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Otolaryngology

THE CORELLATION OF CHLORINE EXPOSURE TO OLFACTORY DISFUNCTION IN X TEXTILE FACTORY'S WORKERS AT MEDAN

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ABSTRACT

Background: Textile factories are the main source of employment throughout the world. the textile industry is considered to be one of the most ecologically polluted industries, the use of chemicals such as chlorine found in textile factories can cause disruption of olfactory function.

Purpose: To determine differences in olfactory function in textile factory workers exposed to chlorine compared to textile factory workers who are not exposed to chlorine in textile factories in the city of Medan.

Method: The study was conducted in an analytical form with cross sectional research design. The research subjects were 64 people, consisting of 32 people exposed to chlorine and 32 people not exposed to chlorine which met the inclusion and exclusion criteria.

Result: Based on the results of the olfactory function examination the proportion of olfactory disorders was obtained by workers exposed to chlorine by 31.3% while those who were not exposed to chlorine by 0%. Significant relationship was obtained between length of work and impaired olfactory function ($p = 0.005$).

Conclusion: There are differences in olfactory function in textile factory workers exposed to chlorine compared to those not exposed to chlorine by using Sniffin 'Sticks Test in the city of Medan.

KEYWORDS : Chlorine, Olfactory Function, Sniffin Sticks Test, Textile Factory

BACKGROUND

Olfactory function impairment is one of the most significant health problems around the world. The prevalence of the disease in the United States was 13.9% and 31.7% in elderly people (with average of 60 – 90 years old). The prevalence of chronic olfactory impairment was estimated to reach 1.42% or amount to 2.7 million US citizens. Similar proportions were also found in Sweden and Germany. Siahaan et al. in 1995 reported that32.3% of patients in Rumah Sakit Cipto Mangunkusumo Jakarta came with olfactory problem as their chief complaint.[1-5]

Olfactory function disruption has been associated with the decline of quality of life. Generally, some of the most common etiologies of the impairment are chemical substances and industrial pollution. Many researches focused on the effects of chemical substances from the work environment on the olfactory function. In addition to directly damaging the olfactory mucosa, some toxins can cause inflammatory response, and also damaging central nervous system structurally and functionally.[6-9]

Although textile industry has created many opportunities for jobs and employment, it is also considered one of the biggest industry to produce great amount of pollutant and working in the industry has been also considered dangerous. In a study conducted in Yogyakarta, from 40 people who were exposed to chlorine, there were 10 people who had olfactory impairment, compared to only 2 people from the non-exposed group.[10-12]

Sniffin' sticks test is a technique to evaluate olfactory chemosensors. The advantages of the test were simple and the ability to examine subtests which are olfactory threshold (T), discrimination (D), and identification (I). The test has been used in more than 100 published studies.[13,14]

Considering the importance of early evaluation and identification of olfactory impairment, we were interested in studying the states of olfactory function in textile factory workers in Medan. They were chosen because of the risk of chlorine exposure among them was relatively high.

METHOD

This study was an analytic study with cross sectional design. It was held in textile factory in Medan from April until May 2018. The study population was all workers who worked in dipping, bleaching, and production process (exposed to chlorine) as well as those who worked in the engineering office and administration matters (not exposed to chlorine).

The inclusion criteria of the study were workers with the age of 18 – 60 years old, had been working for at least 6 months, did not have allergic rhinitis, did not have history of nasal tumor, CNS disease, and were willing to participate on the study. The exclusion criteria was workers who did not agree to participate. Samples were taken based on consecutive sampling technique, by which 32 people were included in each group. The groups were those who were exposed to chlorine and those who were not.

The studied variables were chlorine (as independent variable), olfactory function impairment (as dependent variable), and sociodemographic features such as age, sex, and years of service.

History taking was done to eliminate other factors besides chlorine exposure that could cause olfactory impairment. After It was done, we did physical examination to look for any olfactory impairment caused by mechanical obstruction, such as inflammation, polyp, tumor, septal deviation, and secretion products.

Olfactory threshold, discrimination, and identification were evaluated using the sniffin' sticks test. From the examination, we could determine the olfactory function score by adding up the three scores as ADI. ADI ≤ 15 for anosmia, 16-29 for hyposmia, and ≥ 30 for normosmia.

Data analysis was done using Statistical Package for Social Sciences (SPSS™) computer program. Olfactory threshold, discrimination, identification, and function variables were calculated to get average and standard deviation values from the olfactory function score. To evaluate the relationship of age, sex, smoking habit, and years of service with olfactory function impairment, we used chi square test. Bivariate data analysis with t-independent was done to study the olfactory functional differences between the exposed and non-exposed group.

RESULT

There were 64 people who participated in this study as samples,

divided into 2 groups based on chlorine exposure, each contained 32 people. There were more male workers in both groups, 28 people (87.5%) in the group exposed to chlorine, and 26 people (81.3%) in the other group. The age average of people in the group exposed to chlorine was 38.69 years old, while in the other group was 40.86 years old. The average of years of service in the group exposed to chlorine was 11.44 years with the least was 2 years and the longest was 29 years, while in the other group the average was 14.75 years with least was 3 years and the longest was 28 years. There was no significant difference in characteristics between two groups (p>0.05). This is shown in Table 1.

Table 1. Demographical Characteristics of Textile Workers

Demographical Characteristics	Exposure to Chlorine		p
	Yes (n=32)	No (n=32)	
Sex, n (%)			
Male	28 (87,5)	26 (81,3)	0,372a
Female	4 (12,5)	6 (18,8)	
Age (years)			
Average (SD)	38,69 (8,51)	40,88 (6,68)	0,257b
Min – max.	25 - 53	27 - 53	
Years of service (years)			
Average (SD)	11,44 (6,78)	14,75 (6,78)	0,052
Min – max.	2 - 29	3 - 28	

[a]Chi Square, [b]T Independent, SD= Standar Deviasi

From the subjects exposed to chlorine, we found the total score of ADI was 29.34 with SB=7.54. Based on the category, we found that 3 people (9.4%) suffered anosmia and 7 people (21.3%) suffered hyposmia.

Table 2.Olfactory Function of Textile Workers Exposed to Chlorine

Olfactory Function	Average (SB)	Minimum - Maximum
Threshold	10,09 (4.11)	1,75 – 13,25
Discrimination	9,16 (2,38)	3 - 13
Identification	10,09 (1,53)	6 – 12
ADI	29,34 (7,54)	12,75 – 37,75
Anosmia, n (%)	3 (9,4)	
Hyposmia, n (%)	7 (21,9)	
Normosmia, n (%)	22 (68,7)	

From the subjects without exposure to chlorine, we found the total of ADI score was 32.66 with SB=1.70. Based on the category, we found that all the samples from the group had normal olfactory function.

Table 3. Olfactory Function of Textile Workers without Exposure to Chlorine

Olfactory Function	Average (SB)	Minimum - Maximum
Threshold	11,51 (1,38)	8,5 – 14,25
Discrimination	10,78 (1,10)	9 – 13
Identification	10,37 (1,10)	8 – 13
ADI	32,66 (1,70)	30 – 36,25
Anosmia, n (%)	0	
Hyposmia, n (%)	0	
Normosmia, n (%)	32 (100)	

From the total ADI, the proportion of samples with olfactory function was much higher in the group exposed to chlorine compared to the other group with the ratio of 31.3% by 0%. Analytic result using Fischer's exact test showed significant relationship between chlorine exposure and olfactory function impairment (p=0.001).

Table 4. Relationship between Chlorine Exposure and Olfactory Function Impairment in Textile Workers

Chlorine Exposure, n (%)	Olfactory Function Impairment		p*
	Yes	No	
Yes	10 (31,3)	22 (68,7)	0,001
No	0	32 (100)	

**Fischer's Exact*

The average years of service of the people with exposure to chlorine who had olfactory function impairment was 16.10 years with SD=6.06 years, while in those without impairment was 9.32 years with SD=5.77 years. T-independent test showed there was significant relationship between years of service and olfactory function impairment in workers exposed to chlorine.

Table 5. Relationship between Years of Service and Olfactory Function Impairment in Textile Workers Exposed to Chlorine

	Olfactory Function Impairment		p
	Yes (n=10)	No (n=22)	
Years of service, average (SD)	16,10 (6,06)	9,32 (5,77)	0,005

In the group of people exposed to chlorine, we found significant correlation between years of service and ADI score (p=0.001) using Spearman correlation test. The level of correlation produced was moderate with negative value (r=-0.558) which meant the longer the years of service would be followed by decrease in ADI score. In the group of people without exposure to chlorine, there was no significant correlation between years of service and ADI score (p=0.121).

Table 6. Relationship between Years of Service and Total ADI Score

		ADI Score	
		P	r
Years of service	Exposed to chlorine	0,001a	-0,558
	Not exposed to chlorine	0,121b	-0,280

[a]Spearman, [b]Pearson

From 54 male workers, there 10 people (18.5%) who had olfactory function impairment, while there was not any female who did. Analysis using Fischer's exact test showed there was no significant relationship between sex and olfactory function impairment (p=0.340).

Table 7. Relationship between Sex and Olfactory Function Impairment

Sex, n (%)	Olfactory Function Impairment		p*
	Yes	No	
Male	10 (18,5)	44 (81,5)	0,340
Female	0	10 (100)	

**Fischer's Exact*

From 4 workers with the age of <28 years old, there was only 1 person (25.%) who had olfactory function impairment, while there were 9 people (15.%) with the age of ≥ 28 years old who had olfactory function impairment. Analysis using Fischer's exact test showed there was no significant relationship between age and and olfactory function impairment (p=0.502).

Table 8. Relationship between Age and Olfactory Function Impairment

Age, n (%)	Olfactory Function Impairment		p*
	Yes	No	
< 28 years	1 (25)	3 (75)	0,502
≥ 28 years	9 (15)	51 (85)	

**Fischer's Exact*

DISCUSSION

There were 32 people in each group based on the exposure to chlorine, with the total of 64 people participated in the study. In the study subjects exposed to chlorine, the ADI score was 29.34. Based on olfactory function category, we found 3 people (9.4%) with anosmia and 7 people (21.3%) with hyposmia, while from the group without chlorine exposure the total ADI score was 32.66. This finding was similar with a previous study by Sunderman W et al. (2001) that showed from 73 battery factory workers in England exposed to cadmium, 26% had hyposmia and 1% had anosmia. Another study, conducted by Purnomo (2014), showed olfactory function impairment within the group with chlorine exposure existed in 10 people (25%) and normal function was found in 30 people (75%).[15,16]

There was a significant difference of proportion based on olfactory function impairment between the two groups, with 31.3% in the exposed group compared to 0% in the other group, with Fischer's exact test resulted p=0.001. This finding is supported by the theory which stated that chlorine exposure will trigger inflammation, necrosis, and apoptosis, increasing reactive oxygen species (ROS). This ROS mediator will cause cellular dysfunction, disrupt cell communication,

and cell regeneration from basal membrane. Chlorine exposure also increases intracellular IP_3 which causes an increase in calcium concentration as a result from release from the intracellular. The change in the calcium concentration in the cytosol can trigger apoptosis which further will cause olfactory neuroepithelium tissue and olfactory bulb damage.[17,18]

Analysis on this study showed that there was no significant relationship between age and olfactory function impairment (p=0.502). Age is closely associated with olfactory function impairment, where the functional decline generally happens starting from between the 5th and 6th decade of life and more significantly by the 7th decade. In a previous study conducted by Ulhaq, Tahir, and Ione (2008) on 30 human cadavers, they found the decrease in the number of mitral cells of the olfactory bulb and its nuclei size concomitant with aging. This is considered as the reason for the decline of olfactory function in human. The theory can be applied generally and in our study, the subjects with the age of < 60 years old had been excluded to prevent bias which was dysfunction caused by degeneration.[19,20]

Results from this study showed there was no significant relationship between sex and olfactory function impairment (p=0.340). Similar finding was also found by Adams (1961) in his study on battery factory workers where the proportion of people with olfactory function impairment based on sex between male and female was 15%:0%. In a study conducted by Fathoni (2014) on the workers of gas stations, it was found that there were more males with olfactory function impairment than females with the proportion of 27%:13.5%.[21,22]

Results from those studies are opposite to the theories stated by Cummings (2005), where test on humans showed that females had better olfactory function than males, whether in threshold or identification, but in certain particular smells, however, there was no difference between them. In addition, menstrual cycle affects female olfactory threshold, best during ovulation and worst during menstruation.[23]

As stated before by Majid (2017), besides hormones, brain anatomy difference can also cause functional difference between male and female. In his study, postmortem examination on olfactory bulb cells was done, and the result was females had more neurons than males, and the number of cells correlates with olfactory function. However, in the same study, the relationship between olfactory function and anatomical structures was also examined, but there were no difference in the ability of olfaction between two sexes.[24]

In our study, we found the average of years of service in samples with olfactory function impairment was 16.10 years (SB=6.06 years), while in samples without olfactory function impairment was 9.32 years (SB=5.77 years). Analysis showed there was a significant relationship between years of service and olfactory function impairment (p=0.005). This finding was supported by the theory by Takeuchi (2004), which stated that chronic exposure of toxic substances, that is going more than 6 months, even with low concentration, can cause chronic effects on workers, where in his case exposure of metal dust caused olfactory function impairment to the workers.[25]

CONCLUSION

Based on olfactory function examination with sniffin' stick test, the average of olfactory threshold, discrimination, and identification were lower in subject who were not exposed to chlorine and the proportion of olfactory function impairment in the group with exposure to chlorine was much higher than the other group without the exposure. All workers who were not exposed to chlorine had normal olfactory function, while some of the workers exposed to chlorine had hyposmia and anosmia. There was a significant relationship between age and sex with olfactory function impairment.

Suggestion

We suggest educational counseling on the importance of the effects from chlorine exposure on the olfactory function impairment and regular checkup should be done as preventive action as well as early detection and adequate therapy of olfactory function impairment. Companies should provide protective equipment for their workers, especially for textile production companies. Future researches with bigger and wider number of samples should be conducted and include other variables that could cause olfactory function impairment.

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