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Original Research Article

Occupational asthma in a plastic bags manufacturing factory in Togo

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The objective of the study was to evaluate respiratory function, especially the occupational asthma (OA) of workers in a plastic bag manufacturing factory in Togo. By a cross sectional study, a sample of 182 workers who filled a questionnaire was obtained. Workers with asthma complains was subjected to spirometry test. The mean age of subjects was 37.13±5.71 years with 99.5% male predominance, mean work experience of 7.66±2.88 years and 1.1% smokers. Rhinitis and conjunctivitis were reported in 79.7% of respondents. Subjects that presented with asthma complains were 34.1% with 25.8% of complains associated to the occupation. Abnormal pulmonary function was overlooked by reversible smalls airways pattern (6.6%) and reversible obstructive pattern (4.9%). Spirometry was compatible with asthma in 11.5% of cases. The prevalence of occupational asthma was 7.7%. Occupational asthma was most likely in thermo-welding and extrusion activities as workers involved in these activities did not use respiratory protection. Occupational asthma is a reality in a plastic bag manufacturing factory in Togo hence preventive and corrective measures need to be taken to avoid this disease.

Key words: Occupational asthma, polyethylene, plastic bag, Togo.

INTRODUCTION

Occupational asthma (OA), obstructive chronic bronchopneumonia (OCBP) and pneumoconiosis are occupational respiratory diseases having important impact on morbidity and mortality Balmes et al. (2003). Some population studies show that 15% of asthma cases in adults can be attributed to work environment (Ameille et al., 2006). Occupational asthma affects young and economically active persons with a negative impact on their capacity to work Lindstrom et al. (2011). The direct costs of this are similar to those of asthma whereas the indirect costs through loss of productivity are higher (Ameille et al., 2006). Occupational asthma has heavy medical and socio-economic consequences with a deterioration in quality life and loss of employment (30 - 40% of cases) (Vandenplas et al., 2003). The frequency of OA in the world is nevertheless difficult to determine, especially because the disease is under-diagnosed and not reported in sufficient numbers (Friedman-Jimenez et al., 2015). Among the difficulties a physician faces are the absence of a well codified diagnostic approach, the need for sophisticated and expensive technical processes which are not always available and the absence of specificity of symptoms especially when the physician does not consider establishing any link between the disease and occupational exposure (Toujani et al., 2016). The estimation of OA prevalence rate seem to be inaccurate, in particular because of the inconsideration of

workers having presented it but having left their job without declaring this disease. Other workers would keep working by keeping silent on their symptoms for fear of losing their job (Bardana, 2003)].

In industrialized countries, OA appears to be the most frequent occupational respiratory disease because of the constantly increasing quantity of new potentially hazardous substances which are introduced in industries (Jeebhay and Quirce , 2007). The prevalence rate of OA ranges between 2 and 15% (Becklake et al., 1999; Landric and Demoly, 2006). The incidence rates per year of OA recorded in European countries range between 20 and 40 new cases per million workers (Massin et al., 2015). Jobs presenting the most OA risks are those of bakers, motor car painters, health care workers, hairdressers, plastic material maintenance and production staff (Ameille et al., 2006; Ameille et al., 2003).

In Africa, OA is second in ranking among occupational respiratory diseases behind pneumoconiosis (Esterhuizen et al., 2001). In Tunisia, 219 cases of OA were reported in the private sector in the Central Tunisian Region, and was recognized as an occupational disease in the period 2000-2008 (Chatti et al., 2011). The studies carried out were over a very short time and not exhaustive, and all the available data nearly focused on only one sector that is, concerning some professional groups limited in size and exposed to some clearly identified allergens (Toujani et al., 2016). In Sub-Saharan African countries, with the exception of South Africa where there exists a surveillance system for occupational respiratory diseases, OA is characterized by the ignorance of its prevalence and existence of only a few fragmentary clinical studies focused on some professional environments. Until 2011, Senegal recorded 36 cases of OA (recognized as such by the National Office of Social Security, and three publications on OA) (Ndiaye et al., 2011) among which two cases were caused by latex (Ly et al., 2006), one case each by organic isocyanates (Ndiaye et al., 2006) and exposure to sulphur oxide (Mbaye et al., 2002).

In Togo, statistics from the National Office of Social Security show that from 2010 to 2014, 7168 cases of workplace accidents were recorded compared to only 10 cases of occupational diseases without cases of occupational asthma (CNSS, 2016). The studies published only presented some respiratory symptomatology and ventilation disturbances occurring in some hazardous activities (Adjoh et al., 2013; 2015). As of yet, no study has specifically focused on the question of association between asthma and professional activity.

The production of plastic bags passes through four different stages: The 1st stage takes place during extrusion and ends up with the production of reels which are rolled up plastic films. Here, the workers have the task of ensuring Polyethylene (PE) granules mix with colorants in a basin. The resulting mixture is introduced into machines called "extruders". The plastic material is melted at a temperature of 230 °C and pushed outward. Outside the machine, the material undergoes an inflation of air, gets cold and then takes the form of sheaths or films which roll up around a metallic shaft to give the bobbins. The operator then cuts up the bobbins to prescribed sizes, and brings them down from the machines for weighing. At the second stage, the bobbins are taken to the Thermo-welding section. Here, the workers' job consists of first feeding up the thermo-welder machine with the bobbins. Thermo-welding is done automatically at a temperature of 200°C followed by thermo-cutting or blade-cutting. Then the workers collect the bags to undergo finishing works such as press, packing and weighing. At the third stage, the waste and bag residues are routed to the grinding section where they are ground and the resulting debris, reused at extrusion. Though optional, the last stage involves printing, that is putting some writings or marks using ink on the bags. The factory is subdivided in four sections: extrusion, thermo-welding, grinding and printing. The thermo-welding section includes two subsections: low density polyethylene (PEbd) and high density (PEhd) thermo-welding subsections.

With the advent of Free Trade in Togo, a lot of plastics manufacturing industries have been established. However, in this sector occupational respiratory allergy can occur during handling if they are present in powdered or liquid form or during weighing, decanting or mixing operations. This allergy is also reported for exposure to epoxy resins, acrylates and methacrylate, vinyl oxychloride, polyolefin (polyethylene and polypropylene), aminoplastes and phenoplastes and polyurethanes. Besides, many handling processes in plastic manufacturing require a sufficient increase in temperature to release some additives, and cause resin decomposition. The same risks are present during transformation operations; mixing, and finishing (Attarchi et al., 2014). We therefore initiate this study in order to evaluate the respiratory health condition of workers exposed to thermal deterioration products and/or to polyethylene dusts in a plastic bags manufacturing plant in Togo.

MATERIALS AND METHODS

Study area

This study was carried out in a plastic bags manufacturing plant from October 10 to 22, 2016. Created since July 1st, 2004, the factory has 645 workers with 620 as full-time and 25 as part-time staff. The work time is organized into four different teams: I, II, III work in shifts of eight hours per day (06:30 to 14:30, 14:30 to 22:30, 22:30 to 6:30), in accordance with a previously established plan while the general team works from 07:00 to 17:00 with a break between 12:00 and 14:00.

METHODOLOGY

It was a transversal descriptive study carried out from October 10 to 22, 2016 in a plastic bags manufacturing plant. Selected for the study were individals that fulfilled the inclusion criteria: a worker in any of the sections;

Table 1. Socio-demographics and occupational characteristics

Parameter	No.	%
Age		
<25	1	0.55
25-34	60	32.97
35-44	102	56.04
45-54	17	9.34
≥55	2	1.10
Total	182	100
Sex		
Male	181	99.45
Female	1	0.55
Smoking		
Smokers	2	1.10
Unsmokers	180	98.90
History of asthma		
Pre-existent asthma	10	5.49
Asthma after hiring	5	2.75
Not asthmatic	167	91.76
Work position		
Heat-sealing	124	68.13
Extrusion	45	24.72
Finishing	9	4.95
Grinding	2	1.10
Maintenance	2	1.10
Seniority		
< 2	10	5.50
[2 - 5]	52	28.57
[6 - 9]	69	37.91
[10 -12]	51	28.02
Total	182	100
Personal Protective Equipment (PPE)		
Scarf	1	0.55
Handkerchief	1	0.55
No PPE	180	98.90
Total	182	100

extrusion, heat-sealing, grinding; and given his/her well-informed consent.

Sampling

Through systematic random sampling, 182 respondents were chosen using the formula: $n\ (size) = t^2\ p(1-p) / i^2$ with t = 1.96 deducted from a reliability rate of 95%; p = 13.8% in a group exposed to a mixture of plastic components in a cables manufacturing company in Iran (Attarchi et al., 2014); with an error margin " I " = 5% .

Data collection

Using questionnaires, data on socio-professional characteristics such as age, gender; seniority in the factory, work station, seniority at the work station, use of personal protection equipment; and on the basis of clinical data: tobacco addiction, personal antecedent of asthma, symptoms of rhino-conjunctivitis, reminiscent symptoms of asthma, rhythmicity of respiratory symptoms linked to the work and pulmonary auscultation were collected.

Upon completion of the questionnaire, spirometry was used in checking respiratory volumes and outputs, spirometric syndromes and reversibility to broncho-dilatators. The diagnosis of asthma is based on the rhythmicity of respiratory symptoms linked to work and the spirometric compatibility with asthma (the reversible obstructive syndrom or the small aerial routes reversible syndrome).

The questionnaires were administered by two trained nurses of the company. Workers who showed reminiscent symptoms of asthma were examined by a physician. The workers were, afterwards, sent to a pneumologist to have spirometry carried out. Test of reversibility with β_2-mimetic was also carried out on workers who had undergone spirometry.

Data analysis

Analysis of data were done using the Sphinx Plus2 Software Version 5.1.0.3 (Chavanod, France). The relative frequency of the qualitative variables was expressed in percentage. The average and the standard gap of the quantitative variables were calculated giving precision of extreme values (maximum and minimum). Pearson's test was used to determine the possible association between the nominal variables of the study at a significance of $p \leq 0.05$.

RESULTS

Sociodemographics and occupationnal characteristics

The average age of the workers was 37 (ranging from 24 to 56 years). The 35 to 39 years age group was predominant at 35.2% (n=64). Only one worker was female. There were 2 tobacco-smokers with an average consumption of 1.5 ±0.71 packets/year. Ten workers (5.5%) had existing asthma before their hiring while 5 (2.7%) developed asthma after their hiring. 124 of the workers were from the thermo-welding workstation while 45 were from the extrusion workplace. The mean of seniority was 7.66±2.88 years with extremes ranging from 1 to 12 years. Only 2 workers (1.1%) had a Scarf or cloth as a Personal Protection Equipment (Table 1).

Rhino-conjunctivitis

Symptoms of rhino-conjunctivitis were indicated in 79.7% of workers at their workstations. These symptoms improved during weekends or vacation in 63.2% cases. occupational rhinitis was present in 62.6% of workers.

Table 2. Distribution of workers according to clinical signs of asthma

Respiratory symptoms	No.	%
Dyspnoea	60	33.0
Cough	34	18.7
Thoracic oppression	33	18.1
Respiratory whistling	17	9.3
Sibilant groans	4	2.2

Table 3. Spirometry profile of workers showing symptoms suggestive of asthma

Spirometry profile	No.	%
Spirometry normal	33	18.13
Reversible syndrome of the small air ways	12	6.6
Reversible obstructive syndrome	9	4.9
Not reversible syndrome of the small air ways	2	1.1
Not reversible obstructive syndrome	1	0.5

Respiratory symptoms

Respiratory symptoms suggestive of asthma were present in 62 workers. The most frequent clinical signs of asthma reported are presented in Table 2.

The detection of the occupational aspect of asthma

Among the workers with reminiscent respiratory symptoms of asthma, 25.8% showed symptomatology rhythmed by work while spirometry was carried out in 57 of the 62 workers who presented with reminiscent respiratory symptoms of asthma. The FEV_1 and the forced expiratory flow ($FEF_{25-75\%}$) DEM 25-75 (small air way injury) were pathological in 17 and 19 workers, respectively.

Spirometry disorders (13.2 %) were dominated by the reversible syndrome of the small air ways (6.6%) and follow-ups of the reversible obstructive syndrome (4.9%). The spirometry was compatible with asthma in 21 of the workers (Table 3).

Prevalence of occupational asthma

In our study sample, work-related/occupational asthma was observed in 14 workers in the factory. Inspite of spirometric diagnosis of asthma, the detection of OA could not be done in 7 workers because it was not rhythmed with their work ; non occupational asthma (Table 4).

Risk behaviors of occupational asthma

Occupational asthma is not significantly associated with occupational rhinitis (p=0.11). Both can occur in the same workplace. The thermo soldering (4.9 %) and extrusion work stations (2.7 %) were the locations with the highest tendency to cause OA as workers/respondents used no PPE (Table 5).

DISCUSSION

Socio-demographic characteristics

The average age of respondents in this study was 37 years which is in agreement with Attarchi et al. (2014) who reported an average age of 38 years in a similar study in Iran. There was a masculine predominance of 99.5%; which can be explained by the importance of manual handling tasks in the factory, notably for PE bags and bobbins of at least 25 kg. The employer would prefer to use the physical strength of men rather than women's. The average work experience in the factory was 7 years with a predominance (21.4%) of respondents who have 10 or 11 years of work experience. The respondents seem to show a relative stability of working in the factory considering that it was established 12 years back. In our study, 92% of the respondents work in the Thermo-welding (68%) and Extrusion (24%) stations as against 2% of the workers who are in the Grinding (1.1%) and Maintenance (1.1%) stations. This inequality in the distribution of respondents in the different work stations is according to the importance of work done at each station in the factory. It is also possible that the high number of workers in the Thermo-welding and Extrusion stations explains the presence of OA in these stations.

As for the use of PPE during work, our study revealed that most (98.9%) of the workers did not have any respiratory protection equipment as only 1.1% had an occasional PPE (muffler or cloth). The absence of PPE for

Table 4. Prevalence of occupational asthma

Compatibility of asthma with spirometry	Respiratory symptoms given rhythm with the work	
	Yes	No
Yes	14	7
No	30	6
Total	44	13

Table 5. Risks factors of occupational asthma

Parameters	Presence of OA	Absence of OA	P value
Workplace			
Thermo soldering	9 (4.9)	118 (64.8)	0.59
Extrusion	5 (2.7)	40 (22.0)	
No PPE	14 (7.7)	166 (91.2)	0.35
History of asthma			
Asthmatic	1 (0.5)	14 (7.7)	0.72
Non asthmatic	13 (7.1)	154 (84.7)	
Occupational rhinitis			
Present	12 (6.6)	102 (56)	0.11
Absent	2 (1.1)	66 (36.3)	

exposed workers is often noticed, especially in developing countries such as Morocco where in two milling companies in the industrial zone of Ain Sebaa in Casablanca workers in all the stations are exposed to cotton dusts every day without any personal or collective protection equipment. Among the exposed persons, 45.1% developed clinical respiratory symptomatology and 11.2% asthma (Laraqui et al., 2002). In our study, 34.1% of exposed workers developed reminiscent respiratory symptoms of asthma, with 33% dyspnea, 18.7% cough and 18.1% thoracic oppression. Attarchi et al. (2014) reported 27.5% of respiratory symptoms with 19.1% dyspnea, 12.9% cough and 14% thoracic oppression in exposed workers. The frequency of respiratory symptoms is therefore higher in this study than in Attarchi et al.'s (2014) study. This difference could be explained by the absence of personal and collective protection equipment in our study.

Imputability of formaldehyde in OA

In this study, formaldehyde was regarded as an etiologic agent of OA, inspite of the absence of its atmospheric dosage. In our study, the cases of OA were observed only at the Thermo-welding station (4.9%) and at the extrusion station (2.7%). However, experimental studies show that formaldehyde is the most frequently emitted product during thermal deterioration of polyethylene. Dieudonné et al. (1998) conducted some sampling campaigns in companies where polyethylene is processed into films and bags. They valued the chemical risk during three stages of plastic materials manufacturing (Extrusion - blowing, Thermo-cutting - thermo-welding and Printing). The smoke emmitted during extrusion, thermo-cutting and thermo-welding processes contain some irritating mixtures of low molecular weight gases (formic and acetic aldehydes, formic and acetic acid) (Dieudonné et al., 1998). The concentration intervals of the main pollutants sampled and measured by Dalbey et al. (1992) in polyethylene factories were between 0.13 and 0.19 mg/m^3 for aldehydes among which were formaldehyde and acetaldehyde (Dalbey et al., 1992).

The results in our study are compliant with the literature which has reported some clinical cases of OA as linked with products of PE thermal deterioration. In fact, it was in 1980 that Skerfving described a case of asthma rhythmed by work in a meat packaging female worker, having to perform the task of thermo-welding of PE films (Skerfving, 1980). Five years later, Nordman (1985) reported a case of asthma rhythmed by work in a man having to do the job of thermo-welding of PE boxes. Seven years later, Gannon (1992) reported another case of controlled asthma, in a young packer in a paper mill with hot PE. This study helped to determine the prevalence of OA linked with PE to be 7.7%. In a group of workers exposed to the dusts and smokes coming out of the mixture of plastic components (diisocyanate of toluene, polychloride of vinyl, polyethylene

and polypropylene) Attarchi et al. (2014) found OA prevalence of 13.8% which is superior to this study's. The simultaneous exposure to dusts and smokes coming out of the mixture of this plastic component gave way to potential risks of asthma. This could explain the difference in prevalence with our study. Besides, the same diagnostic criteria of OA were not used in the two studies. Indeed, Attarchi et al. (2014) based the diagnosis of OA on the presence of asthma symptoms (cough, respiratory hissing, and dyspnea) which can improve after occupational non-exposure and the reversibility of spirometry with a gain of at least 20% of Peak Expiratory Flow (PEF) (Attarchi et al., 2014). In our study, OA diagnosis is validated in the presence of reminiscent symptoms of rhythmed OA through the work and spirometric compatibility with asthma (reversible obstructive syndrome or small aerial route reversible syndrome). The prevalence of OA could therefore vary according to the diagnostic criteria of OA used. That is why a standardization of the investigating methods, not so much for the definition of OA as for the diagnostic tools used, is recommended in order to allow a comparison of results (Gautrin et al., 2003). This prevalence of OA as linked to 7.7% polyethylene in our study is higher than OA prevalence with 5.4% isocyanates observed in Algeria (Tibiche et al., 2014). It is lower than OA prevalence of 13% in bakery and supermarket workers in South Africa (Baatijies et al., 2009).

Occupational rhinitis was reported in 62.6% of workers in this study. Attarchi et al. (2014) reported 11.8% occupational rhinitis in exposed workers diagnosed on the basis of its clinical criteria (sneeze, rhinorrhea, nasal obstruction and nasal pruritus in relation to work). Similar criteria of occupational rhinitis were nevertheless used in our study. The high frequency of occupational rhinitis in our study seems to show an irritating work environment in the factory. It is, however, within the frequency variations limits of allergic rhinitis (5-65%) as reported by Johnson et al. (2007). In fact, the allergic respiratory effects observed in the plastic industry are essentially rhinitis and asthma (Rosenberg, 2009).

In our study, the average respiratory volume and flow of workers are: FEV_1(85.46%), FVC (84.53%), FEV_1 /FVC (84.72%), and Maximum Expiratory Flow (MEF) 25-75 (76.32%). These values are higher than those of the study by Attarchi et al. (2014), especially FEV_1 (74.52%), FVC (77.32%), FEV_1/FVC (79.65%), and MEF 25-75 (72.30%) (Attarchi et al., 2014). Spirometric disturbances were present in 13.2% of exposed workers in our study as against 25.6% in Attarchi et al.'s (2014) study. The difference with our study could be explained by the fact that in the Attarchi et al. (2014), all the workers underwent spirometry whereas in this study, only workers having reminiscent symptoms of asthma benefitted from spirometry. Besides, the importance of spirometric anomalies in Attarchi et al. (2014) study appears to be logical as it reports a high prevalence of OA (13.8%).

OA is not significantly associated with occupational rhinitis in our study. The same is true for the workplace, absence of PPE, and antecedent of asthma. This seems to be linked with the transversal descriptive nature of our study. An investigation of the "exposed/ non-exposed" cohort type would be more indicative of factors associated with OA.

Limitations

Within this study, and in order to determine the prevalence of Occupational Asthma (OA), only workers showing reminiscent symptoms of asthma (31.3%) have underwent spirometry, which could contribute to a misdiagnosis of OA, especially because some workers could have presented asymptomatic asthma which would have randomly been detected with spirometry. However, an overestimate of OA was possible in this study. Indeed, within this study, we were not able to carry out a confirmation test between causality of asthma and work through the achievement of the Peak Expiratory Flow (PEF) journal and the bronchial provocation tests. The Metacholin test intended to confirm asthma in the case of normal spirometric profile was not available. Also, the atmospheric dosage of the products of thermal deterioration and polyethylene dusts within the factory were not determined because there was lack of technical facilities and limited financial resources. The recognition of OA was therefore done based on the presumption of origin. Indeed, a worker affected by an occupational disease does not need to prove that his/her disease is work-related if he/she meets the set of criteria of occupational diseases with which his/her disease is linked.

Conclusion

Occupational asthma was detected in a plastic bags manufacturing industry in Togo. The present study established the prevalence of OA in relation to products of thermal degradation and/or to 7.7% polyethylene dust within the factory. Thermo soldering and Extrusion stations were more predisposed to OA. The workers at these stations did not use PPE. The high frequency of the occupational rhintis (62.6 %) is indicative of the irritating environment in the factory. This situation requires urgent implementation of preventive measures to eliminate incidences of OA in the factory. The implementation of a system of to prevent inhalation at sources of production of thermal degraded products and polyethylene dusts thus turns out to be fundamental and necessary through the use of respiratory PPE as a supplement to local ventilation.

Ethical considerations

The workers/participants selected for the study were previously informed on the process of the study. Thus their informed consent were sought and obtained. Refusal to participate in the survey did not imply any disciplinary sanction for the worker. The workers had the right to withdraw freely from the survey at any moment. The confidentiality of data was the investigator's direct

responsibility.

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Conflicts of interest

None declared.

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