ANALYSIS OFRISK FACTORS INCREASE BLOOD PRESSURE IN THE TEXTILE INDUSTRY WORKERS

Sumardiyono[*], Hartono[**], Ari Probandari[*], Prabang Setyono[***]
[*]Department of Public Health, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia
[**]Department of Physiology, Faculty of Medicine, Sebelas Maret University, Surakarta, Indonesia
[***]Department of Biology, Faculty of Mathematics and Natural Sciences, Sebelas Maret University, Surakarta, Indonesia

Abstract

The risk factors for high blood pressure are industrial noise exposure, age, body mass index, and length of exposure to noise. Exposure to noise is often found in industrial workers. Therefore, workers are at increased risk for high blood pressure. The purpose of this study is to investigate the association of noise level, age, body mass index, and length of exposure to noise with blood pressure on textile industry workers. This study was observational research with cross sectional design. The population were textile industry workers in Surakarta. The sample selection used purposive random sampling. Inclusion criterias were women, length of working at least one year, less disciplined use ear protection equipment. The total samples were 245 peoples.Statistical analysis used bivariate correlations and multiple linear regression. There was an association between all variables with blood pressure.However, on multiple linear regression test, length of exposure to noiseexclused. Variables that associated with systolic blood pressure were the noise level (p=0.026), age (p=0.002), body mass index (p=000). Variables that associated with diastolic blood pressure were the noise level (p=0.011), age (p=0.15), body mass index (p=0.000). The risk factors for high blood pressure among industrial worker are the noise level, age, and body mass index.

Keyword: blood pressure, textile industry workers

INTRODUCTION

Noise is often defined as 'unwanted sound.[1] Industrial noise is the most common type of exposure to noise.[2]Industrial noise is a critical occupational health risk factor for workers. One of the type industries is the textile industry since this has been used by many workers, hence, workers at risk of *occupational disease* due to exposure to noise.

Previous research in several countries have shown about the noise level of the weaving machines of 88 dB(A) in Sudan, 95dB(A) in Srilanka and 95.3 dB(A) in Pakistan. In Iran, the noise level of the spinning machine is 97-90 dB(A) and the weaving machine is 99-100 dB(A).[3-6] In Ethiopia, the highest noise level in the weaving section is 99.5 ± 3.2 dB(A).[7]In Indonesia, the noise level is considered at risk of health effect if it exceeds the threshold value of 85 dB(A) for exposure 8 hours per day or 40 hours per week.[8]

The noise effect on the worker may be a hearing loss and a non-hearing loss. Effects on hearing from noise are deafness due to work and non-hearing effects such as irritability, sleep disturbance, stress, hypertension, heart disease and effects on performance.[2]Non-auditory disorders are all effects on health and well-being caused by exposure to noise, except effects on auditory organs and its masking effects, such as irritability, heart disease, insomnia, and sleep disorders.[9]The other researchers also stated that exposure to noise could increase systolic and diastolic blood pressure, changes in heart rate, and causes the release of stress hormones (including catecholamines and glucocorticoids).[10]

The purpose of this study is to analyze the risk factors that affect the increase of blood pressure in textile industry workers in Surakarta. The risk factors are the noise level, age, body mass index (BMI), and length of exposure to noise. Blood pressure measured systolic blood pressure and diastolic blood pressure.

RESEARCH METHODS

The research used observational analytic study with cross sectional design. The study was conducted during three months (August-October 2016). The study population was textile industry workers in Surakarta, Indonesia. The sample selection used consecutive sampling was cluster random sampling (Participants consisted of two groups that were groups exceeding the threshold limit value (TLV) and less than the TLV, determined randomly). Inclusions criteria: women, the length of working at least one year, less disciplined in using of ear protective equipment. The number of samples was 245 people (Exposed to noise over TLV = 133 people, and below TLV = 112 people).

We used questionnaires to find out demographic data, sound level meter type Sanfix GM1356 to measure noise level, height meter type SZ-200, and body scale to measure body mass index, sphygmomanometer type GM-0194SM and its accessories to measure blood pressure. The measurement of noise level measurement was on the interval scale (dBA), while the rest were on age, body mass index, and blood pressure which were on the ratio scale (year, kg/m^2 and mmHg respectively). Statistical analysis used multiple linear regression. The relationships between variables were analyzed using SPSS. The level of statistical significance was $p < 0.05$.

RESULTS

Participants of this study were textile industry workers in Surakarta, Indonesia, exposed to noise in the office administration department (65.8-66.2 dBA), warehouse administration (76.7-84.2 dBA), blowing (82.8-83.9 dBA), warping (82.2-83.8 dBA), Carding (82.8-84.3 dBA), drawing (85.5-88.8 dBA), winding (85.8-87.7 dBA), roving (86.3-86.6 dBA), pallets (86.8-87.2 dBA), spinning 88.0-93.7 dBA), weaving (97.8-98.4 dBA), inspecting (81.0-82.1 dBA), finishing (81.0-82.3 dBA), quality control (81.3-82.0 dBA), and packing (71.7-82.3 dBA).

The measurement of variables on the 245 workers, that was noise level (Leq) measured in dB (A), obtained the lowest level in the administrative office and the highest level in the weaving department. The minimum, maximum, mean and standard deviation values of the measurement results were shown by Table 1.

The findings showed a significant positive association between noise level, age, body mass index, and length of exposure to noise with systolic blood pressure ($p=0.003$, $p=0.000$, $p=0.000$ and $p=0.000$ respectively). The similar results were shown for the correlation between noise level, age, body mass index, and length of exposure to noise with diastolic blood pressure ($p=0.001$, $p=0.000$, $p=0.000$, and $p=0.000$ respectively) (Table 2).

Thus, all independent variables (noise level/Leq, age, body mass index, and length of exposure to noise) were positively correlated with systolic blood pressure and diastolic blood pressure as indicated by $p<0.05$. Therefore, all independent variables could be incorporated into multiple linear regression tests because in the bivariate correlation test all variables had a value of $p<0.25$.

We have tested the normality of data whose results were noise level ($p=0.192$), age ($p=0.184$), body mass index ($p=0,200$), length of exposure to noise ($p=0.186$), systolic blood pressure ($p=0.177$), and diastolic blood pressure ($p=0.163$); All data distribution is normal, so it qualifies multiple linear regression test. The results of multiple regression tests on the independent variables (noise level, age, body mass index, and length of exposure to noise) on systolic blood pressure showed the largest influence sequences on increased systolic blood pressure were body mass index, age, noise level, and length of exposure to noise. After the length of exposure to noise was excluded, then the sequence became age, body mass index, and noise level. The full results were shown by Table 3.

The results of multiple regression tests on the independent variables (noise level, age, body mass index, and length of exposure to noise) on diastolic blood pressure showed the largest influence sequences on increased diastolic blood pressure were body mass index, noise level,

age, and length of exposure to noise. After the length of exposure to noise was excluded, then the sequence became age, body mass index, and noise level. The full results were shown in Table 4. Explanation of predictions of how much influence each independent variable to the dependent variable (Systolic blood pressure and Diastolic blood pressure) showed that the four independent variables together effect on Systolic blood pressure was 26.7%, but because the length of exposure to noise was excluded from the equation, then its influence decreased to 26.3%. The length of exposure to noise was excluded because of the value of p=0.113. Likewise, the effect of four independent variables on diastolic blood pressure was 23.4%, but since the length of exposure to noise was excluded from the equation, the effect was 22.9%. The length of exposure to noise was excluded because of the value of p=0.131. The complete result of the predictive explanation of the effect of the independent variables on the dependent variable was shown by Table 5.

Table 1. Descriptive Statistics Of Variables (N=245)

Variables	Min	Max	Mean± SD
Noise level (Leq) (dBA)	65.8	98.4	85.53±6.96
Age (years)	20	60	37.39±8.96
Body mass index (kg/m^2)	15.2	34.2	23.83±3.93
Length of exposure to noise (years)	2	37	14.14±8.22
Systolic blood pressure (mmHg)	100	160	120.77±16.11
Diastolic blood pressure (mmHg)	70	100	79.02±8.65

Table 2. Bivariate Correlations Test Results (N=245)

Independent variables	n	Test results	Dependent variables	
			Systolic blood Pressure	Diastolic blood pressure
Noise level (Leq)	245	r	0.191	0.204
		p	0.003*	0.001*
Age	245	r	0.456	0.406
		p	0.000*	0.000*
Body mass index	245	r	0.371	0.363
		p	0.000*	0.000*
Length of exposure to noise	245	r	0.422	0.384
		p	0.000*	0.000*

* are significantly correlations (p<0.05)

Table 3. Multiple Regression Results For Systolic Blood Pressure

	Variables	coefficient	correlation coefficient	P
1	Noise level (Leq)	0.288	0.124	0.026
	Age	0.470	0.261	0.002*
	Body mass index	0.890	0.217	0.000*
	Length of exposure to noise	0.259	0.132	0.113
2	Noise level (Leq)	0.277	0.120	0.032
	Age	0.633	0.352	0.000*
	Body mass index	0.973	0.237	0.000*
	Constant	50.182		0.000*

* are significantly correlations ($p<0.05$)

Table 4. Multiple Regression Results For Diastolic Blood Pressure

	Variables	coefficient	correlation coefficient	P
1	Noise level (Leq)	0.181	0.145	0.011*
	Age	0.199	0.206	0.015*
	Body mass index	0.505	0.229	0.000*
	Length of exposure to noise	0.135	0.129	0.131
2	Noise level (Leq)	0.175	0.141	0.014*
	Age	0.284	0.295	0.000*
	Body mass index	0.548	0.249	0.000*
	Constant	40.339		0.000*

* are significantly correlations ($p<0.05$)

Table 5. Prediction Explanation Independent Variable Relationship To The Dependent Variable

Predictors	Predicted	Adjusted R^2	%
Length of exposure to noise	Systolic blood pressure	0.267	26.7
Noise level (Leq)			
Body mass index			
Age			
Noise level (Leq)	Systolic blood pressure	0.263	26.3
Body mass index			
Age			
Length of exposure to noise	Diastolic blood pressure	0.234	23.4
Noise level (Leq)			
Body mass index			
Age			
Noise level (Leq)	Diastolic blood pressure	0.229	22.9
Body mass index			
Age			

DISCUSSION

The results study showed that risk factors related to blood pressure rise were noise level (Leq), age, body mass index, and length of exposure to noise. Not all the workers exposed to high-intensity noise had long-term exposure to noise. Conversely, labor exposed to noise with low-intensity length received prolonged exposure. That was what probably causes the length of exposure to noise to be excluded from the equation. For further research, it was necessary to use a cohort study to know the duration of exposure to noise between groups was balanced. The dominant risk factors for increasing systolic or diastolic blood pressure from the largest sequence were age, body mass index, and noise level (Leq).

The results of this study were somewhat different from other studies on the effect of exposure to noise on blood pressure. A study among 62 male workers in a sack factory in Nigeria suggested that exposure to noise could increase blood pressure systolic significantly, but increased diastolic blood pressure did not increase significantly.[11] The results of the Zamanian study, indicated no significant difference in blood pressure and heart rate before and after acute exposure (for 5 minutes) at a rate of 85, 95, and 105 dBA.[12]

However, the results of this study were in line with research conducted on 72 workers of paper mills in Italy, which showed that noise could cause a significant

increase in systolic and diastolic blood pressure. Noise was a risk factor for cardiovascular effects.[13] A study in among 331 Iranian workers in the rubber plant in Iran. The study in Iran revealed that the workers exposed to noise exceeded the threshold value had a significantly higher mean systolic and diastolic blood pressure compared to the workers exposed to noise less than the threshold value.[14] In a study of 88 workers at a printing plant in Italy, it found a significant increase in systolic and diastolic blood pressure in the group of workers exposed to noise compared with those groups that did not expose to noise.[15] Exposure to noise had an effect on increased blood pressure, found in 75 people Italian sanitary workers in Italy, where the results showed a significantly higher average systolic and diastolic blood pressure group exposure compared to not exposed to noise group.[16] Hence, the results of those studies support the conclusion of noise as a risk factor for increased blood pressure in workers in various industries. However, there was likely to be an effect after exposure to noise over three years.

The significant association between age and blood pressure on the results of this study was in line with one of 1,729 people of petrochemical and gas refinery workers in Rio de Janeiro, Brazil.[17] Similarly, with an opinion that suggested getting older, the greater the likelihood of developing high blood pressure. As time went by, blood pressure increased gradually as the elasticity of the vessels diminishes.[18] The age and family history were uncontrollable risk factors for high blood pressure.[19] The risk of high blood pressure increased with age, middle age, or around the age of 45 years.[20] Increased blood pressure with age was largely due to structural changes in the arteries and especially with large arterial stiffness. It was known from various studies that the increased blood pressure was associated with an increased risk of cardiovascular.[21] The likelihood of hypertension increased steadily with age in three different populations (Ethiopia, Vietnam, Indonesia). The age group of 45-54 and 55-64 years had higher chance of hypertension than the youngest age group of 25-34 years.[22] The description suggested that increasing age was associated with increased blood pressure, and an increase would be seen after a person was over 45 years of age.

The risk of having high blood pressure increased by age.[20] Increased blood pressure with age was mainly due to the structural changes in the arteries and especially with large arterial stiffness. Increased blood pressure was associated with an increased risk of cardiovascular[21]. The likelihood of hypertension increased steadily with age in three different populations (Ethiopia, Vietnam, Indonesia). The age group of 45-54 and 55-64 years had higher chance of hypertension than the youngest age group of 25-34 years.[22] The description suggested that increasing age was associated with increased blood pressure, and an increase would be seen after a person was over 45 years of age.

The relationship between body mass index and blood pressure on the results of this study was similar to that of an analysis of 13,761 adults at the National Health and Nutrition Examination Survey of the Department of Medicine USA, which showed that obesity with body mass index parameters correlated significantly with increased blood pressure.[23] The relationship between body mass index with systolic and diastolic blood pressure was statistically significant; this suggested that obesity and high blood pressure were highly correlated even in old age. It was possible to reduce the rate of hypertension by weight change.[24] Body mass index was directly related to the systolic and diastolic blood pressure levels significantly. The prevalence of hypertension (≥140/90 mmHg) was higher in men compared with women significantly, and subjects who were obese and overweight compared with subjects with normal weight differed significantly.[25] Body mass index along with gender and age was found to be a significant determinant of hypertension in the three study populations (Ethiopia, Vietnam, Indonesia). In Indonesia, overweight and obesity risk were seven times higher than the normal weight (OR=7.64, 95% CI:3.88, 15.0). In Ethiopia, the risk was almost two times greater (OR=1.88, 95% CI:1.42, 4.29), and in Vietnam, the risk was nearly three times higher (OR=2.67, 95% CI:1.75, 4.08).[22] Thus, the increased body mass index was

associated with an increase in blood pressure, and an increase in blood pressure would be seen after a person had overweight and obesity categories. Based on the evidence above, it could be concluded that the risk factors of increased blood pressure in textile industry workers were the noise level, age, and body mass index.

REFERENCES

1. Burn CC. What is it like to be a rat? rat sensory perception and its implications for experimental design and rat welfare. Applied Animal BehaviourScience. 2008;112:1-32.
2. Smith A. Auditory and non-auditory effects of noise on health and safety at work. [Online]. 2014Feb 01. Available at: https://sm.britsafe.org/auditory-and-non-auditory-effects-noise-health-and-safety-work. Accessed April 3, 2017.
3. Ahmed AA, Awadalkarim MA.Noise Exposure In Two Textile Plants InSudan. European Scientific Journal. 2015 February;11(5):188-195.
4. Jayawardana TSS, Perera MYA, Wijesena GHD. Analysis and control of noise in a textile factory. International Journal of Scientific and Research Publications. 2014 December;4(12):1-7.
5. Ashraf HD, Younus MA, Kumar P, Siddiqui MT, Ali SS, M. Siddiqui MI. Frequency of hearing loss among textile industry workers of weaving unit in Karachi, Pakistan. Journal of the Pakistan Medical Association. 2009 August;59(8):575-9.
6. Roozbahani MM, Nassiri P, Shalkouh PJ. Risk assessment of workers exposed to noise pollution in a textile plant. International Journal of Environment Science and Technology. 2009;6(4):591-596.
7. Belachew A, Berhane Y. Noise-induced hearing loss among textile workers. [Online]. 2014. Available at: http://www.ejhd.org/index.php/ejhd/article/download/896/652. Accessed April 3, 2017.
8. Ministry of Manpower and Transmigrationof the Republic of Indonesia Regulation No. Per.13/MEN/X/2011 on *Physics and Chemical Permissible Limits in Work Place*. Jakarta: Manpower Department. p:3. Basner M, Babisch W, Davis A, et al. Auditory and non-auditory effects of noise on health. *Lancet*. 2014;383(9925):1325-1332.
10. Babisch W. Cardiovascular effects of noise. In: Nriagu JO, editor. Encyclopedia of Environmental Health. Burlington: Elsevier; 2011. pp. 532–42.
11. Ismaila SO, Odusote A. Noise exposure as a factor in the increase of blood pressure of workers in a sack manufacturingindustry. Beni-Suef University Journal of Basic and Applied Sciences. 2014. June;3(2):116–121
12. Zamanian Z, Rostami R, Hasanzadeh J, Hashemi H. Investigation of the Effect of Occupational Noise Exposure on Blood Pressure and Heart Rate of Steel Industry Workers. *Journal of Environmental and Public Health*. 2013;2013:256060. doi:10.1155/2013/256060.
13. Sancini A, Caciari T, Rosati MV, Samperi I, Iannattone G, Massini R, et al. Can noise cause high blood pressure? Occupational risk in paper industry. Clin Ter. 2014;165(4):e304-11.
14. Attarchi M, Dehghan F, Safakhah F, Nojomi M, Mohammadi S. Effect of exposure to occupational noise and shift working on blood pressure in rubber manufacturing company workers.Ind Health. 2012 Mar 28.;50(3):205-13.
15. Sancini A, Tomei G, Vitarelli A, Caciari T, Samperi I, Pacchiarotti A, et al. Cardiovascular risk in rotogravure industry. J Occup Environ Med. 2012 May;54(5):551-557.
16. Assunta C, Ilaria S, Simone de S, Gianfranco T, Teodorico C, Carmina S, et al. Noise and cardiovascular effects in workers of the sanitary fixtures industry. Int J Hyg Environ Health. 2015 Jan;218(1):163-8. De Souza TCF, Périssé ARS, Moura M. Noise exposure and hypertension: investigation of a silent relationship. *BMC Public Health*. 2015Apr 3;15:328.
18. American Heart Association. Understanding and Managing High Blood Pressure. [Online]. 2014. Available at: https://www.heart.org/idc/groups/heart-public/@wcm/@hcm/documents/downloadable/ucm_461840.pdf. Accessed April 3, 2017.
19. Centers for Disease Control and Prevention. High Blood Pressure Risk Factors. [Online]. 2014. Available at: https://www.cdc.gov/bloodpressure/risk_factors.htm. Accessed April 3, 2017.
20. Mayo Clinic. Diseases and ConditionsHigh blood pressure (hypertension). [Online]. 2016. Available at: http://www.mayoclinic.org/diseases-conditions/high-blood-pressure/basics/risk-factors/con-20019580. Accessed April 3, 2017.
21. Pinto E. Blood pressure and ageing. Postgraduate Medical Journal. 2007 Feb;83(976):109-114.
22. Tesfaye F, Nawi NG, et al. Association between body mass index and blood pressure across three populations in Africa and Asia. Journal of Human Hypertension. 2007;21:28–37.
23. Martins D, Tareen N, Pan D, Norris K.The relationship between body mass index, blood

pressure and pulse rate among normotensive and hypertensive participants in the third National Health and Nutrition Examination Survey (NHANES). Cell MolBiol (Noisy-le-grand). 2003 Dec;49(8):1305-9.
24. Masaki KH, Curb JD, Chiu D, Petrovitch H, Rodriguez BL. Association of body mass index with blood pressure in elderly Japanese American men. The Honolulu Heart Program. Hypertension. 1997 Feb;29(2):673-7.
25. Papathanasiou G, Zerva E, Zacharis I, et al. Association of High Blood Pressure with Body Mass Index, Smoking and Physical Activity in Healthy Young Adults. The Open Cardiovascular Medicine Journal. 2015 Feb 27;9:5-17