The Role of Urinary Cadmium and Lead Level on Pregnant Women Renal Function

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***Abstract*—Cadmium (Cd) and lead (Pb) are heavy metals which used in many industry and were confirmed as environmental toxin and mainly effects reproductive system and toxic to growing fetus. Determination of cadmium and lead level generally measure by spectrophotometric methods. But in this study, we used a method based on approach adjusting specific gravity. This study aimed to evaluate the potential effect of cadmium and lead exposure on pregnancy outcome by measuring their correlation on renal function. This study was performed between January to May 2013 and targeted 57 pregnant women as the control group (32 patients of normal pregnancy) and case group (25 patients of preeclampsia). For analyzing of the data, SPSS software version 17 was used and was examined by Mann-Whitney test and Spearman correlation test. We found that there are significant correlation between Cd an Pb exposure on urea level, urea-creatinine ratio, and GFR of the pregnancy patients (p < 0,05) but unlike to the creatinine serum.**

***Index Terms*—Preeclampsia, urea-creatinine ratio, glomerular filtration rate, specific gravity**

I. Introduction

Cadmium (Cd) and lead (Pb) are heavy metals which used in many industry, including semiconductor manufacturing, welding, soldering, ceramics and painting. These metal were confirmed as environmental toxin and mainly effects reproductive system and toxic to growing fetus, due to their ability to pass placenta from mother to child and directly deposit in growing fetal tissue, contribute to be infertile, wildly irregular hormone level, and pregnancy loss [1]-[4].

Pregnant women also maywant to consider eliminating sources of cadmium and lead from the house. Long-term exposure during pregnancy to even low concentrations of toxic metals, which have the ability to accumulate, often leads to irreversible damage to fetal developments and maternal morbidities including pre-eclampsia [5], [6]. Preeclampsia is a multisystem and multifactorial disease that affects both the mother and the fetus by vascular dysfunction and by intrauterine growth restriction and it is also associated with oxidative stress that marked by presence of an increase of arterial blood pressure, accompanied by proteinuria, oedema or both. One of the most contributors to the state of oxidative stress is exposure to excess toxic metals in the environment and the deficiency of bio-elements necessary for antioxidant defense mechanisms [6], [7]. Preeclampsia may causing several maternal complication include eclampsia, HELLP (hemolysis, elevated liver enzymes, low platelets) syndrome, liver rupture, pulmonary edema, renal failure [8].

Determination of cadmium and lead level generally measure by spectrophotometric methods. But in this study, we used a method based on approach adjusting specific gravity which developed by Vij and Howel [9].

Urinary cadmium and lead relation on pregnant woman renal function should be determined therefore many studies should be performed. This study aimed to evaluate the potential effect of cadmium and lead exposure on pregnancy outcome by measuring their correlation on renal function.

II. Material and Methods

This analytic case control study was carried out in mother treatment ward Mutiara Bunda Mother and Child Hospital in Martapura. This study was performed between January to May 2013 and targeted 57 pregnant women as the control group (32 patients of normal pregnancy) and case group (25 patients of preeclampsia) who were admitted for treatment or termination of pregnancy due to medical or obstetrical indications. The diagnostic criteria of preeclampsia consisted of blood pressure of 140/90 mmHg or more (using fifth phase sound of Korotkoff) and presence of proteinuria. Exclusion criteria included patient with history of chronic hipertension, kidney and liver failures, and diabetes. Both groups were matched by age (20-40 years), gestational age (≥ 20 weeks), social and economical situation (income and services such as education and health care).

Manuscript received June 20, 2013; revised August 26, 2013.

doi: 10.12720/jomb.3.1.55-58

Urinary cadmium and lead levels were analyzed by approach to adjust urinary specific gravity based on Vij and Howell formula [9]. Urea and creatinin were measured with colorimetric assay by end point methode [10] and kinetic method [11], respectively. We also used urea-creatinine ratio and glomerular filtration rate (GFR) by Cockroft-Gault equation [12].

Statistical Analysis

For analyzing of the data, SPSS software version 17 was used and was examined by Mann-Whitney test and Spearman correlation test. For all outcomes, a nominal p-value of $p < 0,05$ was considered significant.

III. Results

Based on the result of this study we found data from 57 samples, consist of 32 samples for control group (normal pregnancy) and 25 samples for case group (Preeclampsia). The characteristic data for those samples shown at Table I.

TABLE I. Maternal Demographic and Clinical Characteristic (mean±SD) in Normal Pregnant and Preeclamptic Women

Parameter	Normal Pregnancy (n = 32)	Preeclampsia (n = 25)
Age (years)	27,51 ±6,21	28,06 ±6,56
Systolic Blood Pressure (mmHg)	111,79 ±13,93	153,33 ±13,28*
Diastolic Blood Pressure (mmHg)	78,72 ±10,31	101,11 ±13,23*
Number of pregnancy (times)	2,15 ±1,09	1,7 ±0,82
Gestational Age (weeks)	33,53 ±10,95	38,15 ±1,96
Urinary Cd level (µg/L)	1.86±0.32	1.77±0.30
Urinary Pb level (µg/L)	1.84±0.29	1.77±0.30

*) : $p < 0,05$, significantly different.

Table I showed that age, number of pregnancy, gestational age, urinary Cd level, and urinary Pb level are not significant different ($p > 0,05$). But there is significant differences on systolic blood pressure and diastolic blood pressure of the normal group in comparison with preeclamptic group ($p < 0,05$).

Renal function test that we used were urea serum, creatinine serum, urea-creatinine ratio, and glomerular filtration rate. Those results on preeclamptic groups are not significantly different than the normal group (Table II).

TABLE II. Renal Function (mean±SD) in Normal Pregnant and Preeclamptic Women

Parameter	Normal Pregnancy (n = 32)	Preeclampsia (n = 25)
Urea (mg/dL)	25.57±10.78	29.69±9.75
Creatinin (mg/dL)	0.84±0.23	0.91±0.26
U/C Ratio	34.40±22.56	34.51±12.95
GFR (mL/min)	99.11±59.77	85.32±22.73

Spearman correlation between Cd and Pb exposure on renal function of normal pregnancy and preeclamptic groups showed (Figs. 1-4) that there are significant correlation between urinary Cd and Pb level on urea, urea-creatinine ratio, and GFR while there is no significant correlation on creatinine serum (Table III).

TABLE III. Correlation between Cd and Pb Exposure on Renal Function of Normal Pregnant and Preeclamptic Women

Correlation	Cd		Pb	
	r	p	r	P
Urea	0,488	0,000	0,536	0,000
Creatinin	0,135	0,317	0,041	0,762
U/C Ratio	0,579	0,000	0,428	0,001
GFR	0,358	0,006	0,139	0,302

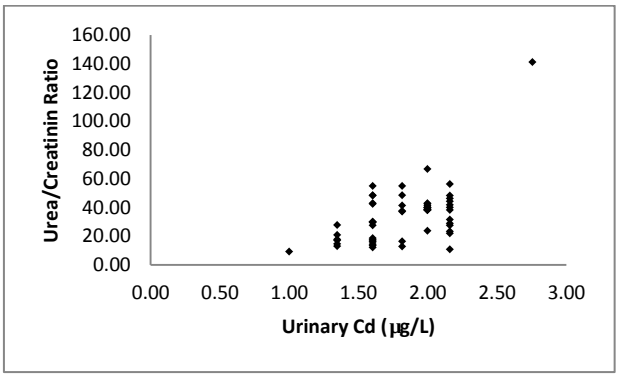

Figure 1. Correlation of urinary Cd level to urea-creatinine ratio of pregnant women

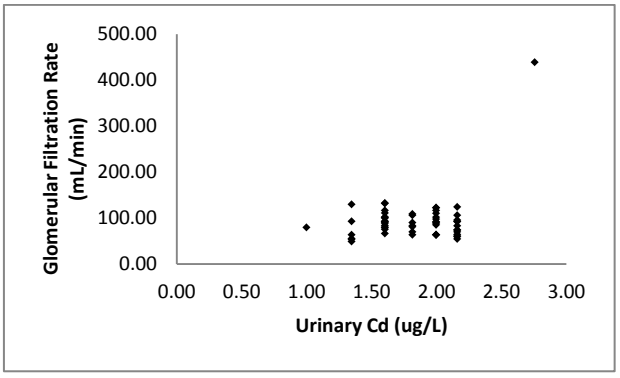

Figure 2. Correlation of urinary Cd level to glomerular filtration rate of pregnant women

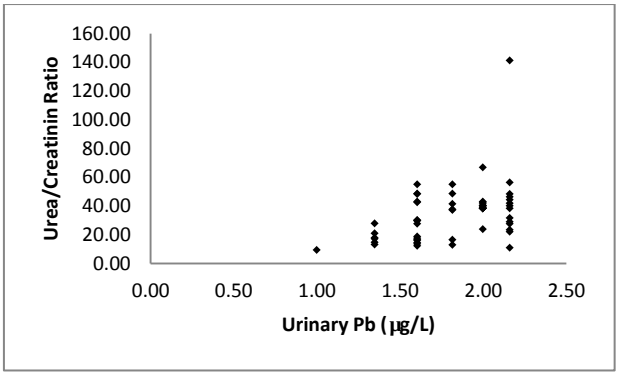

Figure 3. Correlation of urinary Pb level to urea-creatinine ratio of pregnant women

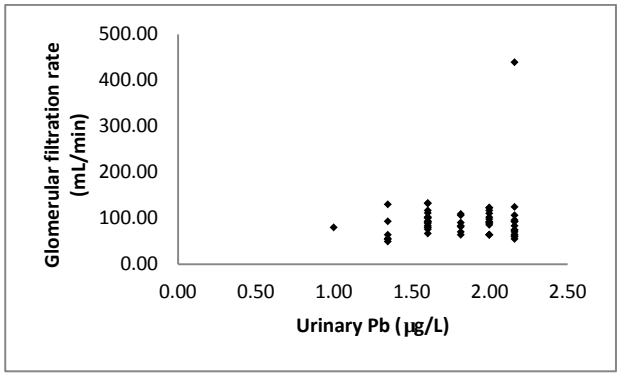

Figure 4. Correlation of urinary Cd level to glomerular filtration rate of pregnant women

IV. Discussion

Cadmium and lead were confirmed as environmental toxin and exposure to it could contribute to pregnancy loss [3], [4]. One study suggests that cadmium may damage the placenta and reduce weight of new born baby. Meanwhile lead can cause neurodevelopmental effects in the developing fetus and also the kidney is the critical target organ for cadmium and cadmium may increase risk for low bone-mineral density [5].

Long-term exposure during pregnancy to even low concentrations of toxic metals, which have the ability to accumulate, often leads to irreversible damage to fetal developments and maternal morbidities including pre-eclampsia [6]. Preeclampsia is a multisystem and multifactorial disease that affects both the mother and the fetus by vascular dysfunction and by intrauterine growth restriction and it is also associated with oxidative stress that marked by presence of an increase of arterial blood pressure, accompanied by proteinuria, oedema or both. One of the most contributors to the state of oxidative stress is exposure to excess toxic metals in the environment and the deficiency of bio-elements necessary for antioxidant defense mechanisms [6], [7]. Preeclampsia may causing several maternal complication include eclampsia, HELLP (hemolysis, elevated liver enzymes, low platelets) syndrome, liver rupture, pulmonary edema, renal failure [8].

In this study we found that there are significant correlation between Cd an Pb exposure on urea level, urea-creatinine ratio, and GFR of the pregnancy patients ($p < 0,05$). We suggest that renal function of pregnant women was also affected by toxicity mechanism of Cd and Pb, alone or co-exposure mechanism. Several studies also indicates that environmentally relevant concentration of dietary Pb only increases the frequency of Cd-induced damage to the kidneys and liver. This remains in some contrast to other studies indicating that Cd and Pb can produce toxicity in additive or synergistic manner both in vivo and in vitro. It is also evident from those studies that oxidative stress may be induced by the two metals. In this regard, Cd and Pb co-exposure produces significantly more lipid peroxidation in the kidneys of rats than either inorganic given alone [13].

Correlation between Cd and Pb exposure to creatinine serum were not significant. This show kidney damage due to those exposure were not significantly happen. We suggest there is defense mechanism involvement of pregnant women like antioxidant activity status that protect injury by oxidative stress induced by Cd and Pb exposure [14].

This study also showed urea-creatinine ratio between normal group and preeclamptic group are not significantly difference and likely still in normal range value ($U/C < 35$) but we proposed that Cd and Pb exposure on pregnant women may affected the renal function of pregnant women as reported by Akerstrom et al [15].

We use a different methods to measure urinary cadmium and lead levels. Generally, generally measure by spectrophotometric methods were used to measure cadmium and lead level but we use a method by approach to adjust urinary specific gravity based on Vij and Howell formula [9]. This method is also used by Fukui et al [16] to measure urinary lead level of non-smoking adult women in non-polluted areas in Japan. Although to accurately measure the lead level may be used the other spectroscopic methods [17].

V. Conclusion

We found that there are significant correlation between Cd an Pb exposure on urea level, urea-creatinine ratio, and GFR of the pregnancy patients ($p < 0,05$) but unlike to the creatinine serum. We hope that alternative study with other method can provide many information for heavy metal exposed community.

Acknowledgement

We thank to Dr. Danny Indrawardhana for supporting us many facility to finish this study.

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