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Air Benzene Level is associated with Urine Phenol Level and Health Complaints in Shoes Home Industry Workers in Jampirogo, Indonesia

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Abstract

Background: Benzene is an organic solvent that has volatile properties so it can enter human body that is exposed to benzene. Benzene will enter human body and undergo a metabolic process, the main results of this metabolic process in the urine is in phenol form. The purpose of this study was to analyze the exposure of air benzene with phenol levels of urine and health complaints of workers exposed to and not exposed to air benzene in the shoes home industry of Jampirogo, Mojokerto Regency, and East Java Province, Indonesia.

Methods: The method of this study was an observational analytic with cross sectional design and this study was analyzed using Mann-Whitney U statistical test to determine differences of phenol urine levels between those two groups. Benzene levels in the air were analyzed using Benzene gas detector C6H6. While urine phenol level was analyzed using spectrophotometric methods. The subject of the study consisted of 26 participants drawn from the population in accordance with predetermined criteria. Interviews conducted using a questionnaire to find out information on work behavior and perceived health complaints. The independent variables of the study were the air levels of benzene, age, hours of work, working days, length of work and nutrition status. The dependent variable in this study was urine phenol levels and health complaints.

Results: The result of the study showed that the levels of benzene in the shoe gluing chamber air exceeded the threshold limit value of 4.25 ppm. Interestingly, there was very significantly differences in the level of urinary phenol between the groups with and without benzene exposure (Mann-Whitney U test, p =0,00), a number of health complaints stated by the benzene exposed workers were nervous system complaints (92.30%) and hematological complaints (76.92%).

Conclusion: It is concluded that air benzene level at work is associated with the urine phenol level and health complaints in shoe home industry workers of Jampirogo, Mojokerto regency, East Java. It is recommended that the workers shall use respirator, add some air ventilation and a rotation policy for the workers.

Keywords: Air Benzene Level; Urine Phenol; Health Complaints; Shoe Home Industry Workers

Abbreviations: ACIGH: American Conference of Government Industrial Hygienists; NIOSH: The National Institute for Occupational Health and Safety; REL: Recommended Exposure Limit; ATSDR: The Agency for Toxic Substances and Disease Registry; BEIs: Biological Exposure Indices; ACGIH: The American Conference on Governmental Industrial Hygienists; ATSDR: Agency for Toxic Substance Registry; ACGIH: American Conference of Government Industrial Hygienists; TLV: Threshold Limit Value.

Introduction

The informal industrial sector holds a very large share in developing countries including Indonesia. The informal sector is a sector that is not organized, irregular, and mostly legal but not registered [1]. One type of informal business that is developing in Indonesia is shoes industry. Shoes home industry became the main contributor to Indonesia's Gross National Product as the third largest national income after the wood and textile industry in the early 1990s. Thanks to the development of the industry, about 40 percent of shoe exports were sent to the United States market and 33 percent were sent to Europe, the rest was exported to African countries, the Middle East and South America. At its peak in 1996 Indonesia was able to export 250 million pairs of shoes by almost US $2.29 billion, since then the volume of shoes industry exports declined until in 2002, shoes industry exports were only US $1.4 billion. As a result of the economic crisis due to falling exports, shoes production remains one of the main industries in Indonesia [2]. In 2013 the value of Indonesian shoes exports reached US $3.86 billion, with the value of these exports Indonesia was able to meet around 3 percent of the world's needs for shoes products [3].

The shoes home industry plays an important role in creating employment for the community, but in order to maintain the quality and existence of the products obtained are often not matched by adequate protection against work risks that are associated with hazardous equipment and materials [4]. In general, the process of making shoes includes several stages of work starting from making designs or patterns of shoes, preparing the upper part of the shoe (making patterns, cutting patterns, lining, decorating, sewing, and insoles), preparing the bottom of the shoes (outer soles, gluing, lining), attaching the upper part of the shoe and the bottom of the shoe (gluing, sewing, nailing), finishing (cleaning, smoothing), packing for further delivery to the consumer or market in the production process using a variety of equipment [5].

Tools and materials used in making shoes are heating machines (ovens), scissors, hammers, wood footprints, adhesives such as glue, gasoline, latex, shoe soles, sponges, and roll an material. The glue used in the shoe gluing process uses two types of glue, white glue and yellow glue. Yellow glue is used to connect openings so that it is usually used on the surface and finishing, while white glue is generally used for patching the soles because of its much stronger adhesion. The high demand for shoes on the market affects the use of glue from the production process. Research conducted by the Director General of Community Health Development of Indonesia, states that the glue contains organic solvents that is 70% toluene and about 1-2% benzene [6,7].

Out of the various tools and materials used in the shoe-making process, chemicals are a high-risk hazard. The use of chemical material which is widely used in shoes home industry of is organic solvent. This makes it very possible for workers to experience adverse effects from the use of chemicals in the work process. Chemicals in this case are glues or adhesives that are applied to the production process. The use of glue in the shoe making process is an unavoidable activity. In general, glues or adhesives contain various mixtures including benzene and toluene as organic solvents. Benzene has been known as a good organic solvent for various industrial processes of the rubber industry, shoes, and paint solvents, components in motor fuels, components in detergents, pesticides, and pharmaceutical manufacturing [8-10]. Benzene is an excellent solvent for latex rubber and has been used extensively in the rubber industry throughout the 19th century. The use of glue containing benzene can pose serious health risks because of the carcinogenic content for humans. According to the American Conference of Government Industrial Hygienists (ACIGH) in 2006 stated that the threshold value of benzene in the workplace was 0.5 ppm and included in the category A-1 which means it was proven to have carcinogenic properties in humans [11]. The National Institute for Occupational Health and Safety (NIOSH) in 2005 established the Recommended Exposure Limit (REL) of 0.1 ppm for 8 working hours [12]. According to Minister of Manpower and Transmigration Regulation No. 13 of 2011 states that the benzene threshold value is 0.5 ppm [13]. Benzene has volatile properties so it is easily exposed by humans. Benzene enters the human body through 3 pathways, namely absorption through the skin, inhalation and ingestion. Through inhalation, benign absorption is around 70-80% in the first 5 minutes, and 20% to 60% for the next hour. Inhalation is the most likely route of chemical exposure, especially at work [14,15]. Inhaled benzene will enter the human body and will undergo major metabolism into benzene epoxide. In the liver, benzene epoxide is an unstable compound and will soon undergo changes to form phenols. Within 2 days after exposure to benzene most of the metabolites from benzene will be removed together with urine. Therefore, phenol levels are used as biological indicators of benzene exposure in the workplace, high levels of urine phenols indicate higher degrees of benzene poisoning [16,17].

The nature of benzene which is volatile to free air so that if a source of exposure is left continuously exposed in a workplace, the greater the concentration of benzene in the work environment [18]. The signs and symptoms of chronic poisoning that will arise due to exposure to benzene include headaches, dizziness, nausea to vomiting, difficulty concentrating, and anemia which is often accompanied by bleeding under the skin and mucosa. The clinical effects of benzene systemically cause disorders in the cardiovascular, respiratory, neurological, gastrointestinal, liver, kidney, endocrine and reproductive systems, dermatology, local effects, hematological, immunological, and allergic [14,19-22]. The American Petroleum Institute (API) states that benzene can certainly cause leukemia and not tolerated even the slightest (zero ppm level). Whereas in epidemiological studies mention the relationship between benzene exposure and leukemia conducted on 28,500 shoe or sandal industry workers showed an annual incidence of leukemia as much as 13 out of 10,000 which is greater than the incidence of the general population which is only 6 out of 100,000 [14]. Several cases of benzene usage in the shoe industry were found in 1946-1956 in the United States there were 107 cases due to concentrations of benzene exposure that exceeded 400 ppm. From the incident found hemophaty and thrombocytopenia. In 1945-1955 there were 125 cases of decreased platelets and abnormal liver function due to benzene exposure in excess of 400 ppm in the shoe industry [22].

The Jampirogo Mojokerto home industry is one of the home industries owned by the Jampirogo Mojokerto community, where the majority of the population works as shoe craftsmen. The Jampirogo Mojokerto shoe home industry which was the site of this research was established in 2016. The building design is done separately in one building using walls as a partition between the gluing room, packing room and household space. The area of the gluing room is approximately 105 m^2, the building area of the packing room is 70 m^2 and the building height is approximately 2.5 m. The number of shoes produced by the Jampirogo Mojokerto shoes home industry is approximately 40 scores per day and can increase on certain days, so that the more demand for shoes, the more glue is used in the shoe making process. The amount of glue used during the shoe making process is approximately 24 kg per month. The use of glue in the shoe production process certainly makes it easier for workers to experience exposure to benzene in the workplace that cannot be avoided. The use of glue which is known to contain hazardous substances to humans should receive attention from the government such as monitoring of its use, but most health and safety monitoring and the work environment are only carried out on the types of large scale industries while small to medium industries still receive less attention to health and safety and the work environment of hazardous materials used during production such as benzene in the work environment. This research was conducted to study and find out the effects of benzene exposure with urine phenol levels and health complaints on workers exposed to benzene in the Jampirogo Mojokerto shoes industry. The purpose of this study was to analyze the association between air benzene level with urine phenol level and health complaints in workers exposed to air benzene in the Jampirogo Mojokerto shoes home industry.

Methods

This study used a cross sectional study design, because the measurement of the variables to be done at the same time. The location of the study was conducted in one of the Jampirogo Mojokerto shoes home industries conducted in June to July 2019. Data used in this study were obtained through measurement of benzene in the air, measurement of urine phenol levels and interviews using a questionnaire to determine the work behavior and health complaints felt by participants. The study population was consisted of the environmental population and the worker's population. Environmental population was population of benzene levels in the air of the Jampirogo Mojokerto shoes home industry. The worker population was all workers who were working in the Jampirogo Mojokerto shoes home industry, namely the gluing area and the packing area. The inclusion criteria set in this study was male, working at least 3 years, working hours at least 8 hours per day, workers who were permanent workers and were willing to become study participant. Environmental samples were levels of benzene in the air taken at two measurement points, namely shoe shading room and shoe packing room, at 3 different times, morning, afternoon and evening.

Sampling of participant could be obtained using the formula of the sample size of two populations [23]. Then the sample size in this study was 13 workers exposed to air benzene. Furthermore, from the sample, 13 workers who were not exposed to benzene were added as a control group, then the sample size in this study was 26 workers. Workers who were selected to be subsequently will also be taken urine samples then measured and examined in the laboratory of Integrated Polytechnic Laboratory of the Health Ministry, Surabaya. The variables in this study consisted of independent variables namely levels of benzene in the air, age, working hours, working days, length of employment and nutrition status. The dependent variable was phenol urine. After the data were collected, it was analyzed further.

Statistical Analysis

The data to be analyzed will be tested in advance using normality data using the Kolmogorov Smirnov statistical

test. Data will be analyzed to see differences in urine phenol levels of two group workers using two independent samples t-test if the data were normally distributed or Mann-Whitney statistical test if the data were not normally distributed.

Ethics Approval

This study involved human as participant and obtained approval from the Ethics Commission of the Faculty of Public Health, Airlangga University on May 12, 2019 in accordance with the Declaration of Ethics with No: 162/EA/KEPK/2019.

Results

Benzene Levels in the Air

Sampling of benzene in the air was assisted by an analyst from the Integrated Polytechnic Laboratory of the Health Ministry, Surabaya using the NIOSH: 1501-2003 method as a reference. Based on the Regulation of the Minister of Manpower and Transmigration Number 13 of 2011 concerning Threshold Value of Physical Factors and Chemical Factors in the Workplace states that the threshold value of benzene in the air is 0.5 ppm for working time of 8 hours per day or 40 hours per week. Measurement of levels of benzene in the air at two measurement points namely the gluing room and packing room at three different times, namely morning, afternoon and evening. The results of these measurements are presented in (Tables 1 & 2).

Parameter	Gluing Room		
	Morning	Afternoon	Evening
Benzene Vapor Levels (ppm)	1,81	4,25	2,65
Ambient Temperature (°C)	30	33	31
Humidity (%)	56	52	53

Table 1: Benzene Levels in the Air, Temperature and Humidity of the Gluing Room in Shoes Home Industry in Jampirogo, Mojokerto Regency, Indonesia

Parameter	Packing Room		
	Morning	Afternoon	Evening
Benzene Vapor Levels (ppm)	0,29	0,38	0,24
Ambient Temperature (°C)	30	33	31
Humidity (%)	55,5	51,5	52,5

Table 2: Phenol Levels in the Air, Temperature and Humidity of the Packing Room in Shoes Home Industry in Jampirogo, Mojokerto Regency, Indonesia

Table 1 showed that the highest benzene level for the gluing room was 4.2 ppm and the lowest was 1.81 ppm. Whereas in Table 2 showed that the highest benzene level for the packing room was 0.38 ppm and the lowest was 0.24 ppm. Based on the measurement results of benzene levels for the gluing room exceeded the threshold limit value of 0.5 ppm according to the Regulation of the Minister of Manpower and Transmigration No. 13 / MEN / X / 2011 while the benzene levels in the air for the packing room still met the threshold limit value that was less than 0,5 ppm.

Characteristics of Participant

Participant's characteristic obtained in this study was including age, total working hours, length of work and nutritional status (Table 3). Nutritional status was measured by Body Mass Index (BMI) which were divided into 4 categories namely thin (<18.5), normal (≥ 18.5- <25.9), overweight (≥25.9- <27.0) and obesity (≥27.0) [23]. The results of the questionnaire found that all participants' working days were the same that were 6 days a week. Based on Table 3, participants with age> 30 years in the exposed and unexposed group to benzene as many as 11 participants with a percentage of 84.61%. The age variation of research participants was very limited because workers had the same average age. The participant's working hours in the table above showed that working hours> 8 hours have the most number, namely 11 participants with a percentage of 84.61% in workers exposed to benzene and 30.77% in the unexposed group. There was a difference working hours of workers of shoes home industry Jampirogo Mojokerto because workers which were exposed or the production section continued their work by making shoes in their houses because the wage system used was a wholesale system, so the more shoes are made, the more wages are earned.

The participant's length of work in the table above showed that the length of work > 5 years had the most number, namely 11 participants with a percentage of 84.61% in the exposed group and 53.84% in the unexposed group. A person who works with a longer time then the exposure of benzene received by workers would also be longer. The average length of work of workers in shoes home industry Jampirogo Mojokerto was 15 years in the benzene-exposed group. This also allowed high urine phenol levels in workers due to prolonged benzene exposure. The participant's nutritional status was measured through Body Mass Index (BMI), based on the table above showed that BMI with thin status had the most number, namely 9 participants with a percentage of 69.23% in the exposed group and 61.53% in the unexposed group. The nutritional status would affect the metabolic processes of benzene in somebody, the thin nutritional status of workers affecting the body endurance

levels to infection was different from someone with normal nutritional status, and this was related to the process of detoxification and neutralization of toxins in the body.

Characteristics	Group			
	Exposed		Unexposed	
	n	%	n	%
Age				
≤30 years	2	15,39	2	15,39
>30 years	11	84,61	11	84,61
Total	13	100,00	13	100,00
Working Hours				
≤8 hours/day	2	15,39	9	69,23
>8 hours/day	11	84,61	4	30,77
Total	13	100,00	13	100,00
Length of Work				
≤ 5 years	2	15,39	6	46,16
>5 years	11	84,61	7	53,84
Total	13	100,00	13	100,00
Nutritional Status				
<18,5	2	15,39	2	15,39
(≥18,5-<25,9),	9	69,23	8	61,53
(≥25,9-<27,0)	1	7,69	2	15,39
≥27,0	1	7,69	1	7,69
Total	13	100,00	13	100,00

Table 3: Frequency Distribution of Age, Working Hours, Length of Work and Nutrition Status of Workers in Home Industry in Jampirogo, Mojokerto Regency, Indonesia.

Urine Phenol Levels

Measurement of urine phenol levels was assisted by analysts from Health Polytechnic Integrated Laboratory of the Ministry of Health in Surabaya using NIOSH 8305 as a reference [11]. Urine phenol levels were analyzed using spectrophotometric methods. According to ACGIH (2012) Biological Exposure Indices (BEIs) for benzene exposure at workplace was 250 mg/g creatinine phenol in urine [24]. The results of measurement of urine phenol levels were then compared between the benzene exposed group and the benzene unexposed group. To compare urine phenol levels, a normality test was carried out, the results of the normality test showed that the data were not normally distributed then the data would be analyzed using the Mann-Whitney test. The results of comparison of these data could be seen in Table 4.

The result of the average urine phenol levels in the exposed group was 258.84 mg/g creatinine, this showed that the average urine phenol levels of workers exposed to benzene exceeded the BEIs that have been set. The Mann-Whitney test results showed p =0,00 that it could be concluded that there were significant differences in urine phenol levels between the benzene exposed group and the benzene unexposed group in the shoes home industry Jampirogo Mojokerto. The results of urine examinations carried out on shoes home industry Jampirogo Mojokerto workers showed 10 out of 13 people exposed to benzene have high urine phenol levels that exceeded 250 mg/g creatinine while 3 of the others had phenol levels of nearly 250 mg/g creatinine. Results of urine phenol levels of 13 people from the number of workers who were not exposed to benzene had the results of normal urine phenol levels which was less than 250 mg/g creatinine. Interestingly, Mann-Whitney statistical test results showed a very significantly difference (p =0.00) in urine phenol levels in the exposed and unexposed groups.

Respondents	Urine Phenol Levels	
	Exposed Group (mg/g creatinine)	Unexposed Group (mg/g creatinine)
1	271	222
2	244	116
3	282	94
4	257	178
5	286	73
6	253	193
7	260	122
8	274	211
9	258	164
10	252	139
11	265	62
12	238	225
13	225	105
x ±SD	258,84 ±17,26	146,46 ±51,67
Mann-Whitney test, p =0,00		

Table 4: Differences of Phenol Urine Levels by Working Group in Shoes Home Industry in Jampirogo, Mojokerto Regency, Indonesia.

Health Complaints

Health complaints in this research were divided into three complaints, namely digestive system complaints, nervous system complaints and hematological complaints. The results of health complaints to workers in the shoes home industry Jampirogo Mojokerto could be seen in Table 5. Table 5 showed the health complaints that often experienced

by workers exposed to benzene in the shoes home industry Jampirogo Mojokerto were nervous system complaints of 12 people with a percentage of 92.30% and hematological complaints of 10 people with a percentage of 76.92% while the unexposed group the most health complaints felt was the digestive system complaints but only 3 people with a percentage of 23.07% and the average in the unexposed group only 1 to 3 people experienced health complaints.

Health Complaints	Group								Total	
	Exposed				Unexposed					
	Yes		No		Yes		No		Yes	No
	n	%	n	%	n	%	n	%	N	N
Digestive System Complaints	4	30,77	9	69,23	3	23,07	10	76,93	7	26,92
Nervous System Complaints	12	92,30	1	7,70	2	15,39	11	84,61	13	50,00
Hematologic Complaints	10	76,92	3	23,08	1	7,70	12	92,30	10	38,47

Table 5: Health Complaints of Workers in Shoes Home Industry in Jampirogo Mojokerto Regency, Indonesia.

Discussion

This study result was in line with previous study which showed the results of the measurement of benzene in the shoe industry area exceeding the TLV of 2.97 ppm [25]. This study was also in accordance with previous study that the benzene levels in the air had a concentration of 0.002-34 ppm. People who live in cities or industrial environments in general would be exposed to higher benzene levels [15]. High benzene levels were affected by several environmental factors including ambient temperature and humidity in the workplace when measured. The results of the ambient temperature increased during the afternoon was 33°C, this showed the temperature in the gluing room has increased which causes high benzene levels in the workplace air, while the humidity in the packing room remained stable at three measurement times namely morning, afternoon and evening were different with the gluing room decreased in humidity during the afternoon was 52%. The high benzene levels in the gluing room were affected by the high ambient temperature at the time of measurement and lack of humidity which caused the benzene levels in the air exceed the TLV. In addition, high benzene levels in the air were affected by inadequate ventilation, this made the benzene vapor from the glue used could not circulate with outdoor air. This was certainly a risk for gluing workers, owners of the shoes home industry and surrounding community. This was caused by the location of the gluing room with households that were only next to each other and the wall as a divider between the two, but there was a door as a connecting path between those rooms so that benzene could spread to the surrounding environment. The close distance between the shoes home industry building and the resident houses in Jampirgo Village Mojokerto allowed the surrounding community to be exposed to benzene. Direct exposure that could cause workers health effects needed to be engineered to reduce health risks due to the use of chemicals in the work process.

Benzene entered the human body in the form of vapor through the main inhalation and absorption pathways through the lungs with an amount of 40-50% of the total benzene that can enter the body. Benzene would be easily absorbed through inhalation; pulmonary resistance could absorb benzene reaching about 50% for several hours of exposure between 2 - 100m^3. Benzene in high air would easily enter the human body through inhalation as its main pathway, which would then go through a metabolic process to become phenol urine. The metabolic process in the human body was affected by several factors, including the characteristics of respondents.

Workers who were exposed to benzene continuously would have serious health effects on humans. A study stated that someone who was exposed to benzene continuously could experience nervous disorders. Fatal respiratory exposure was reported that can cause disorders with the brain. Chronic effects caused by exposure to benzene were disorders of the nerve with symptoms such as insomnia and easy to forget [15]. In addition, it could cause hematological disorders to IARC leukemia in OSHA (2011) stated that chronic benzene exposure of 10 ppm could increase 12-120 cases of leukemia per 1000 workers, while for 1 ppm exposure could increase 1.4-14 cases of leukemia per 1000 workers [26]. The measurement results in shoes gluing room Jampirogo Mojokerto exceeded 1 ppm but still below 10 ppm, therefore, workers in shoes gluing room Jampirogo Mojokerto had a risk of leukemia per 1000 workers.

The statistical analysis revealed a very significant difference in urine phenol levels between exposed and unexposed groups. These results indicated that benzene exposure in the workplace was able to affect urine phenol levels then that urine phenol levels in the two groups of workers were different significantly. These results were supported by the results of measurements of benzene levels in the air of exposed group that exceeded the TLV. Benzene

that entered the body would metabolize into benzene epoxide in the liver, the result of metabolic processes was an unstable compound, that it would change shape to phenol which the body would excrete at the same time through urine, therefore urine phenol levels were used as a biological indicator of benzene exposure to workers.

The American Conference on Governmental Industrial Hygienists (ACGIH) had set 250 mg/g creatinine urine phenol as a Biological Exposure Indices (BEIs) for benzene exposure in the workplace [11,28]. The main BEIs in the exposure index were not the level which health effects might occur from benzene exposure. The acute effects of benzene exposure with very high concentration through inhalation resulted in depression of the nervous system and could result in death. At the initial stage benzene mainly affected the central nervous system with the main signs feeling drowsiness, dizziness, headaches, vertigo, and loss of consciousness. The Agency for Toxic Substances and Disease Registry (ATSDR) data stated that the health effects arising from benzene exposure were found in metabolic systems in the body such as respiration, digestion, cardiovascular and then the impact on the reproductive system which would result in babies born prematurely to infertility and blood disorders that could cause leukemia [15]. In the clinical effects of systemic benzene exposure caused disorders in cardiovascular, respiratory, neurological, gastrointestinal, liver, kidney, local systems, hematological, immunological, metabolic and allergic reactions [15,19-21].

Nervous system complaints that often occurred in respondents exposed group were shoulder pain, difficulty sleeping, difficulty concentrating and headaches. While digestive complaints that were often felt in the unexposed group were decreased appetite and abdominal pain. These results were in line with research by Tanasorn T, et al. [19] which showed that chronic benzene exposure at workplace caused nervous system and hematological disorders in refueling station Bangkok, Thailand workers with symptoms of dizziness, drowsiness and fatigue. In the Agency for Toxic Substance Registry (ATSDR) and the American Conference of Government Industrial Hygienists (ACGIH) also stated that research that had been done in humans, indicated that there was a causal relationship between acute effects through respiratory benzene exposure at high concentration and symptoms indicated disorders of nervous system and hematological. The acute effects caused by lethal and non-lethal benzene exposure caused symptoms such as drowsiness, headaches, vertigo, tremors, delirium, and loss of consciousness. These symptoms were occurred in workers who work in areas with benzene concentration problems [15,18]. The common exposure pathway for workers and needed to be paid attention to was through inhalation, the easy way of benzene entering the body due to the benzene characteristic which volatile in the air. The presence of dangerous concentration of benzene could be identified through measurements of benzene in the air that exceeded the TLV. Acute effects that could be caused by benzene vapor such as irritation, ear buzzing, nausea, vomiting, chest pain, difficulty breathing, abnormal heart rate, headache, weakness, disorientation, impaired vision, lung damage, blood disorders, paralysis, spasms and convulsions coma. Benzene vapor can cause central nervous system, life and throat depressions. While the chronic effects due to benzene exposure vapor in the workplace could cause hearing loss, kidney damage, liver damage, nervous system damage, productive disorders and cancer [29,30]. Several review articles mention epigenetic modifications that correlate with benzene exposure. This is mechanically linked to susceptibility to disease due to benzene exposure [31].

Conclusion

Based on the results of the research, that it was found the benzene levels in the shoes gluing room exceeded the threshold limit value (TLV), there was very significant higher in urine phenol levels in workers exposed to benzene in the workplace compared to control group. The health complaints that often felt by workers in the shoes home industry in Jampirogo, Mojokerto Regency, East Java Province, Indonesia were nervous system and hematological complaints. Therefore, it is concluded that the presence of benzene exposure in the workplace affected high phenol levels in workers and health complaints in the shoes home industry Jampirogo Mojokerto workers. It is recommended that the shoes home industry in Jampirogo Mojokerto workers shall use personal protective equipment such as respirators, add air ventilation at workplace and work rotation policies for gluing workers and packing section workers as well.

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References

1. Rothenberg AD, Gaduh A, Burger NE, Chazali C, Tjandraningsih I, et al. (2016) Rethinking Indonesia's Informal Sector. World Development 80: 96-113.

2. International Labour Organization (2004) Child Labour in the Informal Footwear Sector in West Java, Indonesia: a rapid assessment. ILO, Jakarta, Indonesia, pp: 32-40.

3. Gendalasari G (2020) A Market-Based Analysis on Small and A Medium Business Strategies in Bogor's Footwear Industry. Jurnal Aplikasi Ekonomi Akuntansi dan Bisnis 2(1): 153-166.

4. Sumamur (2009) Higiene Perusahaan dan Kesehatan Kerja (Hiperkes). Sagung Seto, Jakarta, Indonesia, pp: 70-87.

5. Maryiantari ES, Martiana T, Sulistyorini L (2016) Analyze the Level of Health Risks from Exposure to Toluene in Shoes Craftsman Workers. American Scie Res J Eng Tech and Sci 16(1): 137-154.

6. Khan AA, Sultan R, Zamani GY, Rahman SU (2013) Biochemical and Hematological Analysis After Exposure to Hazardous Materials during Shoe Making. J Bio Life Sci 4(2): 116-138.

7. Agustina L, Wulandari RA (2019) Benzene Exposure Analysis in Informal Shoe Industry Workers in Sukajaya Village, West Java Via Leukocyte Count and S-Phenylmercapturic Acid Measurement in Urine. Public Health Indonesia 5(4): 138-144.

8. Kurniawidjaja LM, Ramdhan DH (2019) Buku Ajar Penyakit Akibat Kerja dan Survailans. UI Publishing, Jakarta, Indonesia, pp: 11-54.

9. Kauppinen T, Teschke K, Savela A, Kogevinas M, Boffetta P (1997) International Data Base of Exposure Measurements in the Pulp, Paper and Product Industries. Int Arch Occ Environ Health 70(2): 119-127.

10. Karacic, Ljiljana S, Danica PM (1987) Occupational Exposure to Benzene in the Shoe Industry. Am J Ind Med 12(5): 531-536.

11. American Conference of Governmental Industrial Hygienists (2006) The Threshold Limit Values and Biological Exposure Indices 7th (Edn), American Conference of Governmental Industrial Hygienists, Cincinnati, OH, pp: 1-55.

12. The National Institute for Occupational Health and Safety (2005) NIOSH Pocket Guide to Chemical Hazard. Department of Health and Human Service, US, pp: 362-390.

13. (2011) Regulation of the Minister of Manpower and Transmigration Number 13 Concerning Threshold Values for Physical and Chemical Factors in the Workplace. Indonesia Ministry of Labor and Transmigration.

14. The Agency for Toxic Substances and Disease Registry (2006) Benzene Toxicity. US Department of Health and Human Services, Atlanta, Georgia, pp: 1-16.

15. The Agency for Toxic Substances and Disease Registry (2007) Toxicological Profile for Benzene. US Department of Health and Human Services, Atlanta, Georgia, pp: 239-242.

16. Sugiharto, Eram TP (2009) The Relationship Between the Use of Insecticides in Control of Onion Caterpillar Pests (Spodoptera exigua Hbn) and the Toxicity Levels of Shallot Spraying Farmers in Bangsal Rejo Village, Wedari Jaksa District, Pati Regency. Jurnal Kesmas 4(2): 132-139.

17. Krogholm KS, Bredsdorff L, Alinia S, Christensen T, Rasmussen SE, et al. (2010) Free Fruit at Workplace Invention Increases Total Fruit Intake: A Validation Study Using 24 H Dietary Recall and Urinary Flavonoid Excretion. Eur J Clin Nutr 64(10): 1222-1228.

18. Ummyatul H, Agustin K, Ema H (2020) Effects of Benzene Exposure on Respiratory Symptoms to Workers in the Informal Footwear Industry. Indian J Public Health Res & Develop 11(3): 1201-1206.

19. Tanasorn T, Kalaya Z, Anusorn R (2012) Relative Study on Blood BTEX, Testosterone Hormone, Kidney and Liver Functions in Gasoline Station Workers, Thailand. Int Res J Environ Sci 1(5): 48-53.

20. Hirabayashi Y, Yoon B, Li GX, Kanno J, Inoue T (2004) Mechanism of Benzene-Induced Hematotoxicity and Leukemogenicity: Current Review with Implication of Microarray Analyses. Toxicol Pathol 32(S2): 12-16.

21. McHale CM, Zhang L, Smith MT (2012) Current Understanding of the Mechanism of Benzene Induced Leukimia in Humans: Implications for Risk Assessment. Carcinogenesis 33(2): 240-252.

22. Cohrssen B (2021) Patty's Industrial Hygiene. 7th (Edn), A Willey Interscience Publication, John Willey & Sons Inc, New Jersey, US, pp: 207-254.

23. Levy PS, Lemeshow S (2013) Sampling of Populations: Methods and Applications. 4th (Edn), Willey New Jersey, US, pp: 182-205.

24. Indonesia Ministry of Health (2013) Report of Indonesia Basic Health Survey 2013. Agency of Health Research and Development, Jakarta, Indonesia, pp: 235-252.

25. Setiowati D (2018) High Level of Phenol Urine and Health Complaints in the Benzene-Exposed Workers in Small Industry of Slippers Wedoro, Sidoarjo. Jurnal Kesehatan Lingkungan 10(4): 402-408.

26. Occupational Safety and Health Administration (2020) Benzene Method Number 1005 (Version 2.1). Methods Development Team Industrial Hygiene Chemistry Division OSHA, Salt Lake, US, pp: 1-41.

27. Environmental Protection Agency (2012) Chemical-Specific Reference Values for Benzene (CASRN 71-43-2). National Center for Environmental Assessment Office of Research and Development, US, pp: 1-14.

28. American Conference of Governmental Industrial Hygienists (2012) Benzene. American Conference of Governmental Industrial Hygienists, Cincinnati, OH, pp: 1-6.

29. Soltanpour Z, Mohammadian Y, Fakhri Y (2021) The Concentration of Benzene, Toluene, Ethylbenzene, and Xylene in Ambient Air of the Gas Stations in Iran: A Systematic Review and Probabilistic Health Risk Assessment. Toxicol Ind Health 37(3): 134-141.

30. Bahadar H, Mostafalou S, Abdollahi M (2014) Current Understandings and Perspectives on Non-Cancer Health Effects of Benzene: A Global Concern. Toxicol Appl Pharmacol 276(2): 83-94.

31. Fenga C, Gangemi S, Costa C (2016) Benzene Exposure is Associated with Epigenetic Changes (Review). Mol Med Rep 13(4): 3401-3405.

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