The Relationship Between Benzene Vapor's Exposure and Immunoglobulin a Among Shoes Worker in the Village of Tambak OSO Wilangun Surabaya

Herlina Novita Hasyim1, Abdul Rohim Tualeka[1], Noeroel Widajati[1]
[1]Departement of Occupational Health and Safety, Airlangga University, Surabaya Indonesia

ABSTRACT

Glue is one of the most important ingredient in the making of shoes, that it contains an organic solvent which is benzene. Benzene solvent in glues known by 1-2%. Benzene is known asa carcinogen category A1,confirmed human carcinogen, meaning that benzene has been ascertained and proven carcinogen in humans. Chronic exposure to benzene affects on cellular and humoral immunity. Benzene evaporates into the air very quickly allowing to be inhaled by workers. The purpose of this study are(1) to measure the levels of benzene vapor in the work environment, (2) to determine the concentration of A Immunoglobulin among workers and (3) to determine the relationship between benzene vapor exposure and workers' IgA concentration. The method used to measure the levels of benzene vapor in the workplace was gas chromatography method using GC / FID (Flame Ionization Detector) and to determine the concentration of A Immunoglobulin, venous blood sampling was done and then analyzed by Immunoturbidimetric Assay.

Benzene vapor's levels of shoes workers in workplacewas varied, from 0.0129 ppm to 2.3330 ppm which was 0.5116 ppm in average and IgA concentration experienced a value of 0.86 mg/ml to 3.80 mg/ml. Pearson product moment test was conducted on worker characteristics (age, year of service), Spearman's rank test on nutritional status and contingency coefficient C test for gender and smoking habits with IgA concentration of workers obtained all the variables had a value of p> 0.05.

The result showed that the IgA concentrations among workers which were 8 workers noted as under normal (<2 mg/ml) and 8 workers experienced a normal IgA concentration (2-3 mg/ml) while 4 others were above normal (> 3 mg/ml) with ppm benzene levels 0.0129 - 2.3330 ppm and average levels of benzene in the air amounted to 0.5116 ppm>TVL (0.5 ppm). In conclusion, twelve workers witnessed an abnormal IgA concentration (decrease / increase of the normal value).

Keywords: *Shoes Worker, Benzene, Glue, Iga Concentration.*

INTRODUCTION

Three main toxin in the shoe industry are benzene, toluene and xylene (BTX). Among those three toxin, benzene has a higher health risk than two other toxins. Benzene is a carcinogen category A1 (confirmed human carcinogen), while toluene and xylene are noted as the category A4 (not classifiable as a human carcinogen). This means that benzene has been ascertained and proven human carcinogen [(1,15).] In the shoe industry, benzene is used as a solvent glue latex. The glue used to glue the parts of the shoe, especially shoe soles. The organic solvent toluene solvent in glues containing more than 70% and solvent benzene is about 1-2%.

Indonesia sets a Threshold Limit Value (TVL) for benzene of 0.5 ppm which is according to the regulation of the Minister of Manpower and Transmigration No. PER.13 / MEN / X / 2011 in 2011 on Threshold Limit Values Physics and Chemistry Factors at Work [(13).]

Research among 79 workers in 5 shoes workshops in PIK Region Pulogadung obtained RQ> 1 (RQ realtime RQ lifetime 66% and 46%) and ECR> 10^{-4} (ECR realtime and a lifetime 100%). This means that workers in the shoe's repair shop have a risk to get the effect of non-cancer and cancer due to exposure to benzene at work even though the concentration of benzene under the

TVL that the Indonesian authorities. In average, the concentration of benzene in five shoe's repair shops is 0.2 mg/m3 (0.06 ppm) of three shops while others are 0.0194 mg/m3 (0.0293 ppm) and 0.1298 mg/m3 (0.04 ppm) [14].

In a study conducted byKurniawidjaja L Meily et al, (2012)[8]concerning respiratory complaints and health risk analysis BTX exposure to workers in the informal footwear workshops in Ciomas, Bogor regency obtained a mean grade of 1.40 ppm benzene vapor among 21 workers (63.03 %) complained of respiratory problems.

Research of Maywati Sri (2012)[11]showed that 57 workers in gluing in sandals industry Tasikmalaya obtained benzene vapor levels ranging from 0.138 ppm - 6.271 ppm. Most workers (35 or 61.4%) let alone the affected body part glue or delay cleaning up until it was completed.

Interviewed research conducted by Maryiantari (2016)[10] at RW 2 in the village of TambakOsoWilangun Surabaya showedmost of workers complaints was about respiratory distress, coughing and shortness of breath which was 16 people (31.4%) and colds that noted 15 people (29.4%). While complaint about central nervous system (CNS) disorder widely perceived by the workers was headache 35 people (68.6%), fatigue 33 persons (64.7%) and drowsiness 30 people (58.8%). In addition, most workers feel headaches 2-3 times a week.

The clinical effects of benzene systemically causes disturbances in the cardiovascular, respiratory, neurological, gastrointestinal, liver, kidney, endocrine and reproductive system, dermatology, local effects, hematological, immunological, metabolic and allergic reactions. In chronic exposure of benzene showed effects on cellular and humoral immunity [2,5,12,4].

To learn and anticipate the continued effects resulting from exposure to benzene and refers to various cases in the world in respect of the use of benzene, it is deemed important to see if the same thing applies to the middle of the shoe craftsmen in the village of Tambak OsoWilangun Surabaya. To see it, there should be a study to analyze the relationship between exposures to benzene vapor in particular concentration of A Immunoglobulin (IgA) at the shoes workers in the village of TambakOsoWilangun Surabaya.

MATERIAL AND METHOD

Research design

This study used cross sectional design to measure the levels of benzene in the air with a concentration of A Immunoglobulin among shoes workers.

The place and time of the study

This research was conducted in the home shoe industry in TambakOsoWilangunSurabaya and implemented in November 2016.

Research subject

Subjects of this study was 20 workerswho were healthy, not pregnant and not an alcoholic.

Questionnaires

Questionnaires were distributed to the shoes workers to obtain biographical data and other information.

Measurement of levels of benzene in the air (work environment).

Benzene concentration in the workplace was measured in eight points in seven locations of shoes workers ofTambakOsoWilangun Surabaya. All the measurements performed during the day at 12.00-14.00 PM considering that this time is the peak time of using glue, the temperature is quite high and causing benzene in glue evaporates quickly, so it easily captured the vacuum of air (vacuum pump)[9]. The chosen location was the work site where normallygluing conducted. Measurement of thebenzene concentration in the workplace carried out using the measurement method NIOSH 1501 with pipe material activated carbon absorber (charcoal) using Cromatography Gas Flame Ionisation Detector (GC-FID) techniques.

Measurement of concentrations of IgA

Venous blood was drawn as many as 3 cc and collected in EDTA tubes. Samples were then centrifuged

and the resulting blood serum samples. Examination of serum IgA were calculated using Immunoturbidimetric Assay.

FINDINGS

This study used shoes workers who werestay in site of shoes manufacturing as respondents. Shoes workers in TambakOsoWilangun usually glued by using their fingers, without any personal protective equipment or gloves, so that the solvent benzene in glue can enter through the skin. The air temperature of the workplace was high and the smell of glue fumes are so terrible, the workers also did not use a mask so that the glue vapor can be inhaled and enter through inhalation (respiratory). In fact, most workers were shirtless while smoking or even eat in that place. While the resting time, they took a rest and slept in there. Worker characteristics obtained from the questionnaire can be seen in Table 1 below:

Tabel 1. Worker characteristics

No	Variable	characteristics	Result	
			n	%
1	Age	min (23 years)	-	-
		max (63 years)	-	-
		Mean (46,6 years)	-	-
2	Gender	Male	10	50
		Female	10	50
3	Year of service	min (2,5 years)	-	-
		max (43 years)	-	-
		Mean (25,57 years)	-	-
4	Nutritional status (BMI)	thin (<18.5)	1	5
		normal (18.5 - 25)	9	45
		obese (> 25)	10	50
5	Smoking habit	Smoker	8	40
		Not smoker	12	60

Information :*BMI (Body Mass Index) is the ratio of weight (kg) by the square of height (meters).

Analysis of the relationship between benzene vapor concentration in the air and IgA concentrations in the blood of workers can be seen in Table 2.

Table 2. Levels of benzene vapor in the air with the concentration of immunoglobulin A (IgA) in the blood of workers

Workplace	Level of benzene vapor	IgAconcentration		
		< 2 mg/ml	2-3 mg/ml	> 3 mg/ml
1	0.3975	2	2	0
2	0.0129	2	1	0
3	0.3503	1	1	1
4	0.0193	0	2	0
5	0.9129*	0	0	1
6	2.3330*	2	0	0
7	0.0182	1	1	1
8	0.0485	0	1	1
Total	4.0926	8	8	4
Mean	0.5116	0.4	0.4	0.2

* Exceeding TVL levels of benzene according to Permenakertrans 13 / MEN / X / 2011 of 0.5 ppm.

Table 2 showed the IgA concentrations among workers which were 8workers noted as under normal (< 2mg/ml) and 8 workers experienced a normal IgA concentration (2-3 mg/ml) while 4 others wereabove normal (>3 mg/ml) with ppm benzene levels 0.0129 - 2.3330 ppm and average levels of benzene in the air

amounted to 0.5116 ppm>TVL (0.5 ppm). In conclusion, 12workers witnessed an abnormal IgA concentration (decrease / increase of the normal value).

To determine the relationship between the dependent variable (the concentration of IgA) and independent variables (levels of benzene in the air), a qualitative analysis was conducted by frequency distribution table while to know the relationship between the dependent variable (the concentration of IgA) and independent variables (the characteristics of workers), some analysis were used which were Pearson product moment (age, year), spearman's rank test (nutrition) and test contingency coefficient C (gender, smoking habits). All variables have a value of p>0.05, as shown in Table 3. This shows that there is no significant relationship between all the variables with a concentration of IgA.

Tabel 3. The results of worker's characteristics test by a concentration of ImmunoglobulinA (IgA) of worker's blood (α = 0,05).

No	Variabel	P value	Information
1	Age	0,489	Unsignificant
2	Gender	0,395	Unsignificant
3	length of employment	0,821	Unsignificant
4	Nutritional status (BMI)	0,056	Unsignificant
5	Smoking habit	0,395	Unsignificant

Table 3.shoesworker characteristics (age, sex, length of employment, nutritional status and smoking habits) did not have a significant relationship with the concentration of IgA in the blood of workers due to the value of p> α = 0.05.

The result of the calculation of non-carcinogenic risk characteristics (RQ) and carcinogenic risk characteristics (ECR) on all 20 workers are as shown in Table 4.

Table 4. Distribution of RQ and ECR in the shoes workers in the village of Tambak Oso Wilangun in November, 2016.

		Amount		Total
		person	%	
RQ	RQ ≤ 1	7	35	20
	RQ > 1	13	65	
ECR	ECR ≤ 1	5	25	20
	ECR > 1	15	75	

Based on the calculation of RQ and ECR in all 20 workers was obtained RQ > 1 at 65% and ECR > 1 by 75%, meaning that 65% of workers have exposure non-cancer effects due to benzene exposure and 75% of workers at risk of cancer due to benzene exposure.

This study showed that age, gender, length of employment, nutritional status and smoking habits of workers is not related to the concentration of IgA. By the analysis of the relationship benzene vapor concentration in the air with IgA concentrations in the worker's blood obtained average levels of benzene in the air amounted to 0.5116 ppm>TVL (0.5 ppm) and there were 12workers who have an abnormal IgA concentration. 8 of those experienced a decreased IgA concentration while others were increased.

In line with the research of BogadiSare et al (2000)[3]among women workers in the shoe industry concluded that there was a decrease in the concentration of IgA in workers exposed to benzene (below 15 ppm) compared to the control group, although not showed a significant correlation and confounding factors (age, duration of exposure and the smoking habits) does not affect the value of immunoglobulin. Studyof Kirkeleit J et al (2006)[7] also concluded the same thing on the oil tank working with benzene concentrations between 0.01 to 0.62 ppm which the concentration of IgA oil tank workers has decreased compared to the control group and the absence of a relationship between smoking and duration index exposure to benzene at a concentration of IgA. Similarly, Khadiga Ibrahim S. et al (2014)[6]concluded that workers who were exposed to benzene painting showed a decrease in IgA concentrations than the control group that was not exposed to benzene.

Despite the age, sex, length of employment, nutritional status and smoking habits of workers do not have a significant relationship with the concentration of IgA in the blood of workers, but shoes workers in the village of Tambak Oso Wilangun Surabaya has the effect of exposure to non cancer by 65% (13 of 20 workers have the effect of exposure to non-cancerous) and 75% (15 of 20 workers) at risk of cancer due to benzene exposure.

This study using environmental monitoring to measure exposure to benzene in the workplace, where the environmental monitoring cannot measure the amount of benzene exposure on each worker. Further research may be able to use monitoring personal such as the measurement of benzene by breathing zone or biological monitoring benzene exposure to test S-phenylmercapturic (S-PMA).

CONCLUSION

1. The average air levels of benzene in the workplace ofhome shoe industry ofTambakOsoWilangun Surabaya witnesses 0.5116 ppm, exceeding the levels of benzene according Permenakertrans NAB 13 / MEN / X / 2011 of 0.5 ppm.

2. Characteristics of workers (age, sex, length of employment, nutritional status and smoking habits) did not have a significant relationship with the concentration of Immunoglobulin A (IgA) in the blood serum of workers.

3. Of the 20 research subjects were exposed to benzene obtained 8 of them decreased concentrations of IgA and 4 increased serum concentrations of IgA.

4. RQ and ECR in all 20 workers was obtained RQ > 1 at 65% and ECR > 1 by 75%, meaning that 65% of workers have exposure non-cancer effects due to benzene exposure and 75% of workers at risk of cancer due to benzene exposure.

Conflict of Interest: None

Source of Funding: Departement of Occupational Health and Safety, Airlangga University, Surabaya Indonesia

Ethical Clearance: The study was approved by the institutional Ethical Board of the Public Health, Airlangga University.

All subjects were fully informed about the procedures and objectives of this study and each subject prior to the study signed an informed consent form.

REFERENCES

1. American Conferrence Governmental Industrial Hygienists (ACGIH), (2011). *Threshold Limit Value for Chemical Substances and Physical Agents and Biological Exposurelindices*.Cincinnati, Ohio, USA.
2. ATSDR, (2007). *Toxicological Profile for Benzena*. U.S. Department of Health and Human Service.
3. Bogadi-Sare A, Zavalic M, Trosic I, Turk R, Kontosic I, Jelcic I, (2000). Study of Some Immunological Parameters In Workers Occupationally Exposed to Benzene. *Springer. Int Arch Occup Environ Health* (2000) 73 : 397-400.
4. DrastyanaSerlly Frida, (2014). Pengaruh PaparanUapBenzenaTerhadapImunoglobulin G Dan KeluhanKesehatanPadaPekerjaSpbu Di Surabaya DiukurMelalui Kadar Fenol Urine. *Tesis.* FakultasKesehatanMasyarakat, Program StudiKesehatanLingkungan, Universitas Airlangga, Surabaya.
5. Hirabayashi Y, Yoon Li G, Kanno J and Inoue T, (2004). Mechanism of Benzene-Induced Hematotoxicity and Leukemogenicity : Current Review with Implication of Microarray Analysis. *Toxicologic Pathology*, 32 (Suppl. 2) : p 12-16.
6. Ibrahim Khadiga S, AmerNagat M, El-dossukyElsaid A, Emara Ahmed M, Abd El-Fattah Abd El-Samei M,ShahyEman M, (2014). Hepatic Dysfunction and Immune Suppression among Egyptian Workers Occupationally Exposed to Benzene.*International Public Health Forum*.Vol.1 No.4 December 2014.
7. Kirkeleit J, Ulvestad E, Riise T, Bratveit M, Moen B.E, (2006). Acute Suppression of Serum IgM and IgA in Tank Workers Exposed to Benzene. *Journal compilation_2006 Blackwell Publishing Ltd. Scandinavian Journal of Immunology* 64, 690–698. DOI: 10.1111/j.1365-3083.2006.01858.x
8. Kurniawidjaja L Meily, Nur Aziza Sofia, Hendra, EkoPudjadi, Fatma Lestari, Mila Tejamaya, (2012). KeluhanPernapasandanAnalisisRisikoKesehatanPajanan BTX padaPekerja di Bengkel Alas Kaki Informal di KecamatanCiomasKabupaten Bogor. *JurnalRespir Indo* Vol. 32, No. 1, Januari 2012.
9. Lestari Fatma., (2012). *Bahan Kimia, Sampling &PengukuranKontaminan Kimia di Udara.* Jakarta : EGC.
10. Maryiantari, EllyzaSetya, (2016). Risk AssesmentPajananToluenaPadaPekerjaPengrajin Sepatu Di KelurahanTambak Oso Wilangun, Surabaya.*Tesis.* Program Magister K3, FakultasKesehatanMasyarakat, Universitas Airlangga. Surabaya.

11. Maywati Sri, (2012). KajianFaktorIndividuTerhadap Kadar FenolUrinPekerjaBagianPengeleman Sandal. *JurnalKesehatanMasyarakat* 7 (2) (2012) 142-148. ISSN 1858-1196.
12. Mc Hale C.M, Zhang L and Smith M.T, (2012). Current Understanding of the Mechanism of Benzene-Induced Leukimia in Humans : Implication for Risk Assesment. *Carsinogenesis*, 2012, Vol.33, No.2, p 240-252.
13. Republik Indonesia, PeraturanMenteri Tenaga KerjadanTransmigrasiNomor PER.13/MEN/X/ 2011 tahun 2011 tentangNilaiAmbang Batas FaktorFisikadanFaktor Kimia di TempatKerja. Jakarta.
14. Susilowati, Betty., (2011). Resik oKesehatan Terhadap Pajanan Benzene PadaPekerjaIndustri Sepatu Kulit Di PIK PulogadungTahun 2011. *Skripsi*. DepartemenKesehatanLingkungan, FakultasKesehatanMasyarakat, Depok.
15. Tualeka Abdul RohimdanNawawinetu Erwin, (2014). *Detoktifikasi Toluenadalam Tubuh Melalui Rekayasa Asupan Kaya Glisin (Studikasuspekerjapabriksepatu di Surabaya)*. Departemen K3. FakultasKesehatanMasyarakat. UniversitasAirlangga. Surabaya.