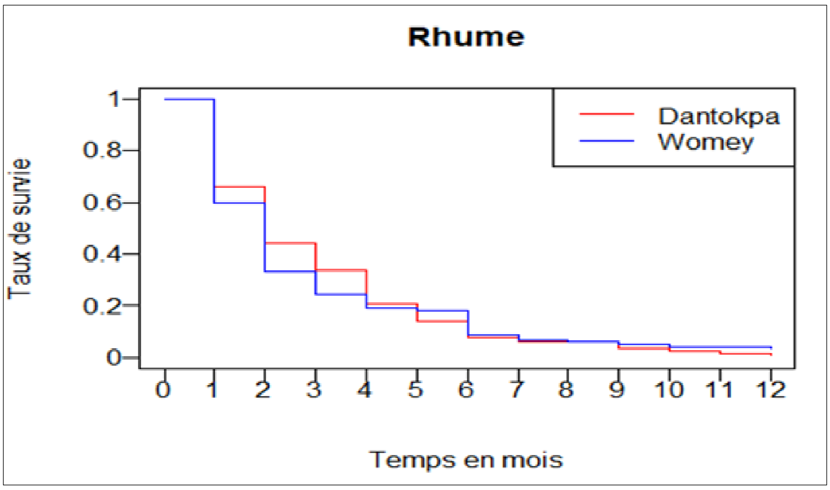

Figure 4 Cold-free survival as a function of time in both groups

3.4.3. Survival without dyspnea

Dyspnea-free survival is comparable between the two sites (Figure 5). The P-value (0.06) of the log rank test also confirms this graphical finding. We can therefore say that whatever the group, the probability of survival without dyspnea is statistically identical at the 5% threshold.

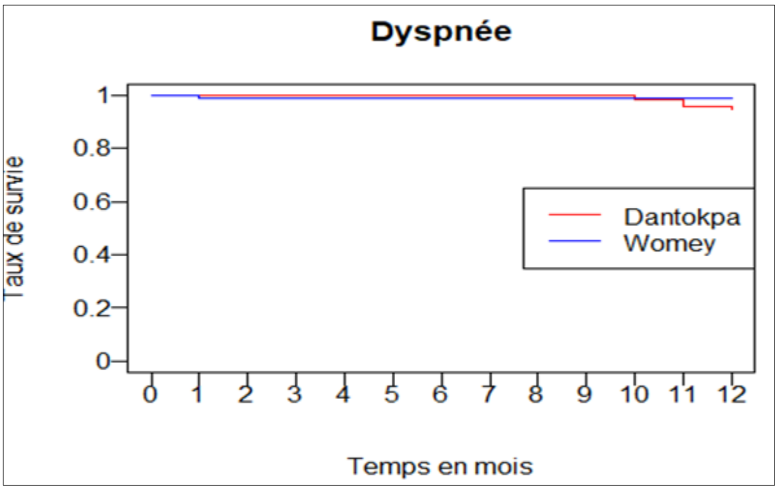

Figure 5 Survival without dyspnea as a function of time in the two groups

3.4.4. Sputum-free survival

Sputum-free survival in controls was better than in saleswomen between September and December, but almost identical in the months preceding September (Figure 6). The P-value (0.009) of the log rank test shows that this difference observed graphically is significant at the 5% level. We can therefore say that survival without sputum is statistically different at the 5% level according to the observation group.

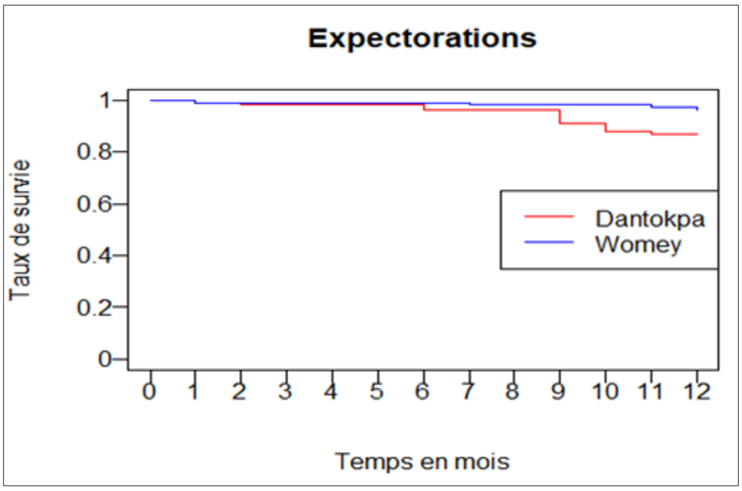

Figure 6 Sputum-free survival as a function of time in the two groups

3.4.5. Survival of wheezing

Survival without wheezing is comparable between the two sites (Figure 7). The P-value (0.2) of the log rank test also confirms this graphical observation. We can therefore say that the probability of having wheeze is statistically identical to the 5% threshold regardless of the observation group.

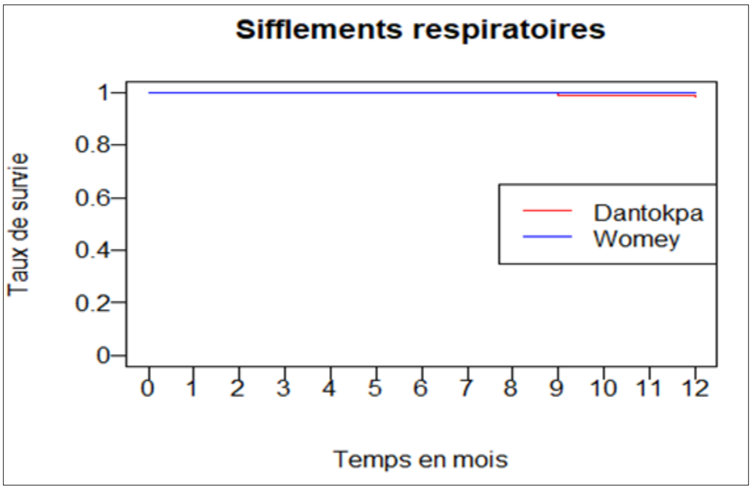

Figure 7 Survival without wheezing as a function of time in both groups

Table 3 Summary of the log rank survival test without each of the five symptoms

Symptoms	Sites	N	Observed	Expected	(O-E)^2/E	(O-E)^2/V	Chisq	p
Cough	Dantokpa	115	113	91,8	4,92	13,2	13,2	0,0003
	Womey	115	106	127.2	3,55	13,2		
Common cold	Dantokpa	115	114	115	0.014	0.0438	0	0,8
	Womey	115	111	110	0.0147	0.0438		
Dyspnea	Dantokpa	115	6	3.49	1.81	3.62	3.6	0.06
	Womey	115	1	3.51	1.8	3.62		
Sputum	Dantokpa	115	15	9.3	3.49	6.91	6.9	0.009
	Womey	115	4	9.7	3.35	6.91		
Wheezing	Dantokpa	115	2	0.998	1.01	2.01	2	0.2
	Womey	115	0	1.002	1	2.01		

3.5. Annual duration of symptoms in respondents

Table 4 Comparison of the averages of the annual durations of symptoms among respondents over the 12 months

Symptoms	symptom duration				
	Saleswomen (n=115)		Controls (n=115)		p
	respondent with symptoms) at least once in the 12 months	Mean ± standard deviation	respondent with symptoms) at least once in the 12 months	Mean ± standard deviation	
Cough	113	21.82±11.12	106	12.78±7.49	P<0.0001
Common cold	114	25.04±12.77	111	21.25±9.98	0.013
Dyspnea	6	0.417±1.98	1	0.02±0.27	0.034
Sputum	15	0.96±2.74	4	0.13±0.77	0.002
Wheezing	2	0.12±0.95	0	0±0	0.177
All 5 symptoms	115	48.37 ±16.06	112	34.20±14.69	P<0.00001

Considering the annual duration of symptoms, we note that their average was higher for most symptoms, in saleswomen compared to controls, with statistically significant differences. This is the case for cough (P<0.0001), colds (p=0.013), dyspnea (p=0.034) and sputum (p=0.002). The average annual duration (day) of all the symptoms were respectively 48.37 ± 16.06 and 34.20 ± 14.69 in the saleswomen and controls. These durations were significantly longer in the saleswomen compared to the controls (p<0.00001) (Table 4).

4. Discussion

4.1. Respiratory effects and outdoor air pollution related to road traffic.

This study, which focused on saleswomen selling near the main road of Dantokpa market and on a control group matched on age, level of education, monthly income, fuel used for cooking and type of housing and who have not done the profession of sales before or near the roads, or hawkers and or other jobs with a high exposure to OAP, sought out to highlight significant differences in the level of the disorders of the pulmonary function and duration of respiratory symptoms between saleswomen and controls. The use of this control group helped to assess the respiratory risk linked to sales near roads in urban areas where the OAP linked to road traffic is high. The average traffic intensities were 7083±709 in Dantokpa among the saleswomen and 258±48 in Womey on the control site (P<0.0000). The difference between the road traffic intensities to which the two groups were exposed was statistically significant. No study has evaluated the intensity of trafficking among people exposed to trafficking in Benin before. Traffic intensity is said to be high from 1900 [31]. In Dantokpa, the average traffic intensity was 7083, nearly four times the high traffic threshold [31]. This degree of high traffic intensity on this site of our saleswomen is the source of high concentrations of traffic-related pollutants [16, 17, 23] whose harmful effect on health is recognized [4, 25, 34 –37]. Unlike Dantokpa, the traffic intensity was only 258 at the level of the main axis among the controls. This low level of traffic intensity would not be associated with concentrations of pollutants causing harmful effects on health [31].

The study found that the two groups of women were comparable regarding obstructive and restrictive disorders. This result is consistent with the criteria defined for the selection of subjects and which led to the exclusion from the study of those who presented clinically with chronic respiratory diseases. This observation is also in line with the literature and could be explained by the bias recognized under the name "Healthy Worker Effect" which establishes that in the workplace, individuals are able to perform work regularly and are a priori in better health than the general population in which there are patients unable to hold a job [38]. This is a particularly strong selection bias in studies of respiratory disorders [38]. The authors recognize that the presence of this unavoidable bias makes it difficult to develop risk estimates related to the “exposure-response” relationship, in workers or in population-based studies [38].

Regarding the symptoms collected, the study found a better survival without cough, cold and sputum in the controls compared to the saleswomen with a significant difference for cough (p=0.0003) and sputum (p <0 ,0009). The difference was not significant for the common cold, dyspnea and wheezing. These findings suggest that the size of our sample would not be sufficient to highlight the difference in survival without these last three symptoms between the exposed to road traffic and controls.

By comparing the average annual durations (days) of symptoms, the study found a significant difference in most symptoms between the two groups. This is the case for cough (P<0.0001), colds (p=0.013), dyspnea (p=0.034) and sputum (p=0.002). The same was true for the average annual durations of all the symptoms, which were respectively 48.37±16.06 and 34.20±14.69 in the saleswomen and the controls; an increase of 43.24% among saleswomen with p<0.00001. These findings highlight the potential additional respiratory risks in the short and medium term that would be linked to exposure to road traffic in the subjects.

The study revealed that saleswomen had more alterations in lung function marked by an impact on most spirometric parameters compared to controls with significant differences. This is the case for FVC (p<0.001), FEV (p<0.001), DEP (p=0.0001), DEM 25-75 (P<0.0001). These differences, which indicate a more marked deficiency in lung function in saleswomen, could explain the longer duration of respiratory symptoms for these rears, who continue to be exposed to very heavy road traffic on the Dantokpa site even though they do not observe no protective measures [11,39]. Despite the methodological diversity, data from the literature suggest a relationship between exposure to road traffic and respiratory morbidity. Lindgren et al. observed a 40% increased risk of asthma [95% CI 4-89%] and 64% increased risk of chronic obstructive pulmonary disease [95% CI 11-240%] in adults residing less than 100 meters from an axis road with a traffic intensity greater than 10 vehicles per minute [35]. In our study, the saleswomen were close to the main road and the average number of vehicles per minute was 118, i.e. twelve times higher than that noted by Lindgren et al. Meng et al. also measured an increased risk of manifesting respiratory symptoms of 211% [95% CI 138–323%] in adults residing in a high traffic area (> 200,000 vehicles/day within a radius of fifteen meters), compared to an area with lower traffic (20,000 vehicles/day) [36]. The traffic intensity on the site of the saleswomen in the study by Meng et al., is similar to that found among the saleswomen and the level of traffic of the low traffic zone in their study is three times higher than that observed. on the control site. This result confirms that the control site is more suitable in terms of traffic level. Three studies carried out in Benin through which the authors compared the respiratory effects in motorcycle taxi drivers with controls found contradictory results. In the study conducted in 2016 in Cotonou where the controls lived in the same localities as the saleswomen, Lawin et al. had reported differences between the two groups but which were not significant either for symptoms or for lung function [13]. This study involved a smaller sample size than ours.

In a 2011 study in Cotonou, Agodokpessi et al. compared the impact of extra- and intra-residential pollution on the respiratory function of people residing around high-traffic intersections compared with a low-traffic road. They observed that the frequency of respiratory symptoms was higher among residents in high traffic than in low traffic ($p = 0.0001$). The same was true for spirometric anomalies in local residents ($p = 0.004$) [40].

Fourn and Fayomi in 2006 compared taxi drivers in two towns in Benin with non-drivers chosen from the same towns [14]. They noticed that motorcycle taxi drivers in Cotonou reported more respiratory symptoms than those in Lokossa, a city where the level of traffic-related pollutants was lower than in Cotonou. They also reported that the frequency of respiratory disorders among non-drivers was lower in both Cotonou and Lokossa compared to drivers, without however specifying the level of significance of the differences observed. Our findings are comparable to those of the last two studies which noted a consistent increase in respiratory effects consistent with the level of subject exposure to OAP. It appears that the variability of the targets and the size of the samples could influence the results of studies here and elsewhere aimed at highlighting the effects of OAP in subjects.

The study found early alterations in lung function marked by a DEM 25-75 <70% of the predictive value in 73.04% and 48.69% of saleswomen and controls, respectively; i.e. a 50.01% increase in incipient pulmonary function insufficiencies located in the distal bronchi in saleswomen ($P<0.0001$). This finding is consistent with findings that OAP generates pollutants that descend to the bottom of the respiratory system, which explains why the alterations start from the distal bronchi towards the peripheral bronchi [22]. This observation also explains the limitations of a short-term study in highlighting significant differences between subjects exposed to OAP and controls in terms of respiratory symptoms. The monitoring of this parameter over time makes it possible to reach more convincing conclusions.

In view of the additional risk observed among saleswomen in the present study, it is necessary to set up actions to raise the awareness of these professionals exposed to road traffic on the danger that OAP represents for health and to ensure interventions aimed at reduction in OAP among professionals exposed to trafficking.

4.2. Limitations of the study

There are some limitations to this study. First, the exposed were saleswomen operating in an area with very high traffic intensity, however, the respiratory effects cannot be attributed solely to OAP due to other confounding factors involved such as the exposure to indoor air pollution that could not be measured among the participants. Similarly, it was not possible to measure the individual exposure of saleswomen to outdoor air pollutants, but we considered the level of pollutants found on the site in three other studies and we measured the intensity of traffic. This could leave a bias on the level of individual exposure to OAP, without being detrimental to the quality of the study insofar as the participants exercised on average nearly nine hours per day and more than five days per week on this site has had very heavy road traffic for nearly 10 years on average with high concentrations of traffic-related pollutants that have been measured by three different studies. Secondly, we were unable to obtain a list of saleswomen working near the main roads of the market due to the informal nature of the activity, which allows saleswomen free entry into the profession, and we had to select saleswomen for convenience. This type of choice somewhat limits the scope of the results of the study. However, the systematic selection of one saleswoman out of two meeting the criteria makes it possible to reduce this weakness. Regarding the type of study, it is not a case-control study, nor an exposed-non-exposed type study because subjects in the study could have a symptom at the time of their inclusion if the symptom is not linked to an established disease. We finally opted for a quasi-experimental longitudinal study here-elsewhere by considering target tracking as experimentation.

The present study is the first of its kind to assess the respiratory effects of traffic-related OAP in these professionals. Its limits could be taken into account by other epidemiological studies in this group of workers.

5. Conclusion

Our research found that respiratory morbidity found in saleswomen exposed to road traffic is of concern. This study showed that these saleswomen selling near the main road at Dantokpa presented more alterations in lung function and respiratory symptoms compared to controls. It is necessary to draw the attention of these professionals on the health risks of this exposure and to set up targeted actions to reduce OAP linked to traffic in Cotonou and in the other major cities of the country, with a focus on these professionals. The present results align with intervention studies, in terms of risk mitigation. The reinforcement of the environmental hygiene police is necessary. At the same time, the monitoring of outdoor air quality should be included in the priorities of government authorities and local communities, with continuous efforts to reduce pollution and the frequency of associated diseases. If nothing is done, the city will face in the medium and long term a worrying prevalence of respiratory diseases that are nevertheless preventable.

Compliance with ethical standards

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Disclosure of conflict of interest

The authors declare no conflict of interest.

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Statement of ethical approval

This study is part of the Pol Chair project which obtained the approval of the National Committee for the Ethics of Health Research in Benin under number 054 of September 29, 2017 and renewed by number 032 of October 15, 2018.

Statement of informed consent

All the participants signed an informed consent form.

References

[1] WHO. Global Surveillance, Prevention and Control of Chronic Respiratory Diseases: A Holistic Approach. Geneva: Jean Bousquet and Nikolai Khaltaev; 2007.

[2] Wang YC, Lin JM, Li CY, Lee LT, Guo YL, Sung FC. Prevalence and risks of chronic airway obstruction: a population-based cohort study in Taiwan. CHEST. 2007 ;131(3) :705-10.

[3] Obaseki DO, Adeniyi B, Jumbo J, Oyewo A, Irabor I, Erhabor GE. Respiratory symptom, lung function and exhaled carbon monoxide among a sample of traffic workers in Lagos, Nigeria: a pilot survey. Nigerian Medical Journal. 2014 ;55(4) :306.

[4] Amaran N, Zainal Abidin E, Rasdi I. Respiratory health symptoms and lung function among street vendors in Serdang and its association with traffic-related exposures. Iranian Journal of Public Health. 2016 ;45 :77-84.

[5] Bénézet L, Delmas MC, Geoffroy-Perez B, Iwatsubo Y. Prevalence of respiratory symptoms and diseases in a cohort of agricultural workers in five French departments in 2010. Archives des Maladies Professionnelles et de l'Environnement. 2020 ;81(1) :68-9.

[6] World Health Organization. Ambient (outdoor) air quality and health [Internet]. Geneva: WHO; 2021 [cited 2021 Nov 23]. Available at https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health

[7] World Health Organization. Nine out of 10 people breathe polluted air worldwide [Internet]. Geneva: UN News; 2018 [cited 2021 Jun 19]. Available at: https://news.un.org/fr/story/2018/05/1012702

[8] Pascal L. Short-term effects of air pollution on mortality. French Journal of Allergology. 2009;49(6):466-76.

[9] Choudhary H, Tarlo SM. Respiratory effects of traffic-related air pollution on outdoor workers. Curr Opin Allergy Clin Immunol. 2014 ;14(2) :106-12.

[10] Amegah AK, Jaakkola JJK. Work as a street vendor, exposure to traffic-related air pollution and risk of adverse pregnancy outcomes in Accra, Ghana. Int J Hyg Environmental Health. 2014 ;217(2-3) :354-62.

[11] Gbegnide HA, Sopoh GE, Davou DA, Makoutode M, Agodokpessi G. Factors associated with chronic respiratory disorders among vendors working near highways in the Dantokpas market in Cotonou, Benin. J. Public health epidemic. 2021 ;13(2) :88-95.

[12] Ekpenyong CE, Ettebong EO, Akpan EE, Samson TK, Daniel NE. Urban transport mode and the effect of air pollution on respiratory health: a cross-sectional study among public transport and non-transit workers in Nigeria. BMJ open. 2012 ;2(5).

[13] Lawin H, Agodokpessi G, Ayelo P, Kagima J, Sonoukon R, Mbatchou Ngahane BH, et al. A cross-sectional study with improved methodology to assess occupational air pollution exposure and respiratory health in motorcycle taxi driving. Sci Total Environ. 2016 ; 550 :1-5.

[14] FOURN L, FAYOMI EB. Urban air pollution in Cotonou and Lokossa, Benin. Bull Soc pathol exot. 2006 ;99(4) :264-8.

[15] International Labor Organization. 90th Session of the International Labor Conference 2002 [Internet]. Geneva: International Labor Organization; 2002 [accessed 2021 Sep 18]. Available at https://www.ilo.org/public/french/standards/relm/ilc/ilc90/pdf/memo.pdf

[16] Mama D, Dimon B, Aina M, Adounkpe J, Ahomadegbe M, Youssao A, et al. Urban transport in Benin and atmospheric pollution: quantitative evaluation of certain chemical pollutants in Cotonou. International Journal of Biological and Chemical Sciences. 2013 ;7(1) :377-386-386.

[17] Houngbegnon P, Ayivi-Vinz G, Lawin H, Houessionon K, Tanimomon F, Kêdoté N, et al. Exposure to PM2.5 linked to road traffic: comparison between crossroads and off crossroads in Cotonou, Benin. Air pollution open diary. 2019 ; 08 :108-17.

[18] Nomnual S, Shendell DG. Young adult street vendors and adverse respiratory health issues in Bangkok, Thailand. Saf Health Work. 2017 ;8(4) :407-9.

[19] Liousse C, Galy-Lacaux C. Urban pollution in West Africa. Meteorology. 2010 ;8(71) :45.

[20] Boko G, Joachim M. Air pollution and respiratory diseases in large African cities: the CAS of Cotonou in Benin. In: Bunch MJ, Suresh VM, Kumaran TV, ed. Proceedings of the Third International Conference on Environment and Health, Chennai, India; 2003 Dec 15–17;32–43.

[21] Oh SM, Kim HR, Park YJ, Lee SY, Chung KH. Organic extracts of urban air pollution particles (PM2.5) induced genotoxicity and oxidative stress in human lung bronchial epithelial cells (BEAS-2B cells). Mutat Res. 2011 ;723(2) :142-51.

[22] Kurt OK, Zhang J, Pinkerton KE. Pulmonary Health Effects of Air Pollution. Curr Opin Pulm Med. 2016;22(2):138-43.

[23] Djossou J, Léon J-F, Akpo AB, Liousse C, Yoboué V, Bedou M, et al. Mass concentration, optical depth and carbon composition of particulate matter in the major southern West African cities of Cotonou (Benin) and Abidjan (Côte d'Ivoire). Atmospheric Chemistry and Physics. 2018;18(9):6275-91.

[24] Magnani R. Sampling Guide [Internet]. Washington: USAID; 2001 [cited 2021 May 21]. EnglishSampling.pdf [Internet]. [cited 2021 May 16]. Available from: http://www.ofarcy.net/documentation/FrenchSampling.pdf

[25] Jones A, Lam P, Gohel D. Respiratory health of road-side vendors in a large, industrialized city. Environmental science and pollution research international. 2008; 15:150-4.

[26] Buist AS, Vollmer WM, Sullivan SD, Weiss KB, Lee TA, Menezes AMB, et al. The Burden of Obstructive Lung Disease Initiative (BOLD): rationale and design. COPD. 2005;2(2):277-83.

[27] El-Gilany A, El-Wehady A, El-Wasify M. Updating and validation of the socioeconomic status scale for health research in Egypt. East Mediterranean Health J. 2012;18(9):962-8.

[28] Fuhrman C, Roche N, Vergnenegre A, Chouaid C, Zureik M, Delmas MC. Chronic bronchitis: prevalence and impact on daily life. Analysis of data from the 2002-2003 INSEE health survey. Journal of Respiratory Diseases. 2009: 26(7): 759-768.

[29] World Health Organization. Screening for Type 2 Diabetes. Report of a WHO and IDF Meeting. Geneva: World Health Organization; 2003 [cited 2021 Aug 2]. Available from: https://www.who.int/diabetes/publications/en/screening_mnc03.pdf

[30] Halounová, L. Relation between road traffic intensity and urban development in cities of the Czech Republic Ostrava: GIS; 2013 [Cited 2021 Aug 15]. Available at: http://gisak.vsb.cz/GIS_Ostrava/GIS_Ova_2013/sbornik/papers/gis201350bc66d331724.pdf

[31] Carlos D. The Urban Transport Footprint. Geneva: WHO; 2005 [cited 2021 May 2]. Available at: https://www.sifee.org/static/uploaded/Files/ressources/actes-des-colloques/geneve/panel-sante/2_Doras.pdf

[32] Miller MR, Crapo R, Hankinson J, Brusasco V, Burgos F, Casaburi R, et al. General considerations for lung function testing. European Respiratory Journal. 2005;26(1):153-61.

[33] Ranu H, Wilde M, Madden B. Pulmonary Function Tests. Ulster Med J. 2011;80(2):84-90.

[34] Host S. Exposure to air pollution linked to road traffic and health risks. VertigO - the electronic journal in environmental sciences [Internet]. 2013 [cited May 12, 2021]; (Special issue 15). Available at: http://journals.openedition.org/vertigo/12816

[35] Lindgren A, Stroh E, Montnémery P, Nihlén U, Jakobsson K, Axmon A. Traffic-related air pollution associated with prevalence of asthma and COPD/chronic bronchitis. A cross-sectional study in Southern Sweden. Int J Health Geogr. 2009; 8:2.

[36] Meng Y-Y, Wilhelm M, Rull RP, English P, Ritz B. Traffic and oFutdoor air pollution levels near residences and poorly controlled asthma in adults. Ann Allergy Asthma Immunol. 2007;98(5):455-63.

[37] Bayer-Oglesby L, Schindler C, Hazenkamp-von Arx ME, Braun-Fahrländer C, Keidel D, Rapp R, et al. Living near main streets and respiratory symptoms in adults: the Swiss Cohort Study on Air Pollution and Lung Diseases in Adults. Am J Epidemiol. 2006;164(12):1190-8.

[38] Le Moual N, Kauffmann F, Eisen EA, Kennedy SM. The Healthy Worker Effect in Asthma. Am J Respir Crit Care Med. 2008;177(1):4-10.

[39] Gbègnidé HA, Sopoh GE, Davou DA, Fayomi B, Makoutodé M, Agodokpessi G. Participatory screening of occupational risks among vendors working near the roads of the Dantokpa market in Cotonou, Benin. Archives of Occupational and Environmental Diseases. 2021; 82 (6): 592-600.

[40] Agodokpessi G, Adjobimey M, Hinson V, Fayomi B, Gninafon M. Atmospheric pollution and respiratory pathology in urban and tropical areas in Cotonou-Benin. Med Trop 2011; 71: 41-44.