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Poor Handgrip and Blood Lead Among Adult Population in Selangor, Malaysia

Mohd. Shahrol Abd. Wahil[1], Mohd Hasni Jaafar[1]

[1]Department of Community Health, Faculty of Medicine, National University of Malaysia Medical Centre, Malaysia.

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ABSTRACT

Background: Lead exerts significant health effect towards human including neuropathy. The peripheral neuropathy is simply measured by handgrip strength test. Objective: To determine the relationship between blood lead and the hand grip strength among the adult population. **Methods:** This was a cross sectional study conducted in Tanjung Karang, state of Selangor, Malaysia, from January 2013 until December 2013, involved 144 adults. Anthropometric measurement and hand grip strength test were done according to a standard protocol. Blood Pb was analysed using ICP-MS at an accredited academic laboratory. **Results:** The prevalence of blood Pb level of 5µg/dL or more was 9.7%. The handgrip strength was directly proportionate with the blood Pb level ($p>0.05$). Associated factors with abnormal blood Pb are found among female respondent ($p<0.01$), elderly ($p<0.05$) and those with higher BMI ($p<0.01$). **Conclusion:** There was a trend of association between blood Pb and handgrip strength, which indicate the peripheral neurotoxicity effect of Pb do occurs at a low blood concentration level.

Keywords: Lead, Handgrip strength, Peripheral neuropathy.

INTRODUCTION

Lead (Pb) is a grey soft, heavy metal widely distributed in the earth's crust. Pb can be found in batteries, electric and electronic,[1] paints,[2-5] toys,[6-8] vehicle fumes and even food.[9-15] Pb can be absorbed directly through the lungs in particulate form as well as the gastrointestinal tract through oral ingestion.[4,16] There were number of experimental studies conducted on rats to find the effect of minerals towards Pb level. The study findings were consistent with the hypotheses; the Pb level was inversely proportionate to the level of minerals.[17-23] Pb is mainly deposited in the bone followed by liver, kidney, brain and other soft tissue. In general, the deposition of Pb in the soft tissue can remain up to three years.[24] An example of soft tissue is adipose tissue. Adipose tissue is consists of adipocytes, connective tissue matrix, nerve tissue, stromovascular cells and immune cells.[25] It is assumed that with the increase amount of fat tissue, the accumulation of Pb will be greater. The decrease pattern of blood Pb level is associated with increase of body fat.[26] Pb has an effect on peripheral nervous system.[27,28] The effect of Pb on the peripheral nervous system is mainly through the process of axonal degeneration and demylination.[29,30] There were several experimental studies done on animals from year 1960's to 1980's to prove such theory.[31-35] The effect of Pb can occur at very low dose.[36-38] Even in low concentration of Pb, the symptom of peripheral muscle weakness can develop.[39] In a study, the prevalence of peripheral muscle weakness among 160 workers exposed to Pb was 7.5%.[40] About 6.5% of patients who had focal complaints referable specifically to the peripheral nervous system were due to Pb poisoning.[41] There are several types of paralysis of the limbs due to Pb toxicity which lead to muscle atrophy, one of which is particularly involving proximal upper limb.[42] Muscle strength of the upper limb can be measured quantitatively by Hang Grip Strength Test.[43-45] The test can be used for the assessment and prediction of limb weakness associated with peripheral neuropathy.[44] Pb has the potential to cause peripheral muscle weakness by the action of demyelination and degeneration of Schwann Cells of peripheral nerves. In this study, the main objective is to determine the relationship between blood Pb and hand grip strength among the adult population.

Name & Address of Corresponding Author
Dr. Mohd Hasni Jaafar
Department of Community Health,
Faculty of Medicine,
National University of Malaysia Medical Centre,
Malaysia.

MATERIALS AND METHODS

This was a cross sectional study conducted among adult population in Tanjung Karang, state of Selangor, Malaysia in 2013. A total number of 144 respondents were enrolled in the study and with their verbal consent obtained. A standardised questionnaire adapted from Population, Urban and Rural Epidemiology (PURE) study was used, which validated and described elsewhere.[46,47] The handgrip strength was measured using a calibrated dynamometer.[48] A total of three measurements were recorded with intervals of at least 30 seconds. The highest value was used for the analysis.[49] About 10mls of venous blood sample was obtained from respondents contained in a heavy metal-free Ethylene-Diamine-Tetra-Acetic Acid (EDTA) tube.[50] It was labelled and kept in -22°C freezer. Blood Pb concentration was determined using the inductively coupled plasma mass spectrometry (ICP-MS). The reference values for blood Pb level for both gender and specific age group adopted by the Agency for Toxic Substances and Disease Registry.[51] The information gathered was analysed using the Statistical Package for Social Science (SPSS Version 22) with the value of p<0.05 is considered as the significant value. The study had an approval from the Research and Etiquette Committee, UKM Medical Centre (FF-2013-313).

RESULTS

Table 1: Descriptive Analysis of the Respondents

Variable	Number of respondents (n)	Percentage (%)
Age Group (year)		
35-39	8	5.6
40-49	33	22.9
50-59	49	34.0
Above 59	54	37.5
Gender		
Female	89	61.8
Male	55	38.2
Education Level		
None	15	10.4
Primary	77	53.5
Secondary	49	34.0
College/University	3	2.1
Marital Status		
Never Married	6	4.2
Currently Married	117	81.3
Living with a partner	5	3.5
Widowed	16	11.1
Blood lead concentration		
Low (<5 µg /dL)	130	90.3
High (>5 µg /dL)	14	9.7

Table 2: Mean and Standard Deviation of Variables

Variables	Mean	SD
Age (year)	55.21	9.21
Blood lead (µg/dL)	2.47	1.70
Handgrip (kg)	23.86	9.28

SD = Standard Deviation,

A total number of 144 respondents were recruited in this study, with age range from 35 to 70 years old [Table 1]. The majority of the population was elderly group. The mean age of respondents was 55.21 (±9.21) year-old [Table 2]. Male were lesser than female with ratio male to female of 2:3. There were 10.4% of respondents have no formal education. The majority of the respondents (53.5%) have attended primary school. About 81.3% of total respondents were married and lived together with their spouse. About 90.3% of total respondent had blood Pb level less than or equal to 5µg/dL, which considered as low blood Pb level.[52] The mean blood Pb level was 2.47 (±1.70) µg/dL. The mean handgrip strength among the respondents was 23.86 (±9.28) kg force.

Table 3: Comparison of Mean of Each Respondent Factor

Variable	Mean handgrip strength (Kg ± SD)	Test
Age group (year)		
35-39	27.63 ± 9.52	F = 3.364*
40-49	26.94 ± 9.45	
50-59	24.16 ± 8.27	
Above 59	21.15 ± 9.43	
Gender		
Male	31.07 ± 9.22	t = 8.377**
Female	19.40 ± 5.93	
Education Level		
None	15.73 ± 6.68	F = 6.605**
Primary	23.38 ± 9.01	
Secondary	26.73 ± 8.93	
College/University	30.00 ± 9.16	
Marital Status		
Never Married	28.00 ± 16.41	F = 3.364**
Currently Married	24.21 ± 9.26	
Living with partner	19.60 ± 6.11	
Widowed	21.06 ± 6.01	
Blood Pb		
≤ 5 µg/dL	24.07 ± 9.52	t = 0.819
> 5 µg/dL	21.93 ± 6.53	

SD = standard deviation, *p<0.05, **p<0.01.

Table 4: Simple Linear Regression Analysis of Factors and Outcomes

Variable	Constant	x Factors	r	r ²	Regression Analysis
Handgrip Strength	38.134**	-0.259 x Age**	0.257	0.066	F = 10.008**
	25.460**	-0.647 x Pb	0.118	0.014	F = 2.003

r = correlation coefficient; r ² = coefficient of determination, *p<0.05, **p<0.01

The study found that the mean handgrip strength seems to be reduced significantly as the age group increased [Table 3]. Male have significantly higher mean handgrip strength compared to female respondents. Respondents with no formal education had the lowest hand grip strength of 15.73 kg force may be due to old age in which majority of them have no formal education. As the education background improved, the handgrip becomes stronger significantly. Respondents who never married were found to have higher mean handgrip strength compared to other marital status and this was statistically significant. The mean for handgrip strength was found to be higher in group of respondents with low blood Pb level compared to those with high blood Pb level, but this was not statistically significant.

[Table 4] shows the simple linear regression analysis and correlation test between quantitative factors and the quantitative outcomes. The blood Pb level was only directly proportionate to the age. An increase of one year of age will decrease significantly the handgrip power by 0.26 kg force. Blood Pb showed an inverse effect toward handgrip strength which able to reduce handgrip strength by 0.65 kg force with increment of 1.0 µg/dL. Nevertheless, it was statistically non significant.

DISCUSSION

The hand grip strength test is a reliable test to determine peripheral muscle weakness,[52,53] which is a proxy outcome of peripheral neuropathy. The study revealed that the handgrip strength is decreasing as the age advanced. The condition is probably due to declining of skeletal muscle tissue due to aging process.[54-56] The handgrip strength was found to be higher among male compared to female respondents, which supported by another study.[48] Further analysis, the study's male respondents was found to have a lower blood Pb level compared to female respondents. Those with lower education were found to showed lower handgrip power significantly. The condition may be due to the higher blood Pb among them. However, the difference between the education categories for blood Pb was not significant.

The neurotoxicity properties of Pb can be seen from the statistical test findings. The higher Pb level will weaken the hand grip strength more. The manifestation of peripheral muscle weakness is still present even in low Pb level. The findings supported by previous study.[57]

CONCLUSION

The prevalence of high blood Pb level above 5 µg/dL was 9.7%. There was a pattern where the hand grip strength has an inverse correlation with age, education status, and blood Pb. The handgrip also has connection with marital status, and gender. Further study in the future might help to fill in the gap and improve the current knowledge.

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