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RESEARCH ARTICLE

PROFESSIONAL EXPOSURE TO WOOD AND CEMENT DUST ON THE VENTILATORY PARAMETERS OF MASONS AND CARPENTERS

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ABSTRACT

Dust has nowadays become one of the major problems which threaten the health of populations, undermine the stability of affected ecosystems and consequently the renewal of biological, even mineral, natural resources. The most common respiratory illnesses and almost all common conditions are linked to occupational dust exposure in humans. The study, conducted in Porto-Novo, Benin, aims to assess the influence of the exposure of wood dust and cement on the ventilatory parameters of carpenters and masons. To achieve this objective, a functional exploration of the subjects' proximal and distal respiratory variables is carried out using the spirometer. The results show a significant decrease in the proximal and distal respiratory variables of subjects exposed to wood dust and that of cement on the one hand, and on the other hand, these parameters are significantly lower in carpenters compared to masons. These results therefore indicate that the dust of wood and that of cement would contain very harmful particles which migrate more quickly towards the lungs by inhalation. These particles cause inflammation of the mucous membranes of the trachea or bronchi and are responsible for damage to the respiratory tract and skin and cancers.

INTRODUCTION

The dust to be composed of a multitude particles with a size less than 500 micrometers. These elements have the particularity of being able to be carried away by drafts (1). Their origins are varied. They may contain some particles which pathogenic properties can cause serious, irreversible and sometimes fatal diseases (2). Air pollution has long been regarded as a disease specific to poor countries, but today it spares neither African nor European countries and is becoming a global health problem. Health is a broad concept that can be influenced by many factors, including environmental ones (3). Air pollution has different consequences on health depending on age: more fragile children and the elderly are more sensitive. The effects of pollution also depend on the profession, the quantity and the duration of the pollutants with which humans are in contact (4). The human profession is one of the sources of air pollution. Professional activities in their practice emit many pollutants which have significant effects on health and particularly of mortality and cardiorespiratory morbidity (2). Among these activities, we can mention carpentry and masonry. These trades in their practice emit many pollutants in the air which have toxic effects especially on respiratory and cardiac health (5).

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Wood dust is inhaled in particular by people exposed of their profession context. This inhalation is the cause of many diseases of the respiratory system, eyes and skin. The most serious condition is cancer of the nasal cavity or facial sinus (nasal sinus cancer). The number of cases of these cancers is estimated at around 100 per year. They generally occur several decades after the start of the exposure (6).Somewhere, the various products used in the wood industry and molds constitute an additional respiratory risk which is far from being negligible. Rhinitis, asthma, conjunctivitis, chronic bronchitis and dermatitis are significantly more common in people exposed to wood dust than in those not exposed (7). As for cement dust, inhalation would cause respiratory problems: asthma, deterioration of the respiratory function, chronic symptomatology (6). Exposure to cement dust can be at two (02) levels: either at the level of cement production in cement factories, or at the level of the use of cement as a finished product by masons (7). Currently where the bill is very heavy both from an economic and health point of view, environmental pollution presente a major problem in the daily and professional life of Beninese. This study aims to assess the impact of inhaling wood dust and cement dust on the respiratory function of carpenters and masons in Porto-Novo at Benin.

MATERIAL AND METHODS

Investigation stage: It's about the collection of anthropometric parameters, professional qualification, health problems encountered and seniority in the job. After filling in the questionnaire, the data for the sampling is analyzed.

Data collection and participants: The non-probabilistic method with the reasoned choice sampling technique is used. We received permission from workshop managers and thestudy was conducted according to the principles of the Helsinki Convention (1974).

One hundred and twenty (120) subjects were shared out three groups to take part in the study.

- G1 group composed of 40 masons;
- G2 group made up of 40 carpenters;
- G3 control group composed of 40 subjects. All subjects live in Porto-Novo.

Inclusion and Exclusion Criteria: The study subjects met the following criteria:

- have at least five (05) years of pratice in the trade;
- No smoking ;
- Be no allergic to dust, heat, perfume and suffer from any allergenic pathology.
- be a man girl aged between 18 and 25;
- practice the activity at least 05 times a week;
- reside in the city of Porto-Novo in Benin ;
- Apparently breast and respiratory or cardiac pathologies;
- give the free and informed consent in writing.

Spirometric measurements: The subject familiarize himself with the spirometer by tests. We give him explanations so that he can understand the progress of the test. The subject have 10 to 15 minute of break before rest functional exploration. In order to avoid the effect of biorhythm on the results, the measurements are carried out in morning between 8H and 10H. After giving its free written and informed consent, the anthropometric data were recorded. The subject performs a trial familiarization with the SPIROBANK II S / N 001267 MIR spirometer regularly calibrated. The standard used was that of the African ethical group incorporated in the software of the spirometer.

Disposable mouthpieces were used to observe medical hygiene. The forced spirometry test was performed to record the ventilatory parameters. Then in the sitting position, he breathes through the mouthpiece that he puts into the mouth. He receives instructions to inflate his thorax to the maximum and then to empty his lungs as quickly and continuously as possible. Maximum instantaneous flows were measured at all points of the curve, but by convention four were selected: peak expiratory flow (DEP) and flow rates at 75, 50, 25% of vital capacity (Fry and Hyatt, 1960) (10). The DEP reflects the diameter of the central airway and the force exerted by the expiratory muscles. It decreases in obstructive and restrictive ventilatory disorders. The mean expiratory flow rates DEM, DEM50%, DEM25% and DEM25-75% make it possible to explore the small airways. After the respiratory functional exploration, the subject resumed normal breathing.

Statistical analysis: The data are processed with STATISTICA Statsoft version 10 software and StatView 5 software from Abacus Concepts Inc for the calculation of means and standard deviations. Comparison of three groups's variables were made using parametric tests. The Kolmogorov Smirnov test was used to verify the normality of the data. The level of significance is set at $p < 0.05$.

RESULTATS

Main characteristics: Table 1 presents the main characteristics of the subjects. The average value of the body mass index (BMI) of the study subjects is between 20 and 25 kg / m2. These subjects are on ideal weight and are not obese. There is no significant difference between the ages of subjects in groups G1, G2 and G3.

Table 1. Main characteristics of the subjects

Main Features	G1 n = 40	G2 n = 40	G3 n = 40
Size (m)	1.67 ± 0.05	1.71 ± 0.07	1.75 ± 0.06
Weight (kg)	60.93 ± 2.89	68.33 ± 10.7	65.13 ± 9.91
BMI (kg/m^2)	22.01 ± 1.57	20.65 ± 2.08	21.19 ± 2.73
Age (year)	24.40 ± 3.79	24 ± 1.71	24.87 ± 1.2

G1 : Group of masons. G2 : Group of carpenters. G3 : Witness group BMI = Body Mass Index ; N = Workforce

Table 2. Proximal respiratory parameters

Paramètres respiratoires	G1 N= 40	G2 N= 40	G3 N= 40
VEMS (L)	2.21 ± 0.28*	2.13 ± 0.43*	2.56 ± 0.53
CVF (L)	3.00 ± 0.3*	3.20 ± 0.46**	2.59 ± 0.52
DEP (L/s)	7.37 ± 0.99	6.77 ± 0.99	8.37 ± 1.68
VEMS/CVF	74.66 ± 4.59*	66.56 ± 3.21**	98.84 ± 4.93

G1 : Group of masons. G2 : Group of carpenters. G3 : Witness group *: Significant , **: Verysignificant, CVF: Forced vital capacity ; VEMS: Maximum expiratory volume per second VEMS/CVF : Tiffeneau's report

Table 3. Distal respiratory parameters

Paramètres respiratoires	G1 N= 40	G2 N = 40	G3 N=40
DEM 75 (L/s)	2.96 ± 0.52*	2.17 ± 0.32*	3.3 ± 0.89
DEM 50 (L/s)	3.75 ± 0.63	3.11 ± 0.88**	4.64 ± 0.15
DEM 25 (L/s)	3.94 ± 0.84*	3.69 ± 0.11**	4.74 ± 0.42

DEM 75: maximum expiratory flow rate at 75% of the CVF DEM 50: maximum expiratory flow rate at 50% of the CVF; DEM 25: maximum expiratory flow rate at 25% of FVC; * :significant; **: Very significant

Respiratory parameters: The Table 2 indicates a significant difference between proximal parameters of G1 and G2. This difference is very significant between the Tiffeneau Ratio of G2 and G3 ($p = 0.0002$). It emerges from the analysis of table 3 thatthe Immediate maximum expiratory flow rate at 25, 50 and 75% of the CVF of group 2 are significantly low in proportion to those of the two other groups.

DISCUSSION

In this study, functional exploration allowed to evaluate respiratory parameters of subjects in different groups. According to body mass index and age, there was no significant difference between the carpenters, masons and control subjects, Referring to the WHO classification, the average BMI values of the subjects range from (18.5 kg / m2 to 25 kg / m2) (8). The subjects are not obese and obesity problem on the ventilatory parameters can be excluded.

Some studies have shown that an increase in BMI up to 30 kg / m2 leads to a decrease in lung volumes (9). The mean values of the subjects' ages are indicate that they are all young. This assumes that the respiratory parameters are stable (10). Air quality depends on the level of pollutants released into the air and their quantity, weather conditions such as wind speed, temperature, and local topography such as mountains. Pollutant levels can vary widely from place to place and from hour to hour (11). The professional environment of carpenters and masons is highly concentrated in particles released by wood dust and cement and other pollutants because they work in the open air. Cement dust is rich in silica, chromium and nickel (4) and that of wood is rich in carbon and silicon, and suffers from it (12). These various compounds inevitably constitute a risk for human health.

However, the longer of exposure has abig consequence. The increase in pollutants in the air directly leads to an increase in cardiorespiratory diseases and associated mortality (11). Long-term exposure to these particles is therefore responsible for many respiratory abnormalities. The measurement of the flow-volume curve corresponds to the simultaneous recording of variations in flow and volume during a respiratory cycle. Physiologically forced vital capacity (CVF) is equal to or less than slow vital capacity (CVL). This difference is all the more marked since there is an obstructive syndrome (24). If the Tiffeneau Ratio is less than 70%, the obstructive syndrome is confirmed. The value of the Maximum expiratory volume per second will define the severity of the obstructive syndrome. If we have the inspiratory part of the curve and it is normal, it is most certainly an emphysema. The average maximum expiratory flow rates (DEM) achieved between 25 and 75% of the CVF allowed to detect a beginning distal obstruction if the VEMS is normal. These measurements are split at different levels of the CVF and help to locate the level of obstruction (5). In carpenters, there is a very significant reduction in proximal respiratory parameters (FEV1 / CVF, CVF and DEP). Similarly, the distal respiratory variables (DEM 25; 50 and 75) decreased very significantly compared to the group of masons. A global analysis of these results shows that dust from wood and cement has an important influence on the proximal and distal ventilatory parameters of the subjects. The significance was observed in the proximal respiratory parameters reflects an obstruction of the airways. This is justified in this study by a significant reduction in the Tiffeneau ratio and the DEP. Studies have reported that a DEP deficiency is a sign of airway obstruction (17). Exposure to wood dust initially causes obstruction of the proximal airways, which will extend to the distal airways as exposure progresses (18). It should be noted that wood dust generates functional modifications which are responsible for the anatomical and physiological modifications of the tracheobronchial tree which lead toan obstructive bronchial hyper responsiveness, the site of inflammation (16, 19).

In addition, the use of products such as: pentachlorophenol and formaldehyde to transform woods in the wood industry is an important parameter. The use of these products causes irritation of the respiratory tract and in particular asthma (occupational disease). The risk is significant when the product is sprayed (16). Other studies have shown that the osmolarity of the airways following dehydration when inhaling particles causes the airways to narrow. (20) These same studies show that airway inflammation and reduced alveolar growth in subjects is due to the exposure of pollutants such as PM 2.5 and PM10 (20, 21). We can therefore conclude that the wood dust would contain fine and ultrafine particles. The lung due to its interaction with ambient air, is a target organ for fine particles. Prolonged exposure to cold and / or dry air, like hyperventilation in an environment loaded with allergens and / or pollutants, seems to play a major role in the development of respiratory diseases (asthma, bronchial chronic obstructive pulmonary disease) (22). Indeed, several studies have highlighted the reduction in the airways (proximal and distal) following long exposure to air pollutants. After inhalation, PM2.5 reaches the most distal regions of the lungs in large numbers (18, 23, 24, 21). These very small diameter particles cross the upper respiratory tract to reach the lower tract where they will stagnate (20). This is what justifies the penetration into the distal airways of particles from wood dust which induce pathologies of the bronchi and pulmonary alveoli (rhinitis, asthma). In addition, exposure to inhalable particles could induce oxidative lesions, capable of causing the abnormal secretion of inflammatory mediators closely involved in the development of pulmonary pathologies (20). The lung, due to its interaction with ambient air, is a target organ for fine particles. Prolonged exposure to cold and / or dry air, like hyperventilation in an environment loaded with allergens and / or pollutants, seems to play a major role in the development of respiratory diseases (asthma, bronchial chronic obstructive pulmonary disease) (22). The magnitude of the risk incurred following exposure to air pollutants is a function of the duration of said exposure (24). The duration of exposure of subjects in this study is five (05) years at the rate of five (05) days per week. Professional exposure to wood dust and cement dust has caused modification in ventilatory parameters and is thought to be responsible for the genesis of respiratory and inflammatory diseases.

Conclusion

This study was undertaken to assess the impact of the carpentry and masonry profession on the respiratory health of workers in the city of Porto-Novo. This assessment was made through a spirometric test. The results indicate that the exposure time and the nature of dust inhaled are responsible for the obstruction of the subjects' airways. It is therefore important and desirable to protect exposed workers, either collectively or personal protective equipment and to control the dustiness of workstations.

Conflicts of interest: No potential conflict of interest was reported by the authors.

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