

## Welding fumes exposure, body mass index and duration of smoking decrease physical fitness among welders

Rudy Wahyu Perdana, Bastaman Basuki, Fikry Effendi

Department of Community Medicine, Faculty of Medicine University of Indonesia

### Abstrak

**Latar belakang:** Paparan asap pengelasan dapat mengganggu kesehatan, antara lain penurunan kebugaran jasmani. Penelitian ini bertujuan menganalisis efek paparan asap pengelasan terhadap kebugaran jasmani pengelas.

**Metode:** Penelitian menggunakan desain potong lintang dan subjek penelitian dipilih secara purposif di antara pengelas di suatu pabrik knalpot di sekitar Jakarta tahun 2012. Beberapa karakteristik demografi, riwayat pekerjaan, dan kebiasaan subjek diperoleh dengan wawancara. Kebugaran jasmani diperiksa dengan metode Queen's College Step Test. Total paparan asap dinilai menggunakan metode semi kuantitatif yaitu perkalian paparan asap dengan masa kerja sebagai pengelas.

**Hasil:** Subjek penelitian berjumlah 110 orang, yang berusia antara 19-55 tahun, dengan masa kerja 1-16 tahun. Paparan asap diperusahaan sebesar  $15 \text{ mg/m}^3$  menurut data pemeriksaan rutin perusahaan tahun 2012. Umur dan aktivitas fisik tidak berkorelasi terhadap tingkat kebugaran jasmani pengelas. Akan tetapi didapatkan korelasi negatif antara total paparan asap, index massa tubuh (IMT), dan kebiasaan lama merokok terhadap tingkat kebugaran jasmani pengelas. Korelasi terhadap tingkat kebugaran jasmani pengelas tersebut adalah: total paparan asap [koefisien regresi ( $r$ ) = -0,07; 95% koefisien interval (CI) = -0,10; -0,04]; IMT ( $r$  = -0,38; 95% CI = -0,64; -0,09); dan kebiasaan lama merokok ( $r$  = -0,16; 95% CI = -0,28; -0,04)

**Kesimpulan:** Peningkatan paparan asap pengelasan, index massa tubuh, dan lama merokok menurunkan tingkat kebugaran jasmani pengelas. (*Health Science Indones 2012;1:37-40*)

**Kata kunci:** paparan asap, kebugaran jasmani, Queen's College Step Test

### Abstract

**Background:** Welding fumes exposure caused health disorders, one of them are decreasing the level of physical fitness. This study aimed to analyze the effect of welding fumes exposure with the level of welder's physical fitness.

**Methods:** This cross-sectional using purposive selected by sampling selection method among welders in the muffler factory at outskirts of Jakarta in 2012. Several characteristic demography, occupational history, and habits were obtained through interview. Welding fumes exposure obtained by semi quantitative method. Physical fitness was obtained by physical examination using Queen's College Step Test.

**Results:** The total of subjects in this study were 110 people, 19-55 years of age, total duration of work between 1-16 years. We found that there were no significant association between the age and physical activity of respondents with the level of welder physical fitness. We noted negative correlation between the total fume exposure, body mass index, duration of smoking habits and the level of welder physical fitness. The correlation were: the total fume exposure [regression coefficient ( $r$ ) = -0,07; 95% confidence interval (CI) = -0,10; -0,04]; body mass index ( $r$  = -0,38; 95% CI = -0,64; -0,09); and duration of smoking habits ( $r$  = -0,16; 95% CI = -0,28; -0,04).

**Conclusion:** Increase in total welding fumes exposure, body mass index, and duration of smoking habit will be decrease welder physical fitness. (*Health Science Indones 2012;1:37-40*)

**Key words:** Total welding exposure, physical fitness, Queen's College Step Test.

Welding process involved in the process of muffler production. High temperature and pressure during the process produces fume metal particles and other combustion products. These resulting fumes cause several disruptions to health, among others, physical fitness. Several factors including physical activity, body mass index, smoking habit, age and many other factors influence physical fitness.<sup>1</sup>

Patil reported a decline in the index of physical fitness among farmers in 2012.<sup>2</sup> The result of another study by Boyce in 2006 also proves a significant decrease in physical fitness to policeman in the United Kingdom with smoking habit compared to those without smoking habit.<sup>3</sup> In Indonesia, Diana et al. in 2008 reported a prevalence of poor fitness levels associated with lack of physical activity among cement factory workers.<sup>4</sup>

Although many studies have been done, research on the correlation of exposure to welding fumes to physical fitness among welding workers in Indonesia has not been done. Therefore, research must be done on the correlation between welding fume and welders' physical fitness along with other influencing factors so that welders can reach an excellent level of physical fitness in accordance to their level of physical activity.

This paper presents the effect of welding fume exposure and other risk factors towards the level of physical fitness among welders.

## METHODS

This cross sectional study used purposive sampling method among welders in a muffler factory at outskirts of Jakarta in 2012.

The participating subject criteria were welder: (1) aged 18-55 years; (2) did not had experience any health problems on the Physical Activity Questionnaire (PAR-Q) sheet, and (3) willing to participate this study who signed written consent. Meanwhile, the drop-out criteria were subjects who did not finish the physical fitness examination.

Prior to the interview, we explained informed consent and emphasized that the research result will be kept confidential, and did not associated with their health condition record on the company's administration. The interview consisted of age, length of work, physical activity, smoking habit, and history of illness.

Physical activity consisted of daily activity habits (cooking, sweeping, mopping with a mop, playing guitar, singing while descending staircase, shopping, praying (*shalat*), washing dishes, making beds, playing with children at home, washing vehicles, going up the stairs, cleaning up the yard, mopping without a mop, gardening, playing with the children outside the house, cleaning the bathroom, showering, holding a child, playing drums, lifting heavy groceries, arranging furniture), habits at work (typing, writing reports, standing without lifting, welding, sitting, walking casually in the workplace, standing, lifting light items, welding while standing, painting, walking briskly at work, standing, lifting heavy objects, digging), exercise habit (warming up before exercise, playing billiard, playing using ball without running, leisure swimming, dancing, badminton, hiking, gymnastic exercise, fishing, table tennis, swimming quickly, basketball, tennis, pushups, sit ups, football, martial arts training) and traveling habits (brisk walking <3 km/hour, riding a bike, taking public transportation, brisk walking >3 km/hour, cycling, walking on the grass, running, quick cycling).

These physical activities were divided into mild, moderate, heavy. Mild activities were scored 3.3 METs. Meanwhile moderate activities were worth 4.0 METs, and heavy activities 8.0 METs. Physical activities for the last week were multiplied by the number of minutes per day.<sup>5</sup> The total physical activities METs are then converted into Mega Calories (MCal).

Blood pressure, height and weight assessment were performed before the physical fitness examination. Physical fitness level was assessed using Queen's College step test method.<sup>6</sup>

Data of the welding fume exposure based on factory's environmental assessment data. A semi quantitative method was used to calculate total exposure on each subject by multiplying the factory's annual environmental assessment result with the subject's length of work as welders.<sup>7</sup>

In this study, the unit for each risk factors were: age (years), body mass index (kg/m<sup>2</sup>), duration of smoking habit (years), physical activity (MCal), total fume exposure (mg year/m<sup>3</sup>) and physical fitness (ml/kgBW/minute). We used *The Asia-Pacific Perspective criteria* body mass index (BMI) categories,

Out of 196 welder workers who were working in the participating factory, we excluded 46 who were

still under contract negotiation with the company. In addition, 26 were excluded from the study (12 did not present during the physical fitness examination, two subject had asthma, two subject had cold, 10 could not finish the physical fitness examination). Leaving 124 subjects the study.

Furthermore, 14 subjects who had low BMI (less than 18.5 kg/m<sup>2</sup>) were exclude, leaving the final subject 110 subjects for this analysis.

Analysis used linear regression using STATA9. This study has been granted ethical approval from the Ethical Commission in Faculty of Medicine, University of Indonesia.

## RESULTS

Table 1 shows physical fitness was homogenous among the subjects (variation coefficient 10.5%). On the other hand, duration of smoking among subjects varies much (variation coefficient 111.6%) while the most homogenous were level of education (variation coefficient 2.2%). Furthermore, Table 2 shows that an increase of age and physical activity might decrease physical fitness.

Table 1. Some demographic and working characteristics and risk of physical fitness

	n	Mean	Std. dev	Min	Max	Var Coef (%)
Age (years)	110	28.15	6.13	19	41	21.7
Education (years)	110	12.03	0.29	12	15	2.3
Body Mass Index (kg/m <sup>2</sup> )	110	23.25	3.02	19	32	13.0
Duration of smoking habit (years)	110	5.96	6.65	0	25	111.6
Physical activities (MCal)	110	16.70	5.03	10	32	30.1
Duration of work (years)	110	6.81	4.41	1	16	64.7
Total fumes exposure (unit)	110	36.53	23.74	5	86	64.9
Fitness (ml/kgBW/minute)	110	45.78	4.83	32	58	10.5

Table 2. Correlation between of age, physical activity with physical fitness

	Crude regression coefficient	95% confidence interval	P
Age (year)	-0.39	-0.52 ; -0.26	0.000
Constant	56.90	53.15 ; 60.64	0.000
Physical activity (ml/kgBW/minute)	-0.17	-0.35 ; 0.02	0.073
Constant	48.54	45.39 ; 51.69	0.000

Table 3 (the final model) shows that there risk factors (body mass index, duration of smoking and total exposure to welding fumes) related to physical fitness. The highest was BMI, and the lowest was total fumes exposure.

Therefore, the equation for physical fitness prediction = 58.33 – (0.38 x BMI) – (0.16 x duration of smoking) – (0.07 x total exposure to welding fumes).

This equation only applies to subject with characteristic similar to this study's subjects.

Table 3. Association between body mass index, duration of smoking habit, and total fumes exposure with physical fitness level

	Adjusted regression coefficient	95% confidence interval	P
Body mass index (kg/m <sup>2</sup> )	-0.38	-0.64 ; -0.09	0.010
Smoking habit (year)	-0.16	- 0.28 ; - 0.04	0.012
Total fumes exposure (year)	-0.07	-0.10 ; -0.04	0.000
Constant	58.33	52.64 ; 64.03	0.000

## DISCUSSION

There were several limitations to this study, among others. The information obtained. Biased information might come from data collection using questionnaire.

Final physical activity level was measured with a questionnaire that consisted of four physical activity habit variables. Assessment with scoring may not be accurately predicting the real level of physical activity. This is shown by the result of the study that could not prove a significant correlation between physical activity and physical fitness. In addition, physical activity, especially sports activities not significantly correlated with physical fitness in this study, probably caused by sports activities conducted by the respondents only in the form of habit, not a routine activity. This is consistent with the theory that sports activities have a significant correlation with physical fitness if done regularly every week (at least 3 times a week) with a duration of at least 30 minutes.<sup>8</sup>

Besides that, in this study, fume exposure data is obtained only from one area, hence unable to represent the exposure condition in the whole factory.

After linear regression is applied, the total exposure to welding fume shows a significant association with the

decrease of physical fitness among welders [regression coefficient ( $r$ )=-0.07; 95% interval coefficient (CI) = 0.10;-0.04]. Therefore we can conclude that increase of 1 (one) unit of fume exposure will decrease physical fitness of 0.07 ml/kgBW/minute. This is similar to a case control study that Nezhad previously has done to workers in steel factory in Iran; where the higher the exposure to steel melting fumes, the lower the physical fitness of the workers ( $r$ =-0,109;  $p$ =0,05).<sup>9</sup>

Body mass index also turned out to have significant association with the risk of decreasing physical fitness among welders after linear regression is applied. In this context, the higher the body mass index, the lower the physical fitness [ $r$ = -0.38; 95% CI = -0.64;-0.09].<sup>10</sup>

Another thing that turned out to have significant association with the risk of decreasing physical fitness among welders after linear regression is smoking habit; in which the longer the habit has begun, the lower the physical fitness [ $r$ = 0.16;95% CI = -0.28;-0.04]. Hence we can conclude every increase of one year in the duration of smoking will decrease the  $VO_2$ max as much as 0.16 ml/kgBW/minute. A similar result is also obtained by previous studies. The study done by Boyce on 218 English policeman found a significant drop on physical fitness among smoking policeman ( $p \leq 0.05$ ).<sup>[3]</sup> A similar result is also obtained on a case control study done on workers on a cement factory in 2008. where heavy smokers are found to have 9.2 times the risk of having a bad physical fitness (OR = 9.23; $p$ =0.000) in comparison with non-smoker workers.<sup>4</sup> On a cohort study done by Bridger, there was a correlation between smoking habit with the decrease of physical fitness in among workers in naval service in the UK (RR=1.6; CI=1.1-1.9).<sup>11</sup>

Our final model noted a linear equation: physical fitness =  $58.33 - (0.38 \times \text{BMI}) - (0.16 \times \text{duration of smoking}) - (0.07 \times \text{total exposure to welding fumes})$ . This equation only applies to subject with characteristic similar to this study's subjects. This might be due to the other factors that are not looked into in this study, such as previous history of illness, gender, numbers of cigarette smoked, and duration of work. For example, a subject with 27 kg/m<sup>2</sup> BMI who has been smoking for 15 years with total fumes exposure of 43 units will have a physical fitness prediction of  $58.33 - (0.38 \times 27) - (0.16 \times 15) - (0.07 \times 43) = 42.66$  ml/KgBW/minute.

In conclusion, increased total welding fumes exposure, body mass index and duration of smoking habit decreases welders physical fitness.

### Acknowledgments

The authors would like to thank all the subjects who were willing to participate in this study, and also to the related company.

### REFERENCES

1. Sultan A, Alkhelaiwi T. Health hazards of welding fumes. Saudi Med J 2003;24:1176-82.
2. Patil R, Doddamani B, Bhutkar M, et al. A comparative study of physical fitness among rural farmers and urban sedentary group of gulbarga district. Al Ameen J Med Sci 2012; 5:39-44.
3. Boyce R, Perko A, Jones G. Physical fitness, absenteeism and workers compensation in smoking and non smoking police officers. Occup Med 2006;56: 353-6.
4. Diana D, Basuki B, Kurniarobbi. Low physical activity work related and other risk factors increased the risk of poor physical fitness in cement workers. Med J Indones 2009;18:201-5.
5. Guidelines for data processing and analysis of the international physical activity questionnaire. c2005 - [cited 2012 Mei 20]. Available from : <http://www.ipaq.ki.se/scoring.pdf>.
6. American College of Sport Medicine. Acsm's guidelines for exercise testing and prescription. 7<sup>th</sup> edition. Baltimore: Williams & Wilkins.2006.
7. Ministry of Man Power Occupational Safety and Health Division. A semi quantitative method to assess occupational exposure to harmful chemicals. Ministry of Manpower Republic of Singapore.
8. Dickerson L, Gibson M. Management of hypertension in older persons. Am Fam Physician 2005;71:469-76.
9. Nezhad M, Siahkuhian M. The effect of air pollution on cardio respiratory fitness of steel plant co. Workers. Mid-East J Sci Res. 2012;11:225-9.
10. Jaafari L. Health-related anthropometric measures in connection with physical fitness factors. Mashhad: Islamic Azad University; 2012
11. Bridger R, Munnoch M, Dew A, et al, Smoking, BMI and psychological strain and fitness in the naval service. Occup Med. 2009;59:195-6.