

## Relationship between Renal Function Tests and the Levels of MDA, Zinc, and Cadmium among Painters in Sulaimani

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### Abstract

Kidney damage in workers within environments of highly expected exposure to toxin, including heavy metals, could be a primary marker to expect hazards in population exposed to low levels of many environmental pollutants. The present study was designed to evaluate the possible effect of environmental exposure to cadmium and zinc on renal function among painters in Sulaimani city. Cross sectional study was performed on 37 male painting workers in Sulaimani city. Each worker was interviewed using structured questionnaire. Twenty five non-exposed healthy subjects were included as control group. Venous blood samples (10 ml) were obtained by vein puncture from both subjects and utilized for estimation of serum urea, creatinine levels, serum levels of cadmium (Cd) and zinc (Zn), and for the estimation of malondialdehyde. The results show that serum urea levels were significantly elevated in painters; meanwhile, no significant difference was reported in serum creatinine levels. The results indicated that both serum levels of (Cd) and (Zn) were not significantly elevated in painting workers; however, MDA levels were significantly elevated in painters compared to control group. In conclusion, the association of cadmium and zinc levels with the disturbance in renal function is not clear in painters working in Sulaimani city.

**Keywords:** Painting workers, Cadmium, Zinc, renal function, oxidative stress

### العلاقة بين وظائف الكليتين ومحتوى الدم من الخارصين والكاديوم والمالونديالدهايد لدى عينة من الصباغين في السليمانية زين أورحمان أحمد<sup>\*1</sup>

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#### الخلاصة

تعتبر الكليتين من أكثر الأعضاء تضررا بالمواد السامة الموجودة في محيط العمل كالمعادن الثقيلة لدى العاملين في مهنة الصباغة. هذه الدراسة صممت لمعرفة مدى تأثير التعرض لكل من الكاديوم والزنك على فعالية الكلى لدى الصباغين العاملين في مدينة السليمانية. أجريت الدراسة على 37 عاملا في مهنة الصباغة و 25 شخصا كمجموعة سيطرة بواسطة طريقة المقابلة مع استخدام استبيان خاص بالدراسة. تم اخذ عينات من دم المشاركين لغرض قياس نسب كل من الكرياتينين و يوريا الدم بالإضافة الى قياس مستوى الكاديوم والزنك والمالونديالدهايد. اظهرت النتائج ان مستوى اليوريا في دم العاملين احصائيا اعلى من نسبته في دم مجموعة السيطرة بينما نسب الكرياتينين لم يظهر تغيرا ملحوظا. كما وكشفت الدراسة عن ارتفاع مستوى المالونديالدهايد في دم العاملين مع عدم وجود تغيير احصائي في مستويات كل من الكاديوم والزنك في دم العاملين اثناء مقارنتهم مع مجموعة السيطرة. استنتجت الدراسة بأنه لا توجد علاقة واضحة بين تداخل وظائف الكلى ونسب كل من الكاديوم والزنك في دم العاملين في مهنة الصباغة في مدينة السليمانية. الكلمات المفتاحية: العاملين في مهنة الصباغة ، الكاديوم ،الزنك ،وظائف الكلى ، الاجهاد التأكسدي .

### Introduction

Occupational kidney diseases provide models for understanding the impact of pollutants on kidney functions. Kidney damage in workers within environments of highly expected exposure to toxin, including heavy metals, could be a primary marker to expect hazards in population exposed to low levels of many environmental pollutants<sup>(1,2)</sup>. The toxic

effect of many heavy metals usually involves an interaction between the metal ion and specific target protein, resulting in modified protein structure and function<sup>(3)</sup>. Cadmium and zinc are among the metals that have etiological role in kidney diseases. Nephrotoxicity caused by cadmium has been described in settings of industrial exposure and environmental pollution.

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Cadmium, a metal ordinarily obtained as a by-product of zinc refining, is used industrially in plating of steel, paints, plastics, alloys, and nickel-cadmium batteries, and in nuclear and electronic engineering<sup>(4,6)</sup>. Furthermore Zinc is an essential trace element that can cause symptoms of deficiency and can be toxic when exposures exceed physiological needs. The relationship between intake and health is affected by physiological factors (homeostasis) and by extrinsic factors that affect the availability of zinc for absorption and utilization or that interfere with the metabolism of zinc and biochemical processes that require zinc<sup>(7)</sup>. Many clinical studies have confirmed the major role played by oxidative stress in renal dysfunction, and malondialdehyde (MDA) has been suggested as one of the best predictors of renal damage in hemodialysis patients<sup>(8,9)</sup>. In painting workers, part of the toxicities appeared on painters could be due to the exposure to organic solvents and some heavy metals present in the paints. The possible role of organic solvent exposure in the development and/or the progression of chronic renal failure are still a controversial scientific issue<sup>(10)</sup>. Accordingly the present study was designed to evaluate the possible effect of environmental exposure to cadmium and zinc on renal function among painters in Sulaimani city.

## Materials and Methods

This cross sectional study was performed on 37 male painting workers in Sulaimani city during the period from February to June 2015. Their age ranges was 20-49 years, and have work experience range of 1-15 years. Each worker was interviewed using structured questionnaire that includes personal data, clinical signs and symptoms, duration of exposure to paint products and the whole time they spend in this profession. All subjects were apparently healthy at enrolment time. Twenty five non-exposed healthy subjects, their age matched with that of workers, were included as control group. Each subject signed informed consent before enrollment and the study protocol was approved by the local ethical committee of the School of Pharmacy, University of Sulaimani. Venous blood samples (10 ml) were obtained by vein puncture from the workers and control group subjects; 5 ml was kept in a plain tube. After clot formation, the samples were centrifuged at 3000 rpm for 15 min to obtain the serum, which was utilized for estimation of serum urea and creatinine levels using autoanalyzer based method<sup>(11)</sup>, serum levels of Cadmium (Cd) and

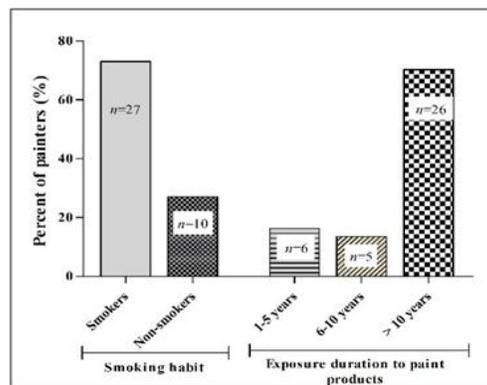
zinc (Zn) using ICP atomic absorption spectrophotometer<sup>(12)</sup>, and for the estimation of malondialdehyde (MDA) as oxidative stress indicator<sup>(13)</sup>.

## Statistical Analysis

All values were expressed as mean±S.D; statistical analysis was performed using Graph Pad Prism software (Version 6.0). Unpaired Student's *t*-test was utilized to evaluate the difference between means. Pearson's correlation was utilized to evaluate the relationship between variables. *P* values less than 0.05 indicated significant differences.

## Results

In figure 1, 27 (73%) of painters were cigarette smokers while 27% of them were non-smokers. Moreover, figure 1 indicates that 6 workers (16.2%) were exposed to painting products from 1 to 5 years, while 5 workers exposure time range was 6-10 years; the remaining number of enrolled workers (26; 70.3%) were exposed for more than 10 years. Figure 2 shows that serum urea levels were significantly elevated (14.2%; *P*=0.028) compared with that reported in control group; however, these values are still within the normal range that exclude impaired renal function. Meanwhile, figure 3 indicates that no significant difference was reported in serum creatinine levels compared with control (0.78 vs. 0.81 mg/dL; *P*= 0.28).



**Figure (1): Distribution of painters (%) according to smoking habits and duration of exposure to painting products in the work environment.**

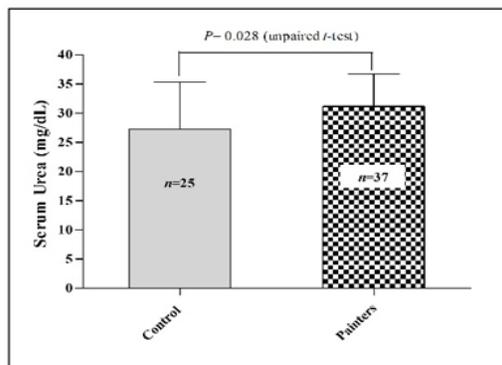


Figure (2): Changes in serum urea levels of painting workers in Sulaimani city. *n*: number of subjects;  $P < 0.05$ : significant difference compared with control group.

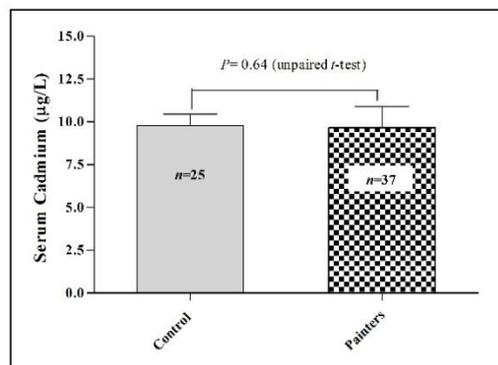


Figure (4): Serum cadmium (Cd) levels of painting workers in Sulaimani city. *n*: number of subjects;  $P > 0.05$ : non-significant difference compared with control group.

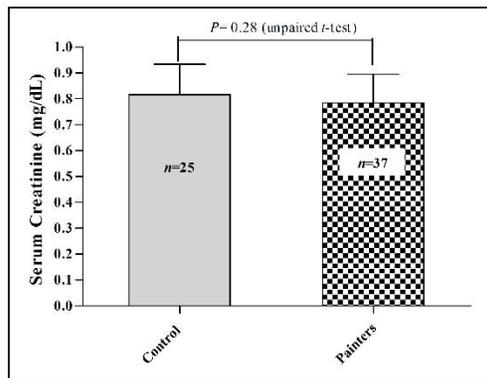


Figure (3): Changes in serum creatinine levels of painting workers in Sulaimani city. *n*: number of subjects;  $P > 0.05$ : non-significant difference compared with control group.

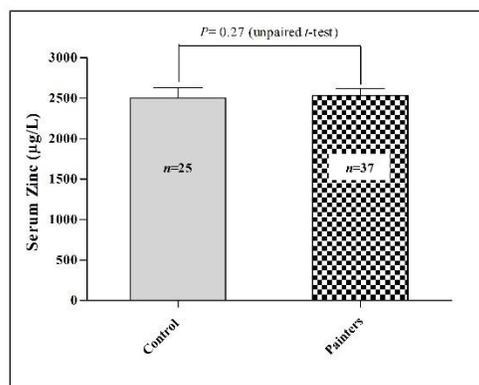


Figure (5): Serum zinc (Zn) levels of painting workers in Sulaimani city. *n*: number of subjects;  $P > 0.05$ : non-significant difference compared with control group.

The results indicated that both serum levels of Cd and Zn were not significantly elevated in painting workers group compared with that reported in controls (9.8 vs. 9.9 µg/L;  $P = 0.64$  for Cd, and 2532 vs. 2502 µg/L;  $P = 0.27$  for Zn) (Figures 4&5). In figure 6, serum MDA levels were significantly elevated (15%;  $P = 0.012$ ) in painting workers compared with that of controls. Utilizing Pearson's correlation method, evaluation of the relationship between the age of workers and their MDA serum levels indicates that they are poorly and non-significantly correlated ( $r = -0.18$  and  $P = 0.29$ ) (Figure 7).

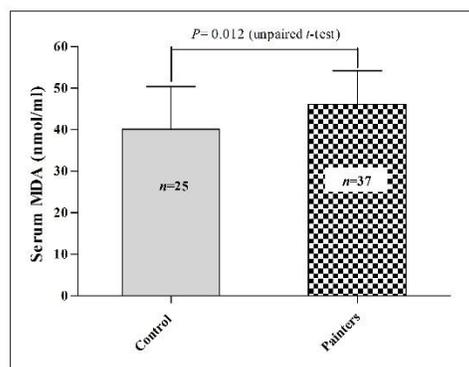
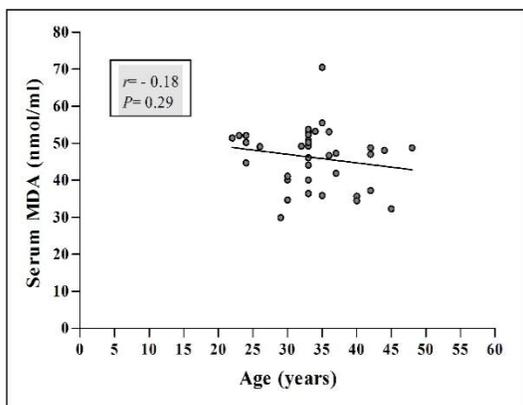


Figure (6): Serum malondialdehyde (MDA) levels of painting workers in Sulaimani city. *n*: number of subjects;  $P < 0.05$ : significant difference compared with control group.



**Figure (7): Correlation between the age of painters and their serum levels of MDA.  $n=37$  subjects;  $r$ : Pearson's correlation coefficient.**

## Discussion

Occupational exposure of humans to heavy metals may predispose to long-term deleterious effects in many vital organs, including the renal function<sup>(14)</sup>. Many epidemiological reports demonstrate that low environmental exposure to cadmium is associated with impaired renal functions<sup>(15)</sup>. Accordingly, monitoring renal functions in highly expected subjects with environmental exposure to cadmium may be vital as occupational safety measure. Among those subjects, painting workers are highly vulnerable to heavy metals toxicity, especially in inappropriate work environments, and cadmium could be potential hazard. Cadmium is one of the common pollutants and it poses occupational hazards to different individuals which include painters<sup>(16)</sup>. However, the present study did not show clear evidence for the involvement of Cadmium as a risk of renal impairment; however, the increase in oxidative stress marker (MDA) could be an early sign of expected toxicity. Moreover, the reported duration of exposure to paint products in the present study is relatively short, and may be not enough to associate with remarkable changes in renal function, even when serum urea shows significant elevation in those workers. Because the biologic half-life of cadmium is long (>30 yr), prolonged low level exposure is required to produce excessive accumulation in certain tissues, especially the kidney<sup>(17)</sup>. In this regard, clinical manifestations of chronic poisoning with cadmium include nasorespiratory signs, mild anemia, tooth discoloration, osteomalacia, and occasional impairment of renal function which may not be easily remarkable due to high compensatory reserve of the kidney. Meanwhile,

cadmium-related nephrotoxicity is multifactorial, with potential influence of age, time of exposure, dietary and smoking habits and associated co-morbidity<sup>(18)</sup>, these factors are not fully covered in the present study which may be considered an important limitation in addition to small subjects sample involved in the study. Environmental cadmium exposure occurs mostly in subjects living in proximity to potential industrial pollution<sup>(19)</sup> and also in heavy smokers<sup>(19)</sup>, since tobacco smoke has a high cadmium contents<sup>(21)</sup>. In the present study, the high prevalence of smoking habit among the included painters could be a potential risk behind the reported changes in oxidative stress marker and blood urea levels. Cadmium is a redox-inactive metals that challenges antioxidant defenses by binding to thiols in many cellular components, including antioxidant defense systems<sup>(22,23)</sup>, which may be associated with disturbance in the concentrations of trace metals that have redox potential like copper and iron. Moreover, the involvement of zinc in this cycle cannot be excluded, since it is potentially involved in the activity of metallothionines involve in the handling and elimination of Cadmium<sup>(24)</sup>. In conclusion, within the limitations of the present study, the association of Cadmium and Zinc levels with the disturbance in renal function is not clear in painters working in Sulaimani city. Larger epidemiological study is highly suggested to cover all the associated factors in this respect.

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