PUBLIC HEALTH RESEARCH

Lower Cut off Point for Blood Lead and Risk of Myocardial Infarction at a Tertiary Hospital in Malaysia: A Case-Control Study

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ABSTRACT

Received 25 August 2020
Accepted 7 March 2021

Introduction Lead (Pb) is one of the pollutants that can cause adverse effects on human health. Exposure to Pb has received much attention in the past decades due to its nearly persistent properties in the environment. Blood Pb measurement is the most convenient as well as most feasible to indicate toxicity exceeded the standard limit of 10 µg/dL. This study aimed to assess the association between blood Pb and myocardial infarction.

Methods This was a case-control study conducted at a tertiary hospital in Kuala Lumpur, Malaysia. This study enrolled about 109 respondents; 71 cases of myocardial infarction and 38 non-cases of myocardial infarction. Study instruments include questionnaires on demographic factors (age, gender, and ethnicity), socioeconomic factors (education, household income, occupation), and venous blood lead level. The blood Pb was measured using Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

Results The median (IQR) of blood Pb among the case group was higher compared to the control groups, 3.72 (0.04 – 96.09) µg/dL and 2.81 (0.73 – 6.23) µg/dL respectively. No difference between high (> 10 µg/dL) and normal (≤10 µg/dL) blood Pb with CVD. However, there was a significant association between high normal blood Pb concentration (≥ 5.00 µg/dL) and myocardial infarction ($\chi^2 = 4.397$; $p = 0.036$).

Conclusions There is a relationship between lower blood Pb level and the occurrence of myocardial infarction. No difference was found between the blood Pb limit of 10 µg/dL and CVD. The findings of this study are very important and provide new information regarding the lower cut off point for blood Pb and outcome of CVD especially myocardial infarction..

Keywords Blood lead - myocardial infarction - CVD Risk factors - lower cut off point.

INTRODUCTION

Myocardial infarction is a leading cause of morbidity and mortality in the United States. About 1.3 million cases of nonfatal myocardial infarction are reported each year, for an annual incidence rate of about 600 instances per 100,000 people. In 2001, approximately 20 per cent of all deaths at the Ministry of Health hospitals were due to myocardial infarction and strokes. Two-thirds of these deaths were due to myocardial infarction and the rest to stroke.[1] It is a silent killer in which the symptoms show only in its advanced stage and symptoms will occur until the onset of a sudden heart attack in some people.[2]

According to Alissa and Ferns (2011) in their review article, they stated that the factors of cardiovascular diseases (CVD) include environmental, dietary, and lifestyle behavioural. However, there are other factors related to the occurrence of CVD.[3] First, non-modifiable factors like advancing age, male gender, family history (genotype), metabolic disorders such as hypertension, diabetes mellitus, metabolic syndrome, and obesity, and other factors like abnormal blood trace elements and heavy metals, lipoprotein, heomocystein, inflammatory markers, and prothrombotic factors.[3]

The risk factor of CVD such as heavy metal is a potentially modifiable risk factor for cardiovascular outcome. The evidence that lead (Pb) exposure is associated with a variety of adverse cardiovascular outcomes is growing.[3,4] In addition, The World Health Organization stated that Pb exposure is responsible for CVD.[5] This study aims to assess the association between blood lead levels with the risk of myocardial infarction.

METHODS

This was a case-control study involving 109 participants enrolled in a tertiary hospital in Kuala Lumpur, Malaysia. The cases were patients diagnosed with myocardial infarction, while controls were those not diagnosed with myocardial infarction. The instruments of the study include a standardised questionnaire (sociodemographic factors such as age, gender, and ethnicity; socioeconomic factors like education, household income, and occupation) and measurement of blood lead level content using *Inductively coupled plasma mass spectrometry* (ICP MS). Written consents were obtained from patients themselves for data collection and blood sample. The blood samples were collected using Sinclair & Dohnt's method and analysed with ICPMS. All data were analysed using SPSS version 22. The Mann-Whitney U-Test was used to compare the differences between the two variables. Multiple regression using the stepwise method was used to determine the factors which most influence the blood lead concentration. A p-value of less than 0.05 is taken as a significant point.

RESULTS

A total of 109 respondents enrolled in this study, which consists of 71 (65.4%) cases and 38 (34.6%) controls. Both groups were dominated by male, 78.9% and 68.4% for case and control respondents (Table 1). Most of the case group respondents were slightly younger than the control group. However, both differences were not significant for age group ($\chi^2 = 0.662$; $p = 0.416$) and gender ($\chi^2 = 0.944$; $p = 0.331$) (Table 2). Malay was the major ethnic in both case and control groups. Analysis found Malay as a risk factor for the myocardial infarction ($\chi^2 = 5.099$; $p = 0.024$). There were significant different between the case and control groups for education level ($\chi^2 = 3.274$; $p=0.700$), household income ($\chi^2 = 0.065$; $p=0.799$) and working status ($\chi^2 = 0.421$; $p=0.517$). About 33.8% of the cases have a blood Pb concentration of ≥ 5.00 µg/dL compared to only 13.2% among the control group. The differences were significant ($\chi^2 = 4.397$; $p=0.036$).

Further analysis, the study found that the case group has a higher median (IQR) of blood Pb (3.72 µg/dL; IQR 0.04 – 96.09) compared to the control group (2.81 µg/dL; IQR 0.73 – 6.23). Blood Pb is a risk factor for myocardial infarction at a lower cut of point concentration than 10 µg/dL.

Table 1 Associated risk factors among respondents

Factors		Case (n=71) n (%)	Control (n=38) n (%)	χ^2	p	OR	CI 95%
Demography							
Age	≥ 60 years old	32 (45.1)	21 (55.3)	0.662	0.416	0.664	0.301
	< 60 years old	39 (54.9)	17 (44.7)				
Gender	Male	56 (78.9)	26 (68,4)	0.944	0.331	1.723	0.707
	Female	15 (21.1)	12 (31.6)				
Ethnic	Malay	37 (52.1)	29 (76,3)	5.099	0.024*	0.338	0.140
	Non-Malay	34 (47.9)	9 (23.7)				
Socioeconomy							
Education	Low	59 (83.1)	25 (65.8)	3.274	0.700	2.557	1.026
	High	12 (16.9)	13 (34.2)				
Income	<RM2,500	48 (67.6)	24 (63.2)	0.065	0.799	1.217	0.533

	≥RM2,500	23 (32.4)	14 (36.8)				
Occupation	Working	47 (66.2)	22 (57.9)	0.421	0.517	1.424	0.633
Blood Lead	≥5 µg/dL	24 (33.8)	5 (13.2)	4.397	0.036*	3.370	1.166
	<5 µg/dL	47 (66.2)	33 (86.8)				

**p<0.05*

Table 2 Blood lead (Pb) concentration between the case and control groups

Variable	Blood Lead Levels (µg/dL)			
Blood Lead (N=109)	Median	IQR	Z	P
Blood lead (MI) (n=71)	3.72	0.04 – 96.09	-1.45	0.140
Blood lead (Non MI) (n=38)	2.81	0.73 - 6.23		

IQR = Inter Quartile Range

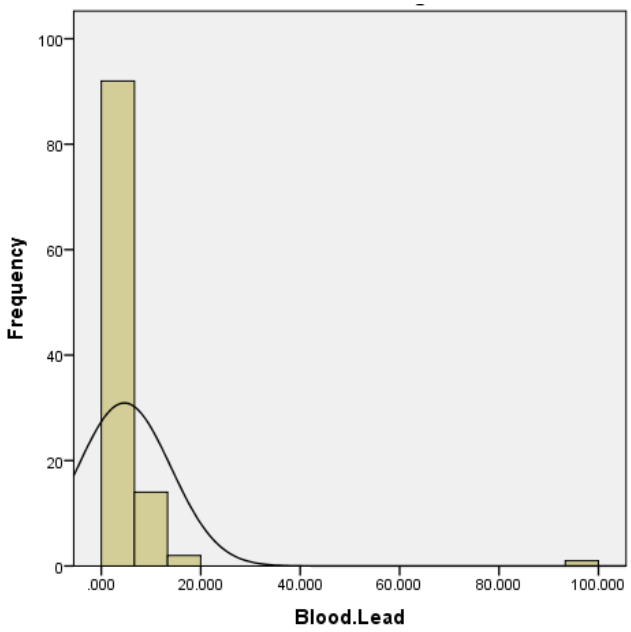

Figure 1 Distribution of blood lead levels

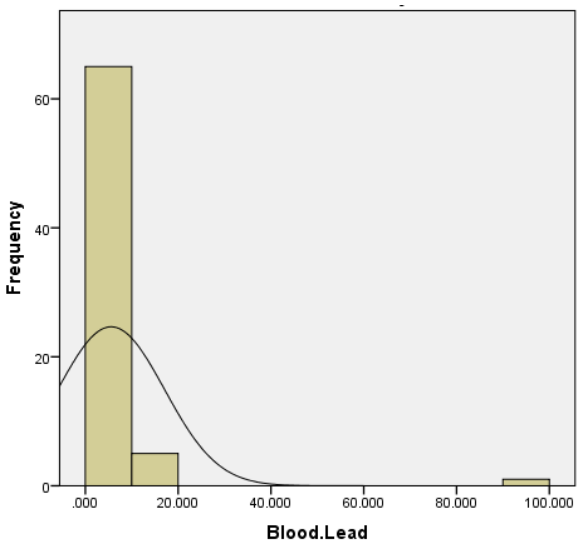

Figure 2 Distribution of blood lead levels in the case group

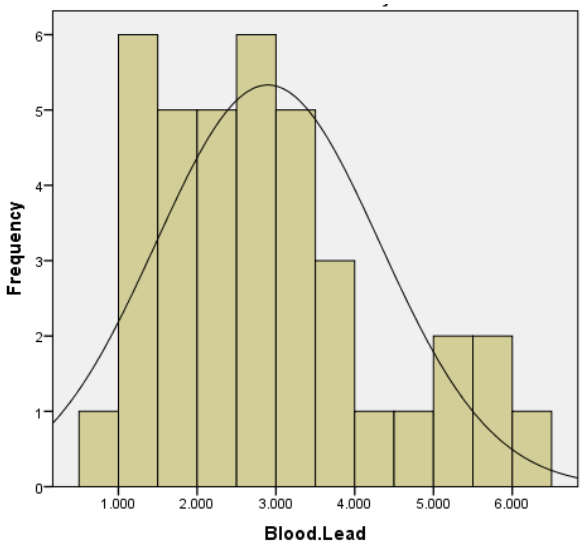

Figure 3 Distribution of blood lead levels in the control group

DISCUSSION

Myocardial Infarction (MI) can be linked to many risk factors, including demography, socioeconomic factors, and exposure to environmental agents. Conventional risk factors play a major role in CVD. The CVD burden afflicts both men and women, accounting for 34.0% of all deaths in female and 28.0% in the male in 1998.[6] In the United States, about 1.25 million people have a heart attack each year; about two-thirds of them were males. In Malaysia, women developed myocardial infarction 10 years later, after men with no difference in survival rate.[7] However, men have a higher tendency of getting MI, which similar to the finding of this study. This is also supported by Venskutonyte et al. (2010).[8] The ethnicity distribution showed a significant difference between case and control respondents. Minority races and ethnic group are at increased risk for CVD. For example, in Canada, there are marked differences between different ethnic groups in the prevalence and death rates from CVD.[9] The challenge of preventing CVD lies in identifying and addressing the most relevant components in each ethnic. There are many ethnics in this study, which are Malay, Chinese, and Indian. The results of the study revealed that Malay has a significant risk of MI ($\chi^2 = 5.099$; $p = 0.024$). This finding was supported by a study conducted by Lu et al. (2013) where they found that the Malays were the highest among the MI patients in Malaysia.[10]

The present study showed that there was no significant relationship between education level ($\chi^2 = 3.274$; $p = 0.700$) and MI. This is contrary to what had been reported in the literature, whereby those with advanced education were more knowledgeable about CVD.[11] In a study done by Kayaniyil et al. (2009) in Ontario, Canada, respondent's education of less than high school had significantly lower CVD knowledge.[11] The present study also demonstrated that there was no significant association between household income ($\chi^2 = 0.065$; $p = 0.799$) and occupation ($\chi^2 = 0.421$; $p = 0.517$) with MI. These factors also do not show a clear relationship because it is influenced by other factor factors and this study cannot relate to the socioeconomic factor and MI.

Blood Pb level of more than 10 µg/dL as the standard limit is normally indicated toxicity.[12] The half-life of Pb in the blood is approximately one month.[13] Jain et al (2007) have proved the association between blood Pb and CVD.[14] The result showed that the median blood Pb for the case group respondents was 3.72 µg/dL, which is higher compared with the control respondents (2.81 µg/dL). These values were lower than the study conducted among Kuala Lumpur children by Hashim et al. (2000),[15] which found that the mean blood Pb to be 5.6 µg/dL. The lower blood Pb concentration may because of the reduction of gasoline.[16] Using the lower cut point of 5.00 µg/dL determined by Menke et al. (2006), the case MI group has more respondents with higher blood Pb. [17] This showed a significant association between blood Pb at lower concentration with MI and this is following the study by Menke et al. (2006) that stated that there is a significant relationship between blood lead levels and cardiovascular disease.[17] The pathophysiology of Pb upon myocardial infarction is still not fully understand.

CONCLUSION

Several studies have been conducted relating the blood lead levels with myocardial infarction, but the risk factors studied are still limited. This study revealed that at a lower concentration of 5 µg/dL, blood Pb showed a significant association with MI. With the limitation of the study, a bigger and better future study should be conducted.

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