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The Correlation Between Length of Work and Nasal Mucociliary Transport Time of Gas/Fuel Station Workers

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Gasoline contains toxic substances such as benzene, toluene, ethylbenzene, xylene (BTEX) that negatively influence gas/fuel station workers' health via continuous inhalation, causing loss of cilia and epithelial cell necrosis of the nasal mucosa. The aim of this study is to determine the correlation between length of work with nasal mucociliary transport time (NMCTT) of the gas/fuel station workers

This study used a cross sectional design. The data were obtained from anamnesis, physical and NMCTT examinations of gas station workers in Yogyakarta, during November 2013. Inclusion criteria were: 1) 18-55 years old, 2) free of nasal topical medication for 10 days. Exclusion criterion: 1) acute rhinitis, 2) chronic sinusitis, 3) ever had nasal trauma, 4) ever had nasal surgery, 5) allergic rhinitis, and/or 6) septal deviation. Correlation analyses between length of work and NMCTT of gas station workers used Spearman correlation test with α 5% level of significance (p <0.05). From 38 subjects, 27 (71.1%) were men and 11 (28.9%) women. Median length of work was 7.37 years, and NMCTT: 10.84 ± 5.60 minutes. Spearman's correlation test results between length of work and NMCTT showed (R): 0.578 (p = 0.001).

Based on the results of this study, it can be concluded that there is a positive correlation between length of work with NMCTT of gas station workers.

INTRODUCTION

Consumption of fuel oil in Indonesia is very large. Motor vehicles for land transportation are reported to account for about 88% of all fuel consumption.[1,2] Fuel oil contains toxic chemicals such as benzene, toluene, ethylbenzene and xylene (BTEX), total petroleum hydrocarbon (TPH) and polycyclic aromatic hydrocarbon (PAH). Benzene exposure has the most serious impact on health.[3,4] The benzene content indoors and outdoors is higher near benzene emissions sources such as a gasoline station.[5]

In Indonesia, fuel distribution for motor vehicles is mostly through gas stations which are provided by PT. Pertamina.[6] Fuel station workers have a high risk of exposure to toxic chemicals in fuel oil. Primarily this exposure is through continuously inhalation of volatile fuel substances. The nose mucosal layer is the first-line of defense in clearing the inspiratory air from dust particles, bacteria, viruses and pollutants. This function is carried out by cilia and mucous blankets as the mucociliary system.[7,8]

Exposure to volatile benzene, toluene and xylene substances can cause ciliary loss and cell necrosis of the nasal mucous.[9,10] One study by Horasanli et al. (2015) found a correlation between length of work as an anesthesiologist exposed to volatile substances and nasal mucociliary transport time (NMCTT).[11] The aim of this study was to determine the correlation between length of work with NMCTT of the gas/fuel station workers.

MATERIALS AND METHODS

Study Population

This research is a cross-sectional study. The data were obtained from history/ anamnesis, physical, and gas station workers' NMCTT examination in Yogyakarta that were exposed to gasoline vapor during the period of November 2013. The study started after approval was granted by the Medical and Health Research Ethics Committee (MHREC) Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada. All subjects signed an informed consent form before participating in this study.

Based on anamnesis and routine Ear, Nose, and Throat clinical examination, the inclusion criteria for samples in this study were: 1) workers aged 18-55 years, and 2) free of topical nasal drugs in the last ten days. Exclusion criteria were: 1) patients with acute rhinitis, 2) chronic sinusitis, 3) history of nasal trauma, 4) history of nasal

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surgery, 5) history of suffered from allergic rhinitis, and 6) septal deviation based on routine Ear, Nose, and Throat clinical tests by anterior rhinoscopic examination.

All subjects were given a saccharin test to measure nasal mucociliary transport time (NMCTT), which is used as the standardized routine examination in Dr. Sardjito General Hospital. The saccharin test was administered by using the method as described by Andersen et al. (1974) and later modified by Rutland and Cole (1981) as cited in Baby et al. (2014). Saccharin tests are considered to be the standard method of measuring NMCTT. About 0.5 mm saccharin particle was placed approximately 1 cm behind the anterior edge of the inferior turbinate. The test is conducted in a sitting position with head fixed forward about 10 degrees to avoid the particle falling backwards into the posterior nasal stream. Patients should not be told about the nature of the particle. It is important not to place it too far anterior, as clearance time is forwards rather than backwards. The subject should be instructed not to snuff, eat, drink, or swallow, and avoid coughing and sneezing if possible. The room environment should be devoid of dust and must not be breezy. The time elapsing until the first experience of sweet taste at the posterior nasopharynx is recorded as NMCTT in seconds.[12]

The variables in this study were length of work, age, sex and smoking habit. Sample size was calculated using the formula for correlation study type with error type I (α) 5%, and error type II (β) 20%, based on research conducted by Horasanli et al. [11], with correlation assumption: 0.45, the minimum sample size needed was 38 samples.

Statistical analysis

The statistical test used in this study was Spearman correlation test with α 5% and statistical significance set as $p < 0.05$.

RESULTS

Spearman's correlation test results between the length of work and NMCTT of gas/fuel station workers obtained R = 0.578 with significance value p = 0.001, which means there was a positive moderate correlation strength that was statistically significant. Pattern of correlation between length of work and NMCTT gas/fuel station workers can be seen in the scatter diagram displayed in Figure 1.

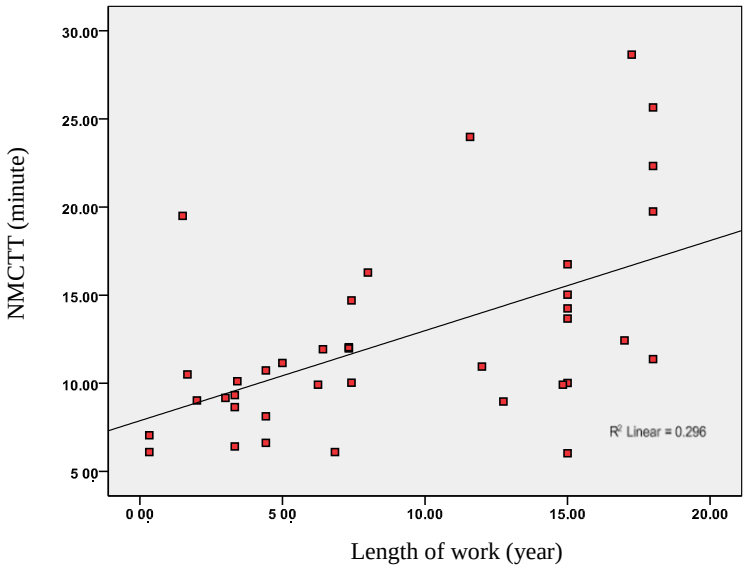

Figure 1. Long-time correlation screw diagram with mucociliary transport time

There were 38 subjects with 27 (71.1%) males and 11 (28.9%) females. Characteristics of the research subjects are displayed in Table I.

The mean age of gas/fuel station worker in this study was 31.5 years old, median value of working time was 7.37 year and the mean mucociliary transport time of gas/fuel station was 10.84 minutes as seen in Table II. Pandya and Tiwari reported that the NMCTT for adults of 18 to 60 years ranges from 5.6 to 13.4 minutes and the rate is 7.5 to 17.9 mm/minute.[13] The gas/fuel station worker labor time was eight hours per day with every week one dayoff. Each worker rotates the same turns to work a schedule in the morning, noon and night, thus each worker had the same probability of exposure to gasoline vapor.

Table I. Characteristics of research subjects

Characteristics	n	%
Sex:		
Male	27	71.1
Female	11	28.9
Smoking habit		
Yes	18	47.4
No	20	52.6

Table II. Measurement results of age, duration of work and mucociliary transport time

	Mean	Median	SD	Minimum	Maximum
Age (years)	33.42	31.50	8.03	20.00	50.00
Length of work (years)	9.08	7.37	5.97	0.33	18.00
NMCTT (minute)	12.51	10.84	5.60	6.03	28.65

SD = Standard Deviation

The correlations between age, smoking habits, length of work and NMCTT of gas/fuel station workers were analyzed by Spearman's correlation test. Table III displays the test results.

Table III. Correlation of age, smoking and duration of work with mucociliary transport time

Variable	Correlation coefficient	P value
Age (year)	0.450	0.005
Smoking habit	-0.233	0.159
Length of work (years)	0.578	0.001

$p<0.05$: statistical significance

DISCUSSION

This result is in accordance with a previous study that found a correlation between length of work as an anesthesiologist who was exposed to volatile narcotic substances during surgical procedures and NMCTT. The study determined the association of exposure to narcotic drugs with mucociliary transport time obtained a positive correlation (coefficient R= 0.45, p= 0.02).[11]

Inhalation of dry gases (such as occurring during mechanical ventilation in the operating room) can diminish ciliary function but can be anticipated with the addition of humidification to the inspired gas. Studies of respiratory secretions obtained from endotracheal tubes during elective surgery demonstrated no abnormalities in mechanical properties (e.g., viscoelasticity, rigidity), suggesting that mucociliary transport is altered via other mechanisms.[14]

Another study on subjects exposed to urban air pollution in Mexico also determined the evidence of a change in the nasal mucociliary defense mechanisms. The result of this in vivo study showed that there was weakened mucociliary activity, irregular mucociliary movement, dry nasal history and crusting.[15]

Further examination by electron microscopic showed the presence of particles which exhibit low mucociliary activity and deficiency of particle clearance. This lowered clearance has the potential for the intraepithelial particles accumulation associated with gas pollution.[16]

Gas station workers during filling the fuel into motor vehicle tanks can inhale gasoline vapor in large concentrations and may even exceed the safety threshold. One study by the WHO reported that concentrations of 3.2 mg/ m^3 (1 ppm) are present in the worker's respiratory zone, and even these benzene concentrations in the air are up to 27 mg/ m^3 at the time of refueling in cars.[5]

A study by Salim at a gas/fuel station in Jakarta reported the average benzene airborne concentration was 0.02 ppm, but long-term continuous exposure may present hazardous risks to health.[17] A modern charging gasoline process for cars at gas stations in Yogyakarta has not yet used a vapor recovery system, which is a system to prevent volatile gasoline evaporation from gas tanks or dispenser machines, so gasoline evaporation is still high.

Another problem faced by gas/fuel station workers in Indonesia is the regulation of the company which since 2006 has obligated workers to the Smile, Greetings Policy while serving customers. These obligations cause the gas/fuel station workers not to wear masks while filling the fuel into the motor vehicle tank. Based on this study result, if someone is exposed to benzene, toluene, ethylbenzene and xylene (BTEX), total petroleum hydrocarbon (TPH) and polycyclic aromatic hydrocarbon (PAH), they should use a special mask, for example for benzene with a concentration less than or equal to 10 ppm using a half mask respirator with an organic vapor cartridge. This lack of safety precautions puts gas station worker/operators at greater risk for exposure to irritating gas vapor that is an irritant to the mucosal airway thus prolonging the NMTT. Continuous and long-lasting exposure to gasoline may result in more intensive nasal mucosa layer damage which causes mucociliary transport time to extend in the fuel station workers.

Research reported that mucociliary transport was slower in regular smokers, and suggested that the exposure of nasal mucosa to cigarette smoke varies considerably depending on the type of cigarette and whether the smoke is exhaled by the nose or mouth. Ciliary dyskinesia includes a variety of temporary, acquired defects of ciliary movement, which can be caused by viral or bacterial infection or by air pollutants such as ozone, aldehydes or cigarette smoke. In the acute effect, this abnormality causes only temporary ciliostasis, while in the chronic effect, dehydration can make the periciliary liquid layer to shrink causing the cilia to become squeezed underneath the mucus layer impeding their movement. If the periciliary liquid layer gets increasingly thin, the mucin glycoproteins of the mucus will bind to the epithelial glycocalyx causing irreversible ciliostasis.[18]

In this study there was no statistically significant correlation between smoking habit and NMCTT. This finding is in accordance with the study by Stanley et al. that determined exposure of toxic products of tobacco smoke to the nasal mucosa is likely to vary considerably between smokers, depending on the number and type of cigarettes smoked and on smoking habits that determine acute or chronic effects.[19] In this study the number, type of cigarettes and whether the smoke is exhaled by the nose or mouth was not measured. In this study it can be concluded that there is a positive correlation between the length of work and nasal mucociliary transport time (NMCTT) gas/fuel station workers. This study has several limitations, among others, not measuring the concentration of gasoline vapor in the air of gas/fuel station environment, neither the average concentration nor when the operator filled the gasoline to the tank of motor vehicle. Gas station workers are advised to seek out periodic medical check-ups and use personal protective equipment such as a special mask that can filter out gasoline vapors and other air pollutants in the gas station environment.

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Key message: Gasoline contains toxic substances such as benzene, toluene, ethylbenzene, xylene (BTEX) that impact on gas station workers' health via continuous inhalation, which includes loss of cilia and epithelial cell necrosis of the nasal mucosa. There is a positive correlation between the length of work with nasal mucociliary transport time of gas/fuel station workers. Periodic medical check-ups and using personal protective equipment such as a special mask during work that can filter out gasoline vapors and other air pollutants are very important and needed for the safety and health of the gas station worker.

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