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Original Article

The Examination of Olfactory Function and Mucocilliary Transport in Gas Station Officers

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ABSTRACT

Introduction: *Chronic exposure to fuel oil can cause chemical burns to the olfactory epithelium, which can cause anosmia. This study aimed to compare mucociliary transport time and olfactory function between operator and non-operator officers at gas stations.* ***Methods:*** *This study was involved 40 subjects divided into two equal groups each consisting of 20 gas station operators and non-operators, respectively. The examination of mucociliary transport time was carried out by saccharin test, while the olfactory function was examined by assessing the olfactory threshold, discrimination, and identification (TDI) score using the Sniffin sticks test.* ***Results****: There was a significant difference between gas station operators and non-operators in the mean mucociliary transport time and olfactory function (P<0.001). In addition, there was also a significant correlation between the mucociliary transit time and olfactory function (p<0.05), with a strong negative correlation coefficient (r=-0.620).* ***Conclusion****: The mucociliary transport time and olfactory function in non-operator public gas station officers were better than operators, which may caused by inhalation of chemical pollutants induces the release of proinflammatory cytokines, chronic inflammation of the nasal mucosa results in impaired olfactory cells and mucin glands.*

1. INTRODUCTION

Smell disorders can arise from various causes and significantly affect the patient's quality of life. Besides that, it may indicate the presence of an occult underlying disease. The sense of smell plays a vital role in protecting a person from environmental hazards such as fire, gas leaks, air pollution, and contaminated food.[1] It is estimated that nearly 2 million Americans experience olfactory dysfunction with less than 1% occur in people under 65 and more than 50% occur in people over 65 years.[2] Recent research also states that nearly 14 million Americans over 55 years old have chronic olfactory dysfunction.[3] In a previous study conducted on gas station officers, 20 (27%) out of 46 men had olfactory disorders, and ten (13.5%) out of 28 women had olfactory disorders.[4]

Smell disorders resulting from exposure to fuel oil containing benzene, toluene, ethylbenzene, and xylene have long been discussed. In the Nordic countries, benzene concentration in fuel oil ranges from 2-6%, and the proper length of work is 8 hours a day. Exposure to fuel oil vapor at gas stations mainly occurs when filling the car's tank.[5] Hydrocarbons (including gasoline and diesel) are the most common fuel oil used by humans. Fuel oil contains volatile and non-volatile components with a relatively broad degree of distillation. Under normal circumstances for fuel users and fuel oil production facilities, exposure can generally occur through inhalation or volatile substances.[6] BTEX (benzene, toluene, ethylbenzene, and xylene) are the four most studied substances from several organic components volatile substances because these substances are widely found in fuel oil and motor vehicle fumes.[7]

Animal studies have shown that fuel oil can interfere with olfactory function by directly interacting with the olfactory epithelium. The material will damage the olfactory receptors and related cell.[8, 9] In studies using electron microscopy in guinea pigs exposed to fuel oil vapors, it was found that histological changes include the presence of inflammatory cell infiltration in the mucosa and submucosa of the trachea; loss of cilia in the tracheal epithelium; damage and desquamation of the tracheal epithelium. It decreased the number of goblet cells.[10] Chronic exposure to fuel oil can also cause chemical burns to the olfactory epithelium, which can cause anosmia.[11, 12] Nasal mucosal disorders, chronic inflammation can interfere with ciliary movement to the quality of secretions, thereby interfering with local mucociliary transport. When this system is disturbed, the material trapped by the mucus hammer will penetrate the mucosa and cause diseases such as rhinosinusitis.[13, 14] In addition, it is also exacerbated by the lack of use of personal protective equipment such as masks when they work. Based on this background, it is necessary to research to determine the impaired olfactory function and mucociliary transport in gas station officers in Makassar. This research has never been done in Makassar before, so it is necessary to do this research with this background.

2. METHODS

Study Design

This research is an observational study with a cross-sectional design conducted at a gas station in Makassar, Indonesia. The study was conducted between September and November 2020. Ethical approval was obtained from the Institutional Ethics Committee (Ref. No. UH20090502). Written informed consent was obtained from all participants.

Subjects

The data collection method in this study used primary data. The sample in this study was gas station workers, both operator and non operator, aged 20-45 years in Makassar, South Sulawesi, Indonesia. Operators were subjects whose daily activity was filling the gas tank for 8 hours a day and non-operators were those who worked in-office and hence were not directly exposed to the gasoline. Subjects were considered eligible for inclusion if they are less than 45 years old and had worked for more than six months; the exclusion criteria were subjects suffering from acute and chronic rhinitis, allergic rhinitis, polyps, concha hypertrophy, septal deviation, nasal tumor, central nervous system disorders, had a history of the nose and head trauma, a history of rhinoplasty, and refused to participate in the study. Subjects with chronic diseases, such as diabetes melitus, were eligible to be enrolled in this study as long as no olfactory function defect was found.

Procedure

Anterior rhinoscopy was performed to screen for abnormalities and conditions for inclusion in the study. The saccharin test examined mucociliary transport time. Before the examination, the patient was asked to rinse his mouth with water. A nasal speculum was placed in one of the nasal cavities. Saccharin was taken with bayonet tweezers (about 30 mg) and then placed about 1 cm behind the anterior edge of the inferior turbinate with the head flexed around 10^0. The patient breathed through the nose with the mouth closed, does not cough, sneeze and snort. Next, the patient was asked to swallow saliva every half to one minute using a stopwatch. The patient was asked to report if he/she perceived sweet taste in the throat. If the patient did not perceive sweet taset within 60 minutes, the test was stopped, and saccharin was placed on the patient's tongue to rule out taste disturbances.

Examination of the olfactory function was carried out with the Sniffin sticks test. This test uses 16 different odorants by assessing the olfactory threshold, discrimination, and identification (TDI) score. The time interval for examining the olfactory threshold is 20-30 seconds with both eyes closed to avoid visual identification. The TDI score ranged from 0 to 48, ranging from 0-16 for each threshold, discrimination, and identification assessment. Determination of the patient's TDI score is done by taking the smallest value in one of the two olfactory nerves, which is interpreted if 15 for anosmia, 16-29 for hyposmia, and 30 for normosmia.

Statistical analysis

Statistical analysis was performed with IBM SPSS Statistics version 24 for Windows. The data normality test (Shapiro-Wilk) was used to see the distribution of the data; the statistical test procedure used a significance level of <0.05 (Alpha = 5%). Independent-T test and Mann-Whitney test were used to determine the significance of differences in olfactory function and mucociliary transport time. In contrast, the Spearman correlation test was used to assess the correlation between olfactory function and mucociliary transport time.

3. RESULTS

This research was conducted on employees of public gas stations in Makassar, South Sulawesi, Indonesia, who had met the inclusion criteria, namely 20 people who worked as gas station operators and 20 people who were not gas station operators. The total sample was 40 people. The characteristics of the research subjects are presented in table 1.

Table 1 shows that the average age, gender, duration of working time, and TDI scores between both groups were not significantly different (p>0.05). Measurement of olfactory function was obtained by taking the lowest score on one nose, where subjects with normosmia were found in 26 (65%) people, hyposmia in 8 (20%) people, and subjects with anosmia as many as 6 (15%) people. No significant baseline olfactory function difference was observed between both groups.

Table 1. Demographic Data and Characteristics of the Sample

Variable	Mean		P-value
	Operator (n=20)	Non-operator (n=20)	
Age (years)	32.80±5.72	33.25±4.66	0.268
Sex			
Male (n)	10	7	0.473
Female (n)	10	13	
Working Time (months)	32.60±21.60	33.25±25.23	0.264
TDI Score			
Threshold (T)			
Right	11.46±2.83	10.37±4.61	0.736
Left	11.65±3.18	10.22±4.40	
Discrimination (D)			
Right	9.55±2.01	9.05±3.18	0.389
Left	9.55±2.25	8.90±3.61	
Identification (I)			
Right	9.75±1.86	9.05±1.73	0.582
Left	9.80±1.82	9.00±2.29	
Total Score			
Right	30.71±5.42	28.57±7.97	0.468
Left	30.98±6.13	28.01±9.10	
Olfactory Function			
Normosmia (≥30)	14 (70.0%)	12 (60.0%)	
Hyposmia (16-29)	5 (25.0%)	3 (15.0%)	0.637
Anosmia (≤ 15)	1 (5.0%)	5 (25.0%)	

Table 2 shows a significant difference in the average measurement of mucociliary transport time (p<0.05). At gas stations, staff who work as refueling operators, mucociliary transport takes longer than non-operators. There was also a significant difference in the mean of olfactory function based on the smallest TDI score, where the olfactory function of non-operator officers showed a better function than those who worked as operators (p<0.05).

Table 2. Comparison of Olfactory Function and Mucociliary Transport Time in Operators and Non-operators of Gas Station Officers

Variable	Officers **(**Mean ± SD)		***p**
	Non-operator	Operator	
Mucociliary Transport Time	7.36±0.66	11.62±2.78	**<0.001**
Olfactory Function	32.32±1.23	22.56±8.40	**<0.001**

*Independent-T test

A significant difference in the mean measurement of mucociliary transport time showed in table 3 (p<0.05), where gas station officers who work >12 months have more extended mucociliary transport than those who work <12 months. There was also a significant difference in the mean olfactory function, where the olfactory function of officers who worked <12 months showed a better function than those who worked >12 months (p<0.05).

Table 3. Comparison of Olfactory Functions and Mucociliary Transport Time based on the length of time Working at Gas Station Officers

Variable	**Working Time (**Mean ± SD)		***p**
	≤ 12 Month	> 12 Month	
Mucociliary Transport Time	7.39±0.75	10.89±3.02	**<0.001**
Olfactory Function	32.78±1.41	23.88±8.16	**<0.001**

*Mann-Whitney test

Table 4 shows significant correlation between the time of mucociliary transport and the length of time working with the olfactory function (p<0.05) with correlation coefficients -0.620 and -0.663, respectively; both show a strong negative correlation so that the longer the mucociliary transport time and the longer the working time at the gas station attendant, the olfactory function will decrease.

Table 4. Correlation between Length of Working Time and Mucociliary Transport Time with Olfactory Function in Gas Station Officers

Variable	**Olfactory Function**	
	r	**p**
Mucociliary Transport Time	-0.620	**<0.001**
Working Time	-0.663	**<0.001**

*Spearman-Correlation test

4. DISCUSSIONS

In this study, we measured mucociliary transport time and olfactory function in public gas station employees. Data on the characteristics of the research subjects showed that there were 26 (65%) subjects with normosmia, 8 (20%) hyposmia, and 6 (15%) subjects with anosmia. These results are supported by previous studies where the figures obtained are also almost the same. As many as 30 people (40.5%) of the total 74 subjects who work at gas stations experiencing olfactory problems.[4] Chronic exposure to fuel oil vapors containing volatile substances (benzene), toluene, ethylbenzene, xylene) can cause the release of substance P, which will then bind to the NK1 receptor (Neurokinin 1), which will trigger the formation of protein kinase C and subsequently cause mucous membrane hyperactivity. The detoxification process and chronic inflammation with a large number of neutrophils can cause damage to the olfactory cells and mucin glands which can cause olfactory disorders.[15]

In our study, we showed that there were significant differences in Mucociliary Transport Time and olfactory function between subjects who worked as operators and non-operators. External factors, namely pollutants, influence mucociliary transport.[16] Inhalation of chemical pollutants induces the release of proinflammatory cytokines. Can cause endothelial cells of surrounding blood vessels to appear adhesion molecules on the cell membrane. Inflammatory cells from the bloodstream into adhesion molecules are carried to the airways' interstitial tissue and ciliary epithelium. These cells then release inflammatory mediators, including reactive oxygen species (ROS), myeloperoxidase (MPO), prostaglandins (PG), and leukotrienes (LT). These mediators cause cellular dysfunction, disrupt cell contact and cell turnover of the basement membrane.[15]

Aldehydes and VOCs are chemical irritants, which cause the release of substance P (SP) from nociceptors of the respiratory mucous membrane. SP has a high affinity for interaction with NK1 receptors (Neurokinin1). Respiratory cells will release nerve growth factor (NGF), which increases nociceptors on the mucous membranes of the respiratory tract, thus causing hyperreactivity of the mucous membranes. Intracellular signal transduction of the NK1 receptor on NGF gene activation is not clearly defined, but there is strong evidence that protein kinase C (PKC) is involved. Lipophilic pollutants such as polycyclic aromatic hydrocarbons (PAH) can pass through cell membranes and bind to cytosolic aryl hydrocarbon (ArH) receptors; in addition, nuclear factor-kappa B (NF-κB) will activate genes for detoxification enzymes. This mechanism induces a chronic inflammatory reaction with large numbers of neutrophils.[15]

In addition, we also found that there was a significant difference between mucociliary transport time and olfactory function based on the length of time worked for gas station officers. There was also a significant correlation between mucociliary transport time and working time on olfactory function. This finding is supported by the theory of Riechelmann et al. Chronic inflammation of the nasal mucosa results in constriction of the nasal cavity, thereby reducing turbulence to the olfactory area, resulting in impaired olfactory transduction. The chronic inflammatory state of the nasal mucosa also disrupts the olfactory cells and mucin glands which are very important in the olfactory process.[15]

We suggest that companies should provide and require personal protective equipment in the form of masks to prevent olfactory function disorders due to exposure to fuel oil vapors and encourage operator officers to perform nasal irrigation after work. In addition, further research should measure the concentration of fuel oil vapor to assess the relationship between exposure to fuel oil vapor and olfactory dysfunction.

5. CONCLUSION

Our study shows that mucociliary transport time and olfactory function in non-operator public gas station officers are better than operators. There is a relationship between olfactory function disorders and mucociliary transport based on the length of work at the gas station operator. The longer they work, there is impaired the function and mucociliary transport.

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Conflict of Interest Statement:

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.