

The Effect of Toluene Exposure on Central Nervous Disorder among Printing Workers

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ABSTRACT

Background: The use of toluene in printing dominates the use of metal chemicals. Toluene is used in 75% of printing work activities. Accumulation of toluene concentrations in printing can cause health problems to workers. The purpose of this study was to analyze the effect of toluene exposure on central nervous system disorders in printing industry workers.

Subjects and Method: This study was cross sectional in the printing industry in Medan, North Sumatra. The population consists of 50 people with consecutive sampling technique sampling. Data on subjective symptoms of central nervous system disorders were measured by the German version of the Q18 questionnaire. The data were analyzed using multiple logistic regression tests.

Results: Subjective symptoms of central nervous system disorders increased with tenure ≥ 2 years (OR = 4.19; $p = 0.018$) and smoking (OR = 8.91; $p = 0.001$). Subjective symptoms of central nervous system disorders decreased with age ≤ 30 years (OR = 0.17; $p = 0.004$), female sex (OR = 0.50; $p = 0.002$).

Conclusions: The most dominant variable affecting the subjective symptoms of central nervous system disorders is the smoking habit variable with a probability value of 0.92 or 92%.

Keywords: subjective symptoms, central nervous system disorders, workers, printing industry

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BACKGROUND

Organic solvents are widely used in printing activities, in addition to lead, copper, and other metals. The organic solvent used is toluene. Toluene ($C_6H_5CH_3$) is a non-corrosive folateil liquid that has a smell like benzene. Workers who use toluene as a solvent cause health problems, such as dizziness, vertigo, eye irritation, skin irritation, respiratory, liver, kidney, and central nervous system disorders (Agency for Toxic Substances and Disease Registry, 2000). The use of toluene in printing dominates the use of metal chemicals. Toluene is used in 75% of printing

work activities. The biggest use of toluene is in automatic cleaning, which is around 50-200 ppm (Svendsen and Rognes, 2000). Toluene is declared safe for the environment and health if it does not cross the threshold. The toluene threshold in the environment is around 50 ppm (American Conference of Industrial Hygienists, 2005). According to Ministerial Regulation No. PER.13/MEN/X/ 2011, the toluene threshold value is 188 mg/m³.

Nervous disorders due to toluene exposure consist of two types, neurotoxic and neuropathy. The prevalence of neuropathy due to exposure to organic solvents

is greater than neurotoxic. Ropper (2000) defines neuropathy as a clinical symptom due to peripheral nerve abnormalities, extensive non-inflammatory regeneration with symptoms of motor weakness, sensory disorders, autonomic nerves, and weakening of tendon reflexes.

Neuropathy due to toluene exposure that often arises is peripheral nerve neuropathy. Collective peripheral nerve neuropathy is available in 2.4% of the world population (Martyn, 1998). Neuropathic pain is defined as sensory pain or discomfort due to lesions or diseases associated with the somato-sensory nervous system (International Association for the Study of Pain, 2011). The prevalence of neuropathy pain is higher than the prevalence of peripheral nerve neuropathy, which is about 3% of the world's population (Gilron et al., 2006). The presence of peripheral nerve neuropathy and its manifestations (neuropathic pain) in workers disrupts work activities. Offset work is less than optimal. This is compounded by exposure to organic solvents which are the cause of neuropathy.

In Germany, diseases due to chronic exposure to solvents associated with neurotoxic chemicals have been included in the list of occupational diseases since 1997. Because many subjective complaints indicate this disease, early recognition is very important, especially in the workplace with exposure to neurotoxic, sensitive, specific chemicals and practical screening equipment is needed.

Ihrig et al. (2001) concluded that the German version of the Q18 questionnaire was a sensitive and reliable screening questionnaire for complaints related to solvent exposure, but not reliable enough for individual diagnosis. The researcher

also distinguished the questionnaire cut-off point by sex for both men and women. For men, the recommended cut-off point for five or more complaints on the German version of the Q18 questionnaire, while for women, the cut-off point for six or more complaints is recommended as the starting point for further evaluation (Ihrig, et al, 2001). After conducting the initial survey, no workers used masks during work. Of the 6 sample points studied, most experienced several health complaints such as frequent dizziness, sore eyes, disturbances in breathing, and hallucinations.

Based on the description above, the researchers want to conduct a study on the relationship of toluene exposure to subjective symptoms of central nervous system disorders in printing workers in Medan.

SUBJECT AND METHOD

This was an analytic observational study with a cross sectional design. The study was conducted in 6 printing industries in Medan. An examination of ambient air samples for toluene measurements was carried out at the Medan K3 Hall Laboratory.

A sample of 50 workers was selected by consecutive sampling. Data on subjective symptoms of central nervous system disorders were measured using the German version of the Q18 questionnaire.

RESULTS

1. Sample Characteristics

Table 1 showed sample characteristics. Table 1 showed that most of the study subjects were at age <30 years (62%) and male gender (76%). As many as 29 workers had tenure less than 2 years. As

many as 70% workers had toluene exposure more than 8 hours/day.

As many as 17 workers (34%) were smokers. A worker (2%) alcohol consumer

and as many as two workers (4%) consumed drugs. As for the use of PPE, there were 43 respondents (86%) who did not use PPE.

Table 1. Sample Characteristics

Variables	n = 50	%
Age		
<30 years	31	62
≥30 years	19	38
Gender		
Male	38	76
Female	12	24
Tenure		
≤2 years	29	58
>2 years	21	42
History of Disease		
No	16	32
Yes	34	68
Smoking		
Yes	17	34
No	33	66
Alcohol drink consumption		
Yes	1	2
No	49	98
Drugs use		
Yes	2	4
No	48	96
PPE use behavior		
Yes	43	86
No	7	14
Exposure time		
> 8 hours	35	70
≤ 8 hours	15	30

Table 2. The Toluene level

Variable	Mean	SD	Min.	Max.	CI (95%)	p
Toluene level	6.97	13.04	0.019	34.46	3.27-10.68	0.001

2. Toluene level

Table 2 described the toluene level in printing industry in Medan. Table 2 showed that the average toluene level was 6.97 mg/m³ with the lowest level was 0.019 mg/m³ and the highest level was 34.46 mg/m³.

3. Subjective Symptoms of Central Nervous System Disorders

Table 3 showed frequency distribution of subjective symptoms of central nervous system disorders among printing workers. Table 3 showed that mostly printing workers did not experience subjective of central nervous system disorders (62%).

Table 3. Frequency Distribution of Subjective Symptoms of Central Nervous System Disorders among Printing Workers

Subjective Symptoms of Central Nervous System Disorders	N	%
No	31	62
Yes	19	38

Table 4. The Results of Chi Square Test

Independent Variables	Symptoms of CNS Disorders				OR	CI 95%	p
	Positive		Negative				
	n	%	n	%			
Age							
≤30 years old	7	22.6	24	77.43	0.17	0.05 to 0.60	0.004
>30years old	12	63.1	7	6.9			
Gender							
Male	19	50	19	50	0.50	0.36 to 0.69	0.002
Female	0	0	12	100			
Tenure							
> 2 years	12	57.1	9	42.9	4.19	1.25 to 14.09	0.018
≤2 years	7	24.1	22	75.9			
Smoking							
Smoke	12	70.6	5	29.4	8.91	2.34 to 33.91	0.001
Did not smoke	7	21.2	26	78.8			
Alcohol Consumption							
Yes	0	0	1	100	1.63	1.31 to 2.04	0.429
No	19	38.8	30	61.2			
Length of toluene exposure							
> 8 hours/day	15	42.9	20	57.1	2.06	0.55 to 7.77	0.280
≤8 hours/day	4	26.7	11	73.3			
Drug Consumption							
Yes	0	0	2	100	1.66	1.32 to 2.08	0.258
No	19	39.6	29	60.4			
PPE use							
Yes	1	14.3	6	85.7	4.32	0.48 to 39.07	0.163
No	18	41.9	25	58.1			
History of Disease							
Yes	13	38.2	21	61.8	1.03	0.30 to 3.52	0.960
No	6	37.5	10	62.5			

4. Bivariate analysis

Table 4 showed the result of bivariate analysis using Chi square test. Table 4 showed that age <30 years old (OR= 0.17; 95% CI= 0.05 to 0.60; p= 0.004) and gender (OR= 0.50; 95% CI= 0.36 to 0.69;

p= 0.002) decreased the risk of subjective symptoms of central nervous system disorders among printing workers. These relationships were statistically significant.

Tenure >2 years (OR= 4.19; 95% CI= 1.25 to 14.09; p= 0.018) and smoking

(OR= 8.91; 95% CI= 2.34 to 33.91; $p=0.001$) increased the risk of subjective symptoms of central nervous system disorders among printing workers.

Alcohol consumption (OR= 1.63; 95% CI= 1.31 to 2.04; $p=0.429$), toluene exposure >8 hours/day (OR= 2.06; 95% CI= 0.55 to 7.77; $p=0.280$), drug consumption (OR= 1.66; 95% CI= 1.32 to 2.08; $p=0.258$), did not use PPE properly (OR= 4.32; 95% CI= 0.48 to 39.07; $p=0.163$), and had history of disease (OR= 1.03; 95% CI= 0.30 to 3.52; $p=0.960$) increased the risk of subjective symptoms of central nervous system disorders among printing workers, but these rela-

tionships were statistically non-significant.

5. Multivariate analysis

Table 5 showed the results of multivariate analysis. Table 5 showed that smoking was positively and statistically significant associated with subjective symptoms of central nervous system disorders among printing workers ($b=5.18$; $p=0.042$).

Age <30 years old ($b=0.27$; $p=0.163$), tenure ($b=1.41$; $p=0.692$), PPE use ($b=0.56$; $p=0.737$), and length of toluene exposure <8 hours/day ($b=0.32$; $p=0.317$) were positively and statistically non-significant associated with subjective symptoms of central nervous system disorders among printing workers.

Table 5. The effects of age, gender, tenure, smoking, PPE use, and toluene level on subjective symptoms of central nervous system disorders

Independent Variables	b	p
Age	0.27	0.163
Gender	4.35	0.999
Tenure	1.41	0.692
Smoking	5.18	0.042
PPE use	0.56	0.737
Length of toluene exposure <8 hours/day	0.32	0.317

DISCUSSIONS

Based on the results of the study by using the German version of the Q18 questionnaire, it was found that there were 19 people who experienced subjective symptoms of central nervous system disorders.

1. The relationship between age and the risk of subjective symptoms of central nervous system disorders among printing workers

The results of this study showed that age <30 years old was positively but statistically non-significant associated with subjective symptoms of central nervous system disorders among printing workers

Age was an important variable in the case of subjective symptoms of central nervous system disorders. The ability of the organs of the body would decrease naturally with increasing age. A study by Gamble (2000) stated that age 20-24 years old showed an increase in the incidence of neurobehavioral disorders due to solvent exposure and continued to be constant until the age of 40 years old, then subsequently decreased.

A study by Rusdy (2012) showed a negative relationship between age and neurotoxic incident ($r=-0.01$), but it was statistically non-significant ($p>0.050$). This was due to the majority of the study

subjects aged 30-40 years old and neurotoxic symptoms that were felt to be subjective, most of them did not understand the associated neurotoxic symptoms.

2. The relationship between smoking and the risk of subjective symptoms of central nervous system disorders among printing workers

The results of this study showed that smoking was positively and statistically significant associated with subjective symptoms of central nervous system disorders among printing workers.

The results of this study were in line with a study by Ovina (2013) which reported that there was a significant relationship between smoking habits and the prevalence of non-hemorrhagic stroke in the Neurology Poly of Raden Mattaher Hospital.

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