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Screening for cytological changes associated with inhaled polluted materials in Khartoum industrial area

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ABSTRACT

Background: Environmental air pollution is the main risk factor for lung cancer. The objective of the present study was to assess cytomorphological changes in sputum specimens of individuals working in the car-maintenance industrial area. *Methodology:* A total of 75 sputum specimens were obtained and demonstrated adopting the standard Pap method. *Results:* The results showed abnormal cytological changes in a form of atypical cellular changes (n= 6, 8%), metaplastic cellular changes (n=12, 16%), in addition to inflammatory changes (n=19, 25.4%). *Conclusion:* Occupational exposure to air polluted with vehicle emissions is a risk factor for developing precancerous changes in lung epithelial cells. People who work in these heavily industrialized areas should be subject to ongoing sputum cytological examination.

Keywords: Atypia, cars, exposure, industrial area, metaplasia, pollution, sputum

1. INTRODUCTION

Air pollution has reached an epidemic state due to numerous factors worldwide. Air pollution includes chemical ingredients and environmental components such as dust, fumes, gases, and biological materials. The upsurge in air pollution has influenced the global health system, mainly in developing countries (Shahrbaf et al., 2020). The most common health consequences of air pollution are its direct effects on the respiratory and cardiovascular systems (Dominski et al., 2021). Air pollution has been linked to a variety of diseases, including lung cancer, asthma, chronic obstructive pulmonary disease, hypertension, atherosclerosis, acute myocardial infarction, stroke, cognitive function loss, and anxiety, according to epidemiological studies (Arias-Pérez et al., 2020).

Long-term exposure to air pollution has been linked to an increased risk of lung cancer (Moon et al., 2020). The initial effects of air pollution in lung epithelial cells usually involve atypical cytological changes. These changes can be revealed in sputum cytology, representing a key to the early detection and screening of at-risk individuals (Alshammari et al., 2018). Therefore, this study

aimed to screen for cytological changes associated with inhaled polluted materials in Khartoum Industrial Area.

2. MATERIALS AND METHODS

This study investigated 75 volunteers living in Khartoum, Sudan, and working in the Sudanese most extensive industrial area, which lies in Khartoum. The study was conducted during the period from July to September 2021. Early morning before food take sputum sample was taken from each participant. Smear was made from the colored part of the sample. The smear was fixed in 95% ethyl alcohol while wet for 15 minutes, then transferred to the lab to be stained by Pap method, as described elsewhere (Alshammari et al., 2018).

Epithelial cytological changes

Epithelial cytological changes were assessed according to the presence of features of cellular proliferative characteristics. These include nuclear enlargement with increased nuclear cytoplasmic ratio, hyperchromatism, chromatin clumping with moderately prominent nucleation and irregular nuclear borders, bi- or multi-nucleation, increased keratinization and cytoplasm scantiness, and variations in cell and nuclei size and/or shape.

Statistical analysis

SPSS software was used to analyze the data in order to obtain frequencies, cross-tabulations, and statistically significant values. A Chi-square test was performed with and 95% confidence interval. A P-value of 0.05 or less was considered statistically significant.

Informed Consent

Participants were asked to sign a written informed consent form during the interview before obtaining the sample.

3. RESULTS

This study investigated 75 participants aged 20 to 60 years. Most participants were aged 20-30 years, followed by 31-40 and 41-50 years, representing 32(42.7%), 24(32%), and 13(17.3%), respectively, as shown in Fig 1. Cytological atypical changes were seen in 8% of the study subjects and metaplasia was seen 16% (images 1 and 2, Table 1 and 2).

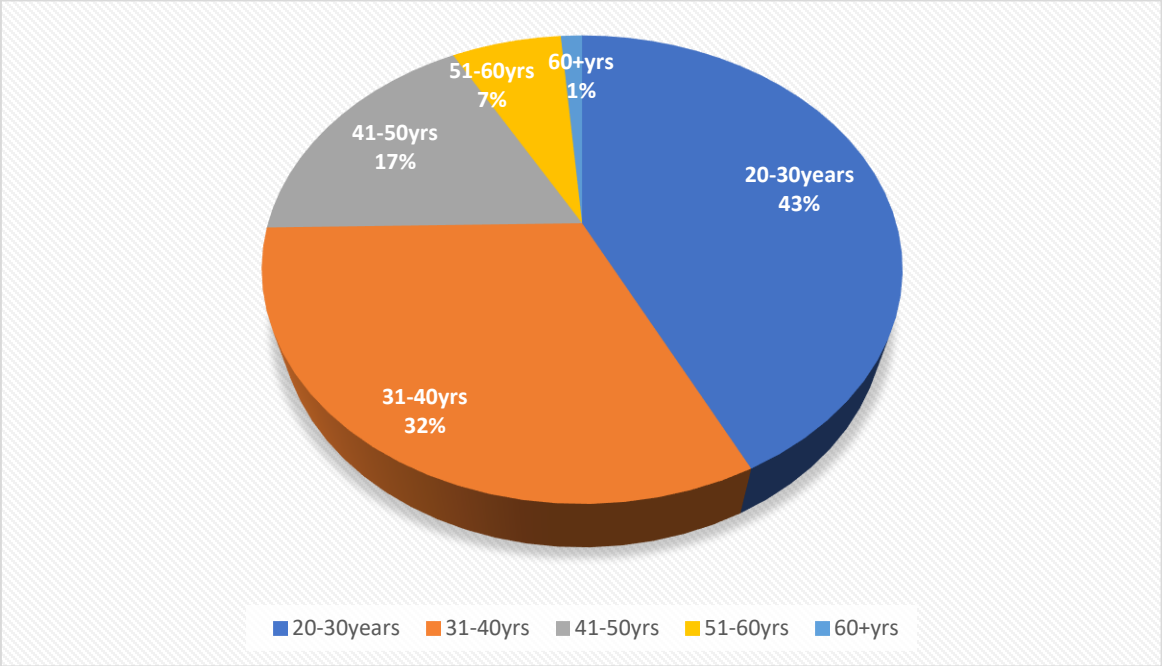

Figure 1 Age distribution of the study population

Table 1 Distribution of the study subjects by atypical cytological changes

Variable	Frequency (n)	Percentage %
Atypia		
No	69	92.0
Mild	4	5.3
Moderate	2	2.7
Total	75	100.0
Metaplasia		
No	56	74.7
Yes	12	16.0
N/A	7	9.3
Total	75	100.0

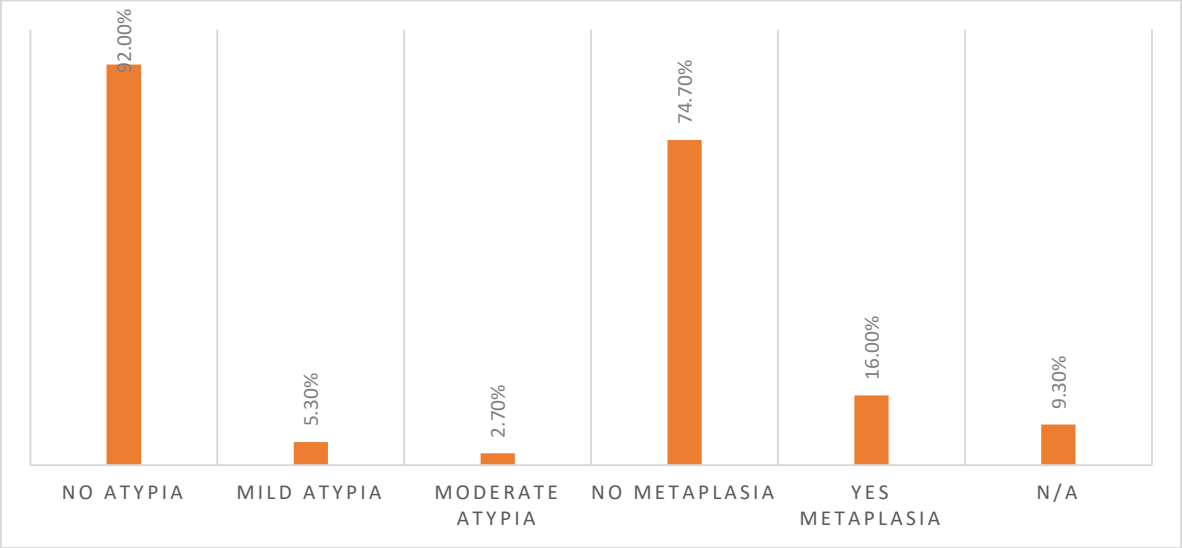

Figure 2 Study subjects by atypical cytological changes

Table 2 Distribution of the study subjects by inflammatory changes

Variable	Frequency (n)	Percentage %
Acute inflammatory cells infiltrate		
No	67	89.3
Yes	8	10.7
Total	75	100.0
Chronic inflammatory cells infiltrate		
No	64	85.3
Yes	11	14.7
Total	75	100.0
White blood cells		
<4000	20	26.7
4001-7000	35	46.7
7000+	20	26.7
Total	75	100.0

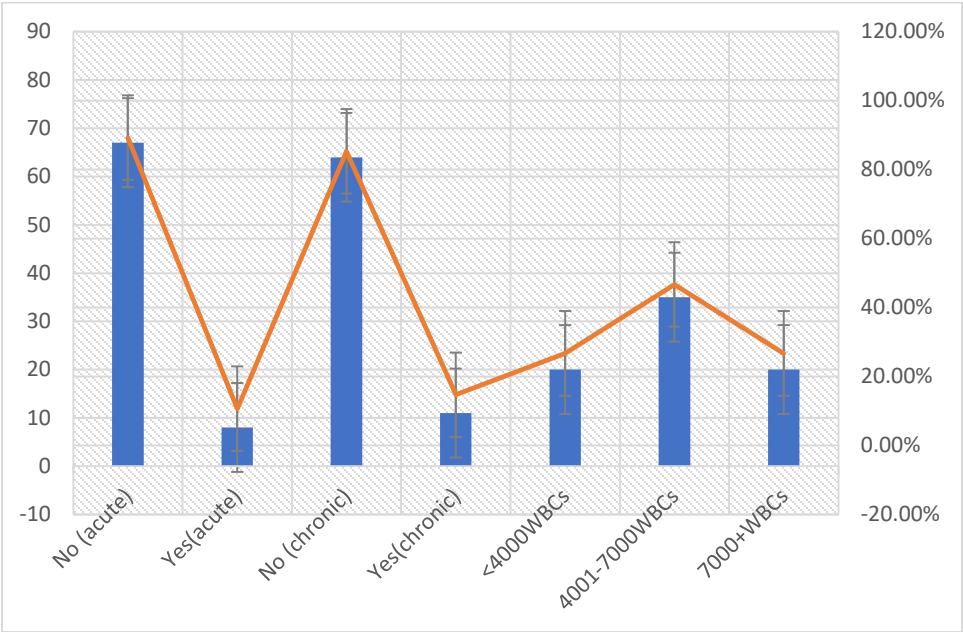

Figure 3 Study subjects by inflammatory cells changes

Table 3 and Fig 4, summarized the distribution of the TWBCs count by cytological changes. Most cases with cytological atypia were seen in WBCs of more than 4000cells/µl representing 6/6(100%). Out of the 12 cases of metaplasia, 10/12(83.3%) were found with WBCs count of more than 4000cells/µl. Acute and chronic inflammatory cell infiltrates were similarly distributed in all WBCs count ranges (Table 3). The proportions within entire cytological changes vary, as shown in Fig 4.

Table 3 Distribution of the TWBCs count by cytological changes

Variable	<4000cell/µl	White blood cells count 4001-7000 cell/µl	7000+ cell/µl	Total
Atypia				
No	20	30	19	69
Mild	0	4	0	4
Moderate	0	1	1	2
Total	20	35	20	75
Metaplasia				
No	16	25	15	56
Yes	2	5	5	12
N/A	2	5	0	7
Total	20	35	20	75
Acute inflammatory cells				
Yes	20	32	15	67
No	0	3	5	8
Total	20	35	20	75
Chronic inflammatory cells				
Yes	17	31	16	64
No	3	4	4	11
Total	20	35	20	75

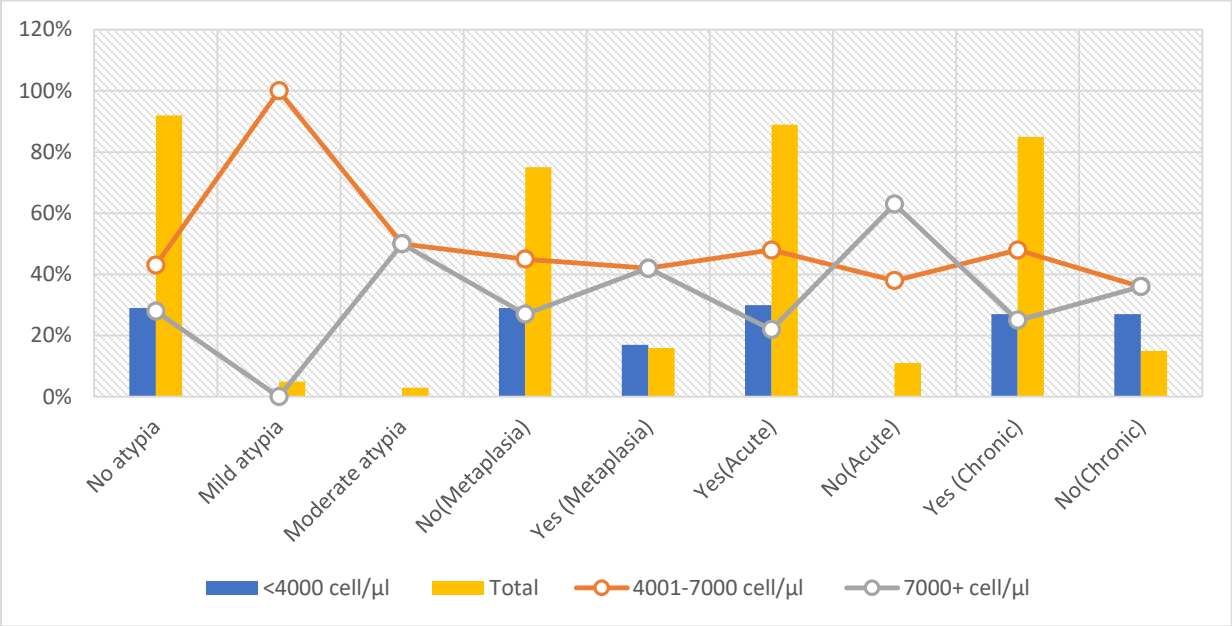

Figure 4 Description of the WBCs count with the entire cytological change group

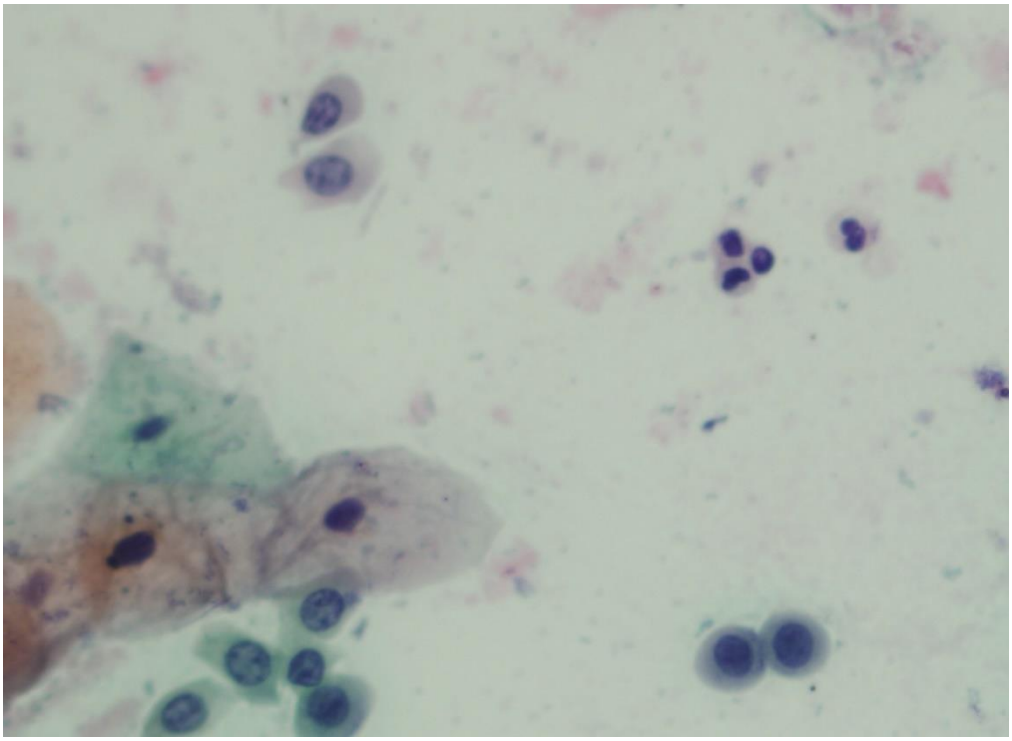

Image 1 Sputum cytology stained by Pap Stain showing cytological atypia

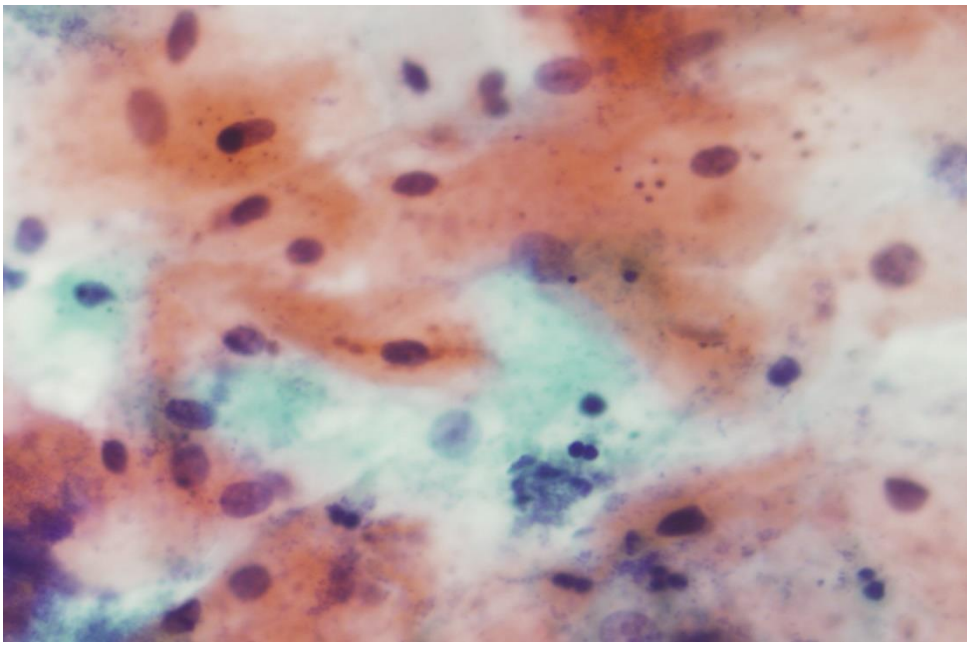

Image 2 Sputum cytology stained by Pap Stain showing metaplasia and inflammatory cells infiltrate

4. DISCUSSION

Industrial areas are used for the mechanical maintenance of cars, buses, and motor vehicles; hence they are considered the source of environmental pollution (Alshammari et al., 2018). Prolonged exposure to environmental air pollutants is the leading cause of several respiratory health problems, such as lung cancer (Chen et al., 2022; Biondi-Zoccai et al., 2021). In addition, it was reported that exposure to air pollutants increased the lung cancer incidence rate among drivers (Chen et al., 2022).

Therefore, the current study aimed to assess the cytomorphological changes of lung epithelial cells associated with prolonged exposure to environmental air pollutants in mechanical cars/motorbikes maintenance industrial areas. In several cytological studies, sputum cytology has been considered a valuable and accurate diagnostic tool for assessing lung epithelial cells abnormality (Salih et al., 2017; Fan et al., 2021). Also, it was used in the diagnosis of several cases of bronchogenic carcinoma (Chinoca et al., 2022).

In the present study, the cytological examination of sputum smears showed variable abnormal findings ranging from results, atypia, and metaplastic cellular changes to acute and chronic inflammatory cellular changes. These results go in the same line with another finding (Salih et al., 2017). Their study observed an increase in the prevalence of abnormal cytological changes and inflammatory cellular infiltrate in sputum smears of industrial workers exposed to air pollutants. Also, it was found that cytological atypia and metaplastic cellular changes are associated with contaminated air with vehicle emissions (Alshammari et al., 2018). Moreover, the same results were reported elsewhere (Ahmed and Rezgalla, 2010; Ahmed et al., 2013). Furthermore, it was mentioned that inhalation of vehicles emission has been associated with lung cancer (Singh and Arora, 2022).

Sputum cytology results concerning inflammatory cells might be applied as a diagnostic tool to test lung function (Shi et al., 2021). In the current study, the total number of WBCs was relatively elevated in most individuals with cytological changes. We think this elevation is due to the inflammatory, immunological response to the inhaled air pollutants. These findings support the fact that polluted air with diesel exhaust particles can cause allergic health problems with the increased production of Th2 cells and IgE (Berger et al., 2021). We correlate abnormal cytological findings in the sputum to the inhalation of polluted materials in the care maintenance workplace. This assumption agrees that diesel engine exhaust is classified as a carcinogenic agent to humans (IARC, 2013). In addition, the emissions that are produced from vehicles contribute to 25-40% of air pollution and include ozone, nitrogen dioxide aldehydes, particulate matter, metals, polycyclic aromatic hydrocarbons, 1,3-butadiene, and benzene (Alshammari et al., 2018).

Furthermore, it was found that exposure to particulate matter, sulfur dioxide, and nitrogen oxides are a risk factor for developing lung cancer (Manisalidis et al., 2020). Moreover, exposure to benzene vapor from vehicles emission causes a wide range of health problems such as hematologic disorders and lung diseases (Li et al., 2021). One study observed cytomorphological changes and immunological disorders due to benzene vapor inhalation (Al Fawzan et al., 2021).

5. CONCLUSION

We assume that daily exposure to air pollutants is responsible for the cytomorphological changes in participants working in an industrial area. People working in such industrial polluted areas should undergo continuous sputum cytological screening.

Acknowledgment

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Informed consent

Written & Oral informed consent was obtained from the patient identified in this study.

Ethical Approval

The ethical committee approved the study protocol at the FMLS, University of Khartoum. Approval number: HERC 0002/CMLS.UOK/6/22.

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This study has not received any external funding.

Conflicts of interest

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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