Environmental Pollution and Cytological changes in sputum samples taken from individuals living in the countryside and industrial area in Sudan

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Abstract

Introduction: Exposure to polluted air is a significant cause of health problems and lung disease. In Sudan, biomass fuel constitutes more than 80% of the total primary energy supply. Exfoliative sputum cytology provides useful information on pulmonary disorders.

Objective: The aim of this study is to assess the cytological changes in sputum samples taken from individuals living in the countryside and in an industrial area.

Materials & Method: This is a case control descriptive study. The participants lived in an industrial area and village. Two hundred adults ≥15 years agreed to participate in this study. Half lived and worked in an industrial area. The other 100 rural participants, native subsistence farmers from village, served as controls.

Results: According to the sputum cytology examination, 7 (3.5%) of the total sputum samples were reported as unsatisfactory. However most of the population153 (76.5%) that were cytological normal 36 (18 %) found to have inflammatory condition. 4 (2%) showed dyskaryosis. Separately, the results of 82 participants (82%) in the control group appeared normal and one individual (1%) showed dyskaryosis. in case 71(71%) normal and three (3%) dyskaryosis. There were no significant differences between the two groups in term of cytopathology finding.

Conclusions: Air pollution has a negative impact on respiratory tract and may lead to cytological changes. Sputum detection methods have the advantage of being the only noninvasive method that can detect cellular atypical changes. Sputum cytological examination combined with other screening examinations may play an important role in the early detection of lung cancer.

Keyword: Sputum, Cytopathology, Air Pollution.

Introduction

Air pollution from car exhaust, factories and biomass fuels has become a worldwide concern.[(1)] Approximately three billion people in the world are exposed to air pollution from biomass burning, originating from the use of wood or coal as cooking fuel.[(2)] Biomass burning emits significant quantities of known pollutants hazardous to health, including several carcinogenic compounds.[(3)] In Sudan, biomass fuel constitutes more than 80% of the total primary energy supply. Prolonged exposure to polluted air is a significant cause of health problems and lung disease .[(4)] Sputum cytology is a low invasive and inexpensive technique that is easy to repeat and allows direct sampling from the lower respiratory tract.[(5)] The relation between exposure to polluted air and increased incidence of lung disorders has been demonstrated in animals and in humans and in epidemiological studies.[(6,7)] Several histopathological and cytological studies have shown that lesions of the respiratory tract epithelium become increasingly severe with longer exposure to high levels of urban air pollution.[(8)] Less obvious is that prolonged exposure to air pollution at levels much below those found under experimental conditions could be an important cause of respiratory disorders. We sought to test the hypothesis that individuals exposed to air pollution would be more likely to have cytological changes than those without exposure to air pollution. Exfoliative sputum cytology, which provides useful information on the pathophysiology of pulmonary disorders, has been used to show the relation between air pollution and respiratory disorders in experimental animals.[(5,9)] previous studies investigated the effect of exposure to smoking and second-hand tobacco smoke at home and its link with many complications, including impaired lung ventilator function.[(10)] To our knowledge, this is the first community-based study that investigates the association between air pollution and cytopathological changes in Sudan.

Materials and Methods

Study Design

This is a case control descriptive study, conducted by the Histopathology and Cytology Department, Faculty of Medical Laboratory Sciences, University of Khartoum. Participants lived in a northern Khartoum industrial area and in El Ogda; a village located in Aljazeera state, 200 kilometers southern Khartoum state the capital city of Sudan as non-exposed group.

Study population and selection criteria

Two hundred adults ≥15 years Agreed to participate in this study. They were divided into to two groups: one hundred individual lives and works in Khartoum north industrial area for a period more than 10 years were considered as case group and rural

participants consist of one hundred native subsistence farmers from El Ogda village lives for the same period selected as control. Tobacco users and smokers were excluded from both case and control. Participants were selected randomly from houses and markets, case and control matched by age and gender.

Participants who could read provided written informed consent. Participants who could not read provided verbal consent. The study was approved by Faculty of Medical Laboratory sciences University of Khartoum research board.

Sample collection and preparation

Participants' information and clinical condition were obtained through interviews and examination at the time of enrollment. Each participant was instructed to produce sputum by coughing vigorously. Sputum was collected in wide-mouthed, disposable plastic containers. The sputum was decanted into a Petri dish and examined against a black background. When present, blood-tinged, discolored and solid particles were selected for examination. The sputum samples were spread evenly over two clean glass slides. One slide was fixed immediately in 95% ethyl alcohol for 30 minutes, and then stained with Papanicolaou procedure.[11] The other smear was allowed to air dry, then post-fixed in methanol and stained with May-Grünwald Giemsa stain.[12] Both smears were screened, at a low power (x 100) by three well-trained cytologists working independently for detection of abnormal cells. The final diagnosis was determined and confirmed by a cytopathologist, and smears were classified as unsatisfactory, negative, inflammatory, or dyskerosis.

Data analysis

The basic data of participants were collected using a structured questioner interview. The data were analyzed by SPSS version 16.0 for Windows. A chi-square test was used to detect the difference between the groups. A P-value of less than 0.005 was considered statistically significant; each group was correlated to cytological results**.**

Results and Discussion

Two hundred people participated in this study. In the case group exposed to air pollution in a northern Khartoum north industrial area, there were 71 males (71%) and 29 females (29%), with a mean age of 42.75 years. Age range was from 16 to 85 years. The control rural group consisted of 67 males (67% of the group) and 33 females (33%), with a mean age of 34.35 years; ages ranged from 9 to 80 years. Participants were from different age groups. Group 1 less than 15 years constituting 25 (12.5%), group II from 15-30 years old include 75 (37.5%), group III from 31-45 years old 59 (29.5%) and group IV more than 45 years old are 41(20.5%) individuals As regards occupation, in the control group (El Ogda villagers), worker were 55 (55%), house wife 15 (15%) and student 30 (30%). In case, 59% were workers and 11% were housewives (See table 1).

Table 1: Cytopathological Finding among Study Groups

Study Groups	Unsatisfactory	Negative	Inflammatory	Dyskerosis	Total
Case(Khartoum north industrial area citizen)	5 (5%)	71 (71%)	21 (21%)	3 (3%)	100 (100%)
Control (Aljazeera citizen (Elogda Village))	2 (2%)	82 (82%)	15 (15%)	1 (1%)	100 (100%)
	Chi-Square P value =0.07				
Gender of Case/ control					
Male	3 (3%) /0 (0%)	48 (48%) /54 (54%)	18 (18%) /12 (12%)	2 (2%)/1(1%)	71 (71%) / 67 (67%)
Female	2 (2%) /2 (2%)	23 (23%) /28 (28%)	3 (3%)/3 (3%)	1 (1%)/0 (0%)	29 (29%) / 33 (33%)
	Chi-Square P value =0.000				
Ages Case / Control					
Less than 15 years	3 (3%) / 1 (1%)	6 (6%) / 18 (18%)	3 (3%) / 6 (6%)	0 (0%) 0 / (0%)	12 (12%) / 25 (25%)
16 to 30 years	2 (2%) / 0 (0%)	20 (20%) /35 (35%)	6 (6%) / 4 (4%)	1 (1%) / 0 (0%)	29 (29%) / 39 (39%)
31 to 45 years	0 (0%) / 0 (0%)	28 (28%) / 17 (17%)	7 (7%) / 1 (1%)	1 (1%) / 0 (0%)	36 (36%) / 18 (18%)
More than 45 years	0 (0%) / 1 (1%)	17 (17%) / 12 (12%)	5 (5%) / 4 (4%)	1 (1%) /1 (1%)	23 (23%) / 18 (18%)
	Chi-Square P value =0.000				
Occupation of study groups case/control					
Workers	1 (1%) / 2(2%)	43 (43%) / 52(52%)	12 (12%) / 0 (0%)	3 (3%) / 1(1%)	59(59%) /55 (55%)
House Wives	0 (0%) / 0(0%)	9 (9%) / 15 (15%)	2 (2%) / 0(0%)	0 (0%) / 0(0%)	11 (11%) / 15 (15%)
Students	4 (4%) /0 (0%)	19 (19%) / 15 (15%)	7 (7%) / 15 (15%)	0 (0%) / 0(0%)	30(30%) / 30 (30%)
	Chi-Square P value =0.000				

Sputum cytology examinations showed different condition. Seven sputum samples (3.5% of total) were reported as unsatisfactory. However, most of the population's samples: 153 (76.5%) were cytological normal; 36 (18 %) displayed an inflammatory condition with normal cellular pattern. The bacterial infections ranged from chronic infection to acute infections.

Fungal infections were not common: Only 3 samples (1.5%) showed an inflammatory condition; 4 (2%) showed dyskaryosis. All inflammatory conditions

were caused by human papilloma virus (HPV), as indicated by koilocytosis. Separately, among control results, 82 (82%) samples were normal; 15 (15%) inflamed; and 1 (1%) showed dyskaryosis. Five (5%) samples were unsatisfactory; 71 (71%) normal; 21 (21%) inflamed; and 3 (3%) showed dyskaryosis. For different variables in case and control samples, see table 1. Chi- square tests showed no significant differences between the two groups in term of cytopathology finding P. Value > 0.000.

Approximately 60% of the participants in the industrial area group were workers. The cytopathological finding showed a statistically significant increase in the percentage of their inflammatory conditions and cytological abnormalities compared to the control group. There were also significant differences in term of cytological atypical changes in age groups and gender between the case and control. Higher percentages of inflammatory and dyskaryotic changes were found in the industrial group exposed to air pollution. See the table.

Cytological examination of sputum with Papanicolaou stain is accepted as a useful diagnostic tool in carcinoma of lung.[13,14] this study examined the relationship between exposure to air pollution in an industrial area of Sudan, and cytopathological changes in a control population living in a rural residential area. We sought to test the hypothesis that individuals exposed to air pollution would be more likely to show cytological changes than those without exposure to air pollution. In the present study, approximately 60% of all study participants were worker. The cytopathological finding showed a statistically significant increase in the percentage of inflammatory conditions and cytological abnormalities compared to the control group. This study noticed inflammatory response as shown by the increase in the number of inflammatory cells as well as epithelial inflammatory changes in the sputum of individual inhibiting Khartoum north industrial area compared to control group. These findings are in accord with the studies of Florence N. Schleicher and Mazzei.[15,16] these two studies demonstrated that in patients with asthma, sputum analysis and inflammatory components can be used to improve lung function. Furthermore, air pollution has been associated with respiratory cytological changes by several studies.[17,18] those two studies revealed that the air pollution with diesel exhaust particles can induce allergic diseases with increased IgE production and preferential activation of Th2 cells.

The prevalence of abnormal cytopathological changes was higher our case group compared to control group, although the difference was not statistically significant. A. Van Rensburg found that sputum cytology has high diagnostic accuracy for detection of endobronchial tumors.[19] Dyskaryosis (abnormality of the nucleus of a cell) is generally infrequent in sputum of healthy control groups. However, we found many dyskaryosis among individuals living in a northern Khartoum industrial area. Since excess dyskaryosis may indicate underlying pulmonary abnormality, exposure to air pollution and an abundance of dyskaryotic nuclear changes in sputum have been regarded as an indicator of adverse lung reaction to air pollution.[20] In our study, no significant differences in the incidence of sputum cytopathological changes were found between case and controls. The differences in the incidence of cytopathological changes related to air pollution appear only when Khartoum participants (the case group) were classified based on age, gender and occupation and compared with the participants living in Elogda village (the control group) (P < 0.005). Age and gender were associated with cytopathological finding of inflammatory in sputum of individuals living in Khartoum industrial area compared to control group. This finding is supported by the study of W Merrill and colleagues, who found the association between lavage fluid and cytological changes. They stated that inflamed sputum qualified as an important marker of bronchial injury.[21] A 1984 study by Madison et al. concluded that sputum cytology could be a potent predictor of abnormal respiratory functional tests.[22] They also said it could indicate a predisposition of related subjects to pulmonary disease.

In our study, living and working in the northern Khartoum industrial area and daily exposure to environmental air pollution appears to be an important factor in cytological abnormalities, together with being a worker in that area. These findings can represent cytopathological changes that might rise over time and lead to the development of lung cancer. Age in this group was also an important factor in the promotion of respiratory epithelium alterations. Students and young people exposed to air pollution displayed no major cytopathological changes. Most cytopathological abnormalities were found in people aged over 30 years in the present study, despite the relatively homogeneous age groups, subjects' age and occupation appeared as a significant causative factor for cytopathological changes. It is known that the length of exposure plays an important role in respiratory tract changes.[23,24] Many other studies of environmental air pollution have shown that there is correlation between age and length of exposure in lung function.[25,26] In this study gender was significantly associated with cytopathological changes. The exposure of participants to pollution in Khartoum industrial area revealed a higher incidence of cellular atypical changes in males compared to females. A 2017 epidemiological study of air pollution and its effects on lung function in children and adolescents reported that there is no conclusive data to support evidence of effects differentiated by gender.[25] However, some studies have shown that the respiratory tracts of men exposed to air pollution evidenced more changes than those of women.[27] The increase in

cytopathological changes in the course of aging can be explained by the gradual decline in efficiency of the defense mechanisms and regenerative potential of the respiratory system. In addition, cytopathological changes more frequent in man than women; this may be because men are more affected by occupational exposure and by indoor and outdoor pollution compared to women. Cytological changes in the sputum are probably the most sensitive indicator of the effects of exposure to polluted air. This study recommends the use of cytological examination of the sputum in air-pollution surveys and indicates the necessity of such examination. Sputum detection methods have the advantage of being the only noninvasive method that can detect cellular atypical changes; sputum atypia is associated with an increased risk of lung cancer.

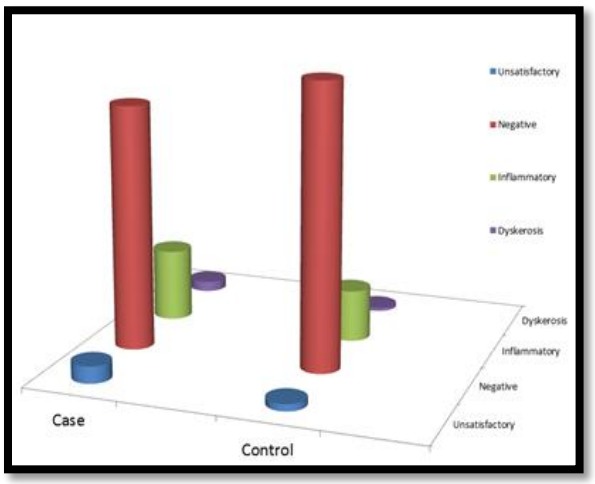

Fig. 1: Cytopathological Finding among Study Group

Conclusion

Sputum cytological examination combined with other screening examinations may play an important role in the early detection of lung cancer or in the selection of the optimal target population for more intensive lung cancer screening. Exposure to air pollution has a negative impact on the respiratory tract and may lead to cytological changes. The impact of air pollution exposure on children, women and workers is sparsely investigated, so future studies should be made to capture these groups, their asthma status and lifetime exposures and to investigate the cytopathological changes, in ways in addition to lung function tests (e.g., spirometry and oscillometry).

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