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RESEARCH PAPER

Assessment of Risk Behaviors and Toxic Heavy Metals Exposure of Car Dye Workers in Repairing Services in Erbil City, Kurdistan Region, Iraq

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A B S T R A C T:

The main objective of this study was to determine blood cadmium (BCd) and blood lead (BPb) contents for 16 car dye workers in repairing service and compared to those of 16 controls (non-occupational exposed subjects) in Erbil City, Kurdistan Region, Iraq. Strong wet acid digestion method was applied to digest whole blood samples using a mixture H_2O_2 (50% v/v) and HNO_3 (65% v/v) with a volume ration (1:2). Inductively coupled plasma - optical emission spectrometer (ICP-OES) was used to determine these toxic metals in collected whole blood samples. The recorded mean of BCd and BPb contents in subjected painters were higher levels compared to the control group. The mean ± standard deviation (SD) contents of BCd and BPb of painters were 2.93±2.35 µg/L and 32.19±16.95 µg/L, respectively. The mean ± SD contents of BCd and BPb of controls were 0.870±0.34 µg/L and 22.46±12.55 µg/L, respectively. A set of formal investigation questionnaire was performed to know participants history profile, smoking status, clinical profile, the risk behaviors at the workplace, and occurrence symptoms. The results showed that the percentages of occurrence of most investigated symptoms (especially respiratory and musculoskeletal) system on the experimental painters were significantly (p-value = 0.016) higher than those symptoms of the control group. The collected data on risk behaviors confirmed that personal protection equipment (PPE) had not been concerned by most of the experimental painters. Duration of work (years), and the use of PPE (wearing a respirator) were noticeably associated with BCd and BPb levels of painters.

KEY WORDS: Heavy metals, Blood, Painters, ICP-OES, Erbil City
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1. INTRODUCTION

Due to the continuing of industrial activities, the presence of toxic heavy metals in the environment has become major pollution, health problem and widely released and detected in the air (Amin et al., 2017), water (Aziz and Rasheed, 2017), food (Al-Attar, 2016), soil (Mwstefa and Ahmed, 2019), and many other natural and human-made samples. Lead and cadmium which are the most harmful heavy metals that are broadly used in the manufacture of batteries, the color pigment in paints, several alloys, piping, electrical systems, construction materials, industrial agents, stabilizers, and a variety of other occupational purposes (Järup, 2003). During the last decades, the toxic heavy metals exposure to the human body has been encountered in several ways such as water consumption, inhalation of polluted air, skin contact, food ingestion, and occupational exposure

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at the workplace. Thus, heavy metals could enter the human body, accumulate for a long half-life, and slowly released from the human compartment. Human blood and urine samples are the most common, known, and scientifically recommended matrices to bio-monitor and assess toxic heavy metal exposure in environmental and occupational (Ladeira and Viegas, 2016). These matrices could be used as the direct approach, provide prerequisite and unequivocal evidence for evaluating human exposure to natural and synthetic chemicals from surroundings (Schulz et al., 2011).

In the recent years, several biomonitoring studies have been intensively carried out on human immune (Marth et al., 2001), hematopoietic (Pyszel et al., 2005), diabetes mellitus (Akinloye et al., 2010), cardiovascular (Solenkova et al., 2014), renal (Lentini et al., 2017), prenatal (Taylor et al., 2018), and musculoskeletal (Rodríguez and Mandalunis, 2018) systems effects due to cadmium and lead metal exposure. To monitor heavy metals exposure, compare purposes, and evaluate risk behaviors, the establishment of reference values for blood metals have been early proposed and scientifically set by many countries including the different European community countries (Sabbioni et al., 1992), the Czech Republic (Černá et al., 2001), Germany (Wilhelm et al., 2004), and the United States (CDC, 2013) based on the investigation of their normal and healthy population.

More recent papers also prove the view that environmental and occupational exposures to the risk of toxic metals have been persisted to be a major public health concern in the world. Workers blood lead and cadmium levels were significantly associated with the occupation, environment, lifestyle, and risk behaviors (An et al., 2017, Ishola et al., 2017, Junaid et al., 2017, Khlifi et al., 2014, Mierna et al., 2015, Vitayavirasuk et al., 2005). There are numerous studies in the literature to assess blood heavy metals exposure of country workers such as batteries worker in Poland (Wasowicz et al., 2001), sanitary landfill and painter workers in Thailand (Decharat, 2016, Vitayavirasuk et al., 2005), steel and leather workers in Pakistan (Afridi et al., 2011, Junaid et al., 2017), welder workers in Indonesia (Mierna et al., 2015), changers, mechanics and metalworkers in Nigeria (Ishola et al., 2017, Sani and Abdullahi, 2017), e-waste workers in Ghana (Wittsiepe et al., 2017), smelting workers in Korea (An et al., 2017) and different manufacturing workers in Iran (Nakhaee et al., 2019).

Paint is generally classified into two main types including industrial and decorative (domestic) paints which are broadly utilized to protect, decorate, and preserve surface or object by covering it with a varying pigmented coating. Decorative paints which are either oil-based or water-based are mainly applied for the exterior or interior decoration of homes and buildings surface. However, industrial paint products are commonly applied in automobile coatings, marine coatings, steel structures, and many other high-performance purposes (Kameti, 2013). Paints are mainly included four important components which are pigment, binder, solvent, and required additives. Pigments are generally categorized as either synthetic or natural solid granular which is added into the paint as a powder to contribute color, texture, and toughness (Buxbaum, 2008).

Heavy metals which are known as the most polluting chemicals in the environment have been commonly encountered and used in paints as pigments and recorded with a high amount in various paint samples (Apanpa-Qasim et al., 2016, Kameti, 2013, Ogilo et al., 2017, Okewole and Omin, 2013, Hsu et al., 2018). Lead and cadmium have been used as paint pigments as they speed drying, increase durability, retain a fresh appearance, and resist moisture that causes corrosion.

Kameti (2013) revealed that a high level of Pb metal in the oil-based paints with a range of 275.86 – 37084.48 mg/L was recorded and exceeded the set limit of 90 mg/L by far. However, the recorded level range for Pb in water-based paint was 48.53 – 298.38 mg/L and lower than this metals level in oil-based paint. Okewole and Omin (2013) stated that in both oil and water-based paints manufactured in the city of Lagos, Nigeria, Pb contents ranged from 4.271 to 49.609 mg/L and 0.391 to 2.194 mg/L respectively while the corresponding Cd contents were recorded to be 0.733 – 0.991 mg/L and 0.810 – 1.334 mg/L. Apanpa-Qasim et al. (2016) verified that the levels of lead and cadmium in the 174 various dry paint samples sold in Lagos and Ibadan ranged from 170–3231 mg/Kg and 98–1999 mg/Kg, respectively. They also mentioned that the levels of the selected metals in all the examined samples were exceeded permissible limits (90 mg/Kg for Pb and 100 mg/Kg for Cd in dry paint) of the US and EU Consumer Product Safety Commission respectively. According to a recent study in Nairobi City County, Kenya, the recorded mean concentrations (ranges) of Cd, Cr, Pb, and Zn were 73.45 mg/Kg (3.07 to 89.87 mg/Kg), 77.54 mg/Kg (12.39 to 189.01 mg/Kg), 289.59 mg/Kg (16.86 to 740.52 mg/Kg), and 321.77 mg/Kg (38.63 to 1056.37 mg/Kg) for the house paint chip samples respectively (Ogilo et al., 2017). Hsu et al. (2018) mentioned that the recorded levels of lead in a car refinishing solvent-based paints were two to three orders of magnitude higher than these found levels in water-based paints, especially in yellow and red paints. They suggested that water-based paints can be used as eco-friendly paints and to decrease the exposure potential of refinishing painters to lead metal. Hsu et al. (2018) found that lead levels ranged from 0.25 mg/Kg to 107,928 mg/Kg in solvent-based paints, while the Lead levels in water-based paints were low and ten times lower than that in the solvent-based paints.

During spray painting, the paint can easily cause aerosolization, disperses in the air, and consequent inhalation exposure to these ingredients by painters. Thus, painters in automobile painting services may inhale paint and are potentially exposed to toxic chemical and safety hazards during spray painting at their workplace (Kim et al., 2013). In a particular case study, Kim et al. (2013) investigated that the developed lung cancer of bumper spray painter in an automobile body shop for 15 years seems to have been affected by yellow paint, which causes increasing the level of heavy metals in the workplace air. They suggested that the uses of eco-friendly paint are better than the normal paint due to the present low levels of hexavalent chromium and lead chromate.

The main objective of the study was to assess the concentration of heavy metals, including cadmium and lead in blood samples of experimental automobile dye workers/painters group and control group (non-painters) in Erbil city; evaluating of the history profile, clinical profile, and work characterization of the study subjects; and surveying of the automobile painters risk behaviors during spray painting; comparing selected metals level in the experimental control group with other world countries group.

2. MATERIALS AND METHODS

2.1. Chemicals and Instruments

All chemicals were of analytical grades including nitric acid (HNO_3 65% v/v) and Hydrogen peroxide (H_2O_2 50% v/v) (Scharlau, Spain, Extra Pure). Distilled water was used to wash glassware and dilute samples. Inductively coupled plasma - optical emission spectrometer (ICP-OES, Spectro Arcos FHS22, GmbH, Kleve, Germany) was utilized as an advanced instrument during metal analysis. Classical Digestion-Heater (Gerhardt) with digestive Kjeldal's flask was used during blood digestion.

2.2. Sample Collection

During sampling (December 2019), a blood sample for metal analysis was collected from two different worker groups in Erbil city, Kurdistan Region, Iraq. The first group was sixteen automobile dye workers (exposed group) in the different automobile repairing services workplace, while the second group was sixteen control workers (none exposed group). None exposed group was control workers who have not used and worked with any chemical products yet. After sampling, whole blood samples were directly and individually kept in the special clean blood test tube, labeled and preserved in a refrigerator till the digestion process. To collect informative data on participants, a set of formal investigation questionnaire was performed and directly asked participants to know their history profile, smoking status, clinical profile, risk behaviors at the workplace, and symptoms occurrence.

2.3. Sample Digestion

Prior to sample digestion, all glassware equipment was cleaned and washed with dilute nitric acid solution and distilled water to avoid contamination. A strong wet acid digestion method was applied according to common previous applied studies (Alrobaian and Arida, 2019, Badran et al., 2018, Lech, 2013, Junaid et al., 2016) for completing the whole blood digestion. During digestion, 2.5 mL of the blood sample was quantitatively added to digestive Kjeldal's flask and then treated with 2 mL of H_2O_2 (50% v/v) and 4 mL of HNO_3 (65% v/v) by using Classical Digestion-Heater until completing the digestion process. After cooling, the clear solution was quantitatively transferred; diluted to 5 mL with distilled water, and then labeled before being analyzed by ICP-OES instrument. In the same conditions, digestion processes were repeated three times for the collected blood samples and blank. The blank solution which contains only the digested chemicals was individually used for calibration purposes or zeroed the absorbance of all the other presented components in the sample solution except the component of interest.

2.4. Metal Analysis

Inductive capable plasma - optical emission spectrometer (ICP-OES, Spectro Arcos) was used as an advanced instrument to detect blood cadmium (BCd) and blood lead (BPb) contents in collected whole blood samples. Optimum operating conditions for the instrument were easily selected and conducted because all operating parameters are software controlled. The detailed fundamental features of the instrument, applied operating conditions in the analysis, and selected wavelengths (lines) with a limit of detection (LOD) for the investigated metals were chosen according to instrument manufacture (AMETEK, FHS22) and are presented in **Tables 1** and **2**. The instrument was also calibrated against multi-element standards. The accuracy and precision of the method were investigated in excellent agreement for the analyzed elements using the standard reference material SRM 1640 (Trace Elements in Natural Water) (AMETEK, FHS22). A limit of detection (LOD) for the analyzed metals is calculated according to **Equation 1** as follows.

$$\mathrm{LOD} = \frac{3\ \mathrm{RSDb}\ .\ \mathrm{c}}{\mathrm{SBR}} \qquad (\textbf{Equation 1})$$

Where, RSDb, c, and SBR denote relative standard deviation of 10 replicates of the blank, concentration of the standard, and signal to background ratio.

Table 1: shows ICP Operating Conditions

Parameters	Condition
Power	1280 W
Coolant flow	13 L/min
Auxiliary flow	0.8 L/min
Nebulizer flow	0.75 L/min
Plasma Torch	Quartz, demountable, 1.8 mm injector tube
Spray Chamber	Cyclonic
Nebulizer	SeaSpray
Sample aspiration rate	2.0 mL/min
Replicate read time	48 sec per replicate

Table 2: shows LOD for selected lines (nm)

Metal (Symbol)	Wavelength Line (nm)	LOD 3σ (μg/L)
Cadmium (Cd)	214.438	0.333
Lead (Pb)	220.351	3.44

2.5. Statistical Analysis

Results data of the BCd and BPb contents were calculated and expressed as parts per billion (μg/L) and are shown as mean± standard deviations (SD) in tables. The data were subjected to statistical significance analysis by using GraphPad Prism 6 and Microsoft Excel 2010 software program. Statistical analysis was conducted using Student's t-test and the significance level was set to 0.05.

3. RESULTS AND DISCUSSIONS

3.1. History Profile and Work Characteristics

In the present study, the participated subjects were sixteen automobile spray painters (exposed group); sixteen control workers (non-exposed group) who have not used or worked with any chemical's product yet. All attended subjects were Kurdish, male gender, workers, 42±6 years old, and lived in Erbil city, Kurdistan Region, Iraq.

Detailed information on the participant's profile and work characteristics including gender, age, occupation, weight, education, smoking status, and working experience, were collected through conducting the formal questionnaire and are shown (as mean±SD & %) in **Table 3**. In the same table, the given results of the study were also compared with the previously reported studies (Vitayavirasuk et al., 2005). Note that statistical data of an analysis of variance (ANOVA) showed that there is no significant difference (p-value = 0.403) among the recorded results between the participated study profile information with the compared study (Vitayavirasuk et al., 2005) excluding their education profile. Although painters age, weight, and work experience duration data (means ±SD) for the present study were 42±6 yrs, 77±12 Kg, and 21.0±8.3 yrs, respectively, while the data for the previously reported painters were noticeably lower and equal to 27±7 yrs, 56±9 Kg, and 8.3±5.6 yrs, respectively (Vitayavirasuk et al., 2005).

Table 3: compares history profile of this study subjects with a previous study (Vitayavirasuk et al., 2005)

History profile	This study		(Vitayavirasuk et al., 2005)	
	Exposed subjects	Controls	Exposed subjects	Controls
Kinds of occupation	Painters*	Non-painters*	Painters*	Non-painters*
Nationality	Kurdish/Iraqi	Kurdish/Iraqi	Thai	Thai
Sex (%male)	100	100	100	100
Age (years old) m	42.0±6	42.0±7	27.0±7	26.0±7
Weight (Kg) m	77.0±12	79.0±13	56.0±9	57.0±7
Work duration (years) m	21.0±8	13.5±6	8.3±5.6	7.8±5
Daily working (hours) m	9.0±2	10.0±2	8.0±1	8.0±1
Smoker (%)	68.8	56.2	64.3	31.4
Non-smoker (%)	31.2	43.8	35.7	68.6
Education (%)				
Under graduated (%)	12.5	12.5	0.0	0.0
12th grade (%)	0.0	18.75	15.7	20.0
9th grade (%)	18.75	25.0	24.3	25.7
6th grade (%)	56.25	12.5	60.0	54.3
Illiteracy (%)	12.5	31.25	0.0	0.0

*; no significant difference as p-value = 0.403, Non-painters; controls or workers who have not used and worked with any chemical products yet, m : represented results as mean ±SD,

3.2. Occupational Risk Behaviors

Due to conducting a formal questionnaire, detailed information on hygiene and risk behaviors in this study were only collected on participated painters. Data on the painter's risk behavior were compared with another previously examined study (Vitayavirasuk et al., 2005) and are presented in **Table 4**. According to data in the present study, in the worst situation, all the painters stated that they are not wearing a protective hat and cloth during spray painting in the automobile repairing services workplace in Erbil City. The whole painters also declared that they do not have the isolated laundry for clothes worn at work; they are not always taking a shower immediately after work; they are not going home with the same working clothes. In the present study, note that 37.5% of the painter's subjects were also not wearing respirator equipment during spray painting. Thus, the collected data on risk behaviors confirm that personal protection equipment (PPE) was not concerned by most of the experimental painters. Statistical data (paired t-test) proved that there is no significant difference (p-value = 0.337) between the painter's risk behaviors among these two compared studies (**Table 4**). Painters may face harmful chemicals because spray paint can easily cause aerosolization and consequent inhalation exposure to hazardous chemical ingredients by the painter (Vitayavirasuk et al., 2005). Tahir et al. (2010) mentioned that workers, air, plants, soil, and all environments around the “Auto body refinishing” service shops were potentially exposed to aerosolized organic solvents, noise, dust, and metal pigments.

Table 4: Comparison of Frequencies of the study subjects (painters) risk behaviors

Risk behaviors at work	Frequency (%)	
	This study*	**(Vitayavirasuk et al., 2005)***
Not wearing a protective hat at work	100	87.2
Not wearing protective clothing at work	100	91.4
Not wearing a respirator while spraying	37.5	72.8
Smoking without washing hands first	68.8	64.3
Eating food/drinking water without washing face first	12.5	74.3
Eating food/drinking water without washing hands first	12.5	30.0
Not always taking a shower immediately after work	100	85.7
No separate laundry for clothes worn at work	100	92.9
Going home the same working clothes	100	87.1
Always living at the workplace	0.0	30.0

*; no significant difference as p-value = 0.337

3.3. Occurrence Symptoms

Frequency data of occurrence of symptoms related to painters digestive, respiratory, musculoskeletal, and nervous systems are shown in **Table 5** amongst this study and earlier reported study (Vitayavirasuk et al., 2005). Finding data in this study showed that the percentages of occurrence of most investigated symptoms (especially respiratory and musculoskeletal system) on the experimental painters were significantly (paired t-test, p-value = 0.016) higher than those symptoms of the study control group. Statistical data also showed that the frequencies of evaluated painters symptoms reported in the previous study (Vitayavirasuk et al., 2005) were also significantly (paired t-test, $p < 0.0001$) different and higher than that symptoms result on the present control group. Thus, results reveal that the presence of high symptoms of diseases on experimental painters could come from the effects of their occupation (painting), risk behaviors, and workplace environment.

Table 5: Comparison studies data of occurrences of symptoms between subjects group

Symptoms	Frequency (%)			
	This study		**(Vitayavirasuk et al., 2005)**	
	Study subjects (Painters)**	**Controls** (Non-painters)**	**Study subjects (Painters)****	**Controls (Non-painters)**
Digestive system				
Dry mouth	37.5	18.75	54.3	32.4
Sore throat	12.5	25	54.3	20.3
Respiratory system				
Nasal congestion	25	18.75	44.3	32.4
Cough	25	0.0	30.0	18.9
Sneezing	25	12.5	38.6	24.3
Asthma	37.5	0.0	4.3	1.4
Nasal irritation	12.5	12.5	32.9	8.1
Phlegm discharge	25	18.75	34.3	17.5
Musculoskeletal system				

Muscle pain	43.75	25	44.3	24.3
Tremor	25	6.25	30.0	14.8
Joint pain	37.5	25	34.3	13.5
Nervous system				
Poor co-ordination	31.25	6.25	35.7	5.4
Insomnia	12.5	25	30	14.8
Numbness of extremities	12.5	31.25	32.9	10.8
Forgetting	50	18.75	NA	NA
Angry	37.5	31.25	NA	NA

NA: none available, ** significant difference as p-value < 0.05

3.4. Heavy Metals Level

Blood cadmium (BCd) and blood lead (BPb) contents were determined for sixteen automobile painters (exposed group) and compared to those of sixteen control group (non-occupational exposed subjects) in this study. Detailed information on the recorded BCd and BPb contents in the present study are shown in **Table 6**. The detected mean±SD (range) for BCd and BPb contents of overall examined painters were 2.93±2.35 µg/L (ND – 7.52 µg/L), and 32.19±16.95 µg/L (ND – 61.64 µg/L), respectively. However, the recorded mean±SD (range) for BCd and BPb contents of overall controls group were 0.870±0.34 µg/L (ND – 1.46 µg/L), and 22.46±12.55 µg/L (ND – 26.15 µg/L), respectively. Findings data verify that the documented contents of BCd and BPb in automobile painters were increased due to the increase in subjects' work experience (working years). Data also confirmed that both BCd and BPb contents were noticeably increased ongoing to not using and wearing respirator equipment by participated painters (PNWR).

The mean with a standard deviation of BCd and BPb concentrations (µg/L) in the study was clearly illustrated in **Figure 1**. Statistical data (Unpaired t-test, Assuming Unequal Variance) confirmed that the recorded mean content of BCd (2.93±2.35 µg/L) in the participated painters was three times significantly (p-value = 0.044) higher than that content (0.870±0.34 µg/L) in the study control group. However, the detected mean content of BPb (32.19±16.95 µg/L) in the examined painters was also higher (not significantly, p-value = 0.205) than that content (22.46±12.55 µg/L) in the examined control group due to using a statistical Unpaired t-test and assuming both populations have the same variance **(Table 6).**

Table 6: Variables related to study subjects blood Cd levels and blood Pb levels

Characteristics	Comparison of blood metal level (µg/L)			
	Cd	**p-value**	**Pb**	**p-value**
Overall painters group Mean ± SD (Range) n	2.93±2.35** (ND – 7.52) 16	**0.044**	32.19±16.95* (ND – 61.64) 16	0.205
Overall controls group Mean ± SD (Range) n	0.870±0.34** (ND – 1.46) 16		22.46±12.55* (ND – 26.15) 16	
Painters Subject				
Work experience (yrs) < 15 ≥ 15	1.66±1.70* 3.25±2.50*	0.424	26.0±16.70* 33.4±17.60*	0.596
Wearing respirator		0.214		0.148

Wearing (PWR)	1.76±1.40*		22.00±10.10*	
Not wearing (PNWR)	3.72±2.60*		37.30±17.90*	

SD; standard deviation, ND; not detectable, *; no significant difference, ** significant difference, PNWR: painters not wearing a respirator, PWR: painters wearing a respirator

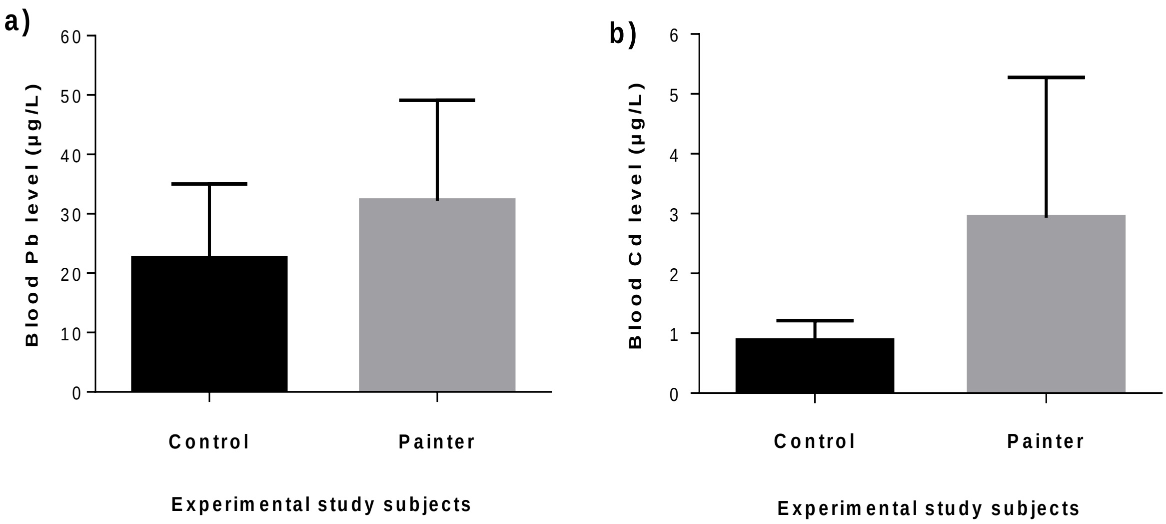

Figure 1: Illustrates study subject's comparison as mean±SD (µg/L) for a) BPb content and b) BCd content

The recorded average for BCd and BPb contents in the study control group (Kurdish people) and the other sixteen different country controls previously reported for different healthy nationalities in the world are clearly ordered, compared and shown in **Figures 2** and **3**, respectively. The compared and previous reported world controls were Thai (Sirivarasai et al., 2002), Czech (Batáriová et al., 2006), German (Heitland and Köster, 2006), American (Crinnion, 2010), Italian (Forte et al., 2011), Pakistani (Shafique et al., 2011), Korean (Kim and Lee, 2011), Iraqi (Hassan et al., 2011) Emirati (Yousef et al., 2013), Chinese (Zhang et al., 2015), Turkish (Akinci et al., 2016), Iranian (Aliomrani et al., 2016), Nigerian (Ishola et al., 2017), Ghanaian (Wittsiepe et al., 2017), Serbian (Stojsavljević et al., 2019), and Saudi (Alrobaian and Arida, 2019) people.

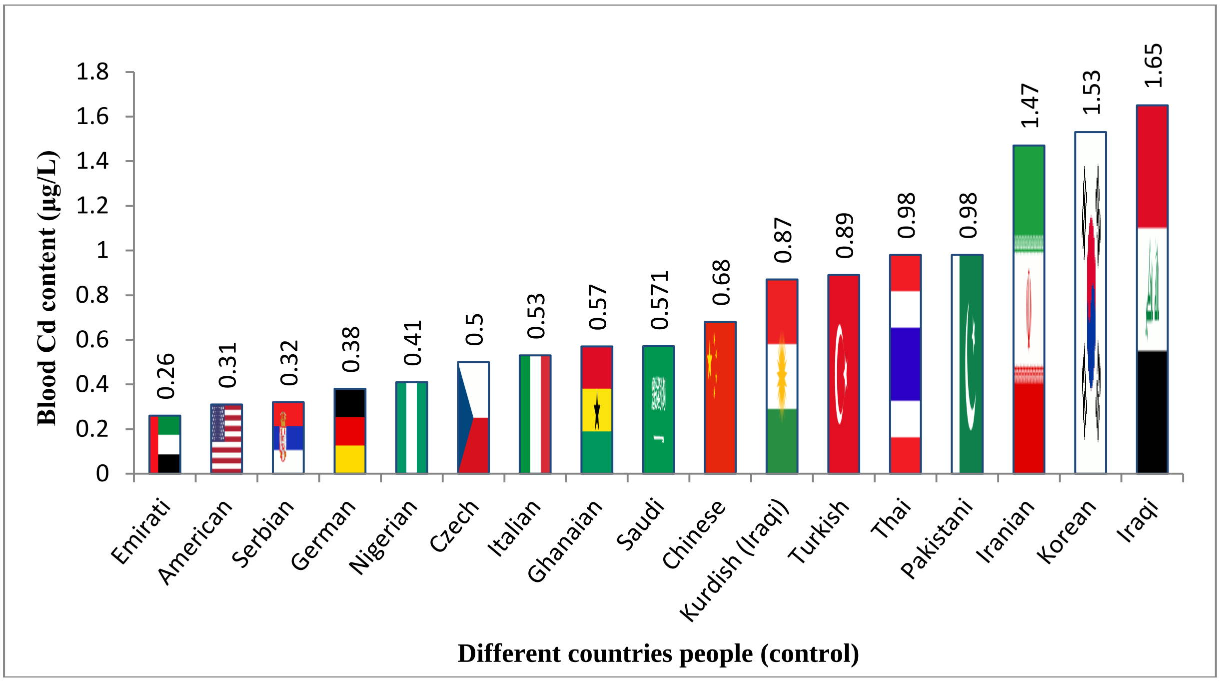

Figure 2: shows a comparison of the recorded average of BCd level (µg/L) of different countries control people

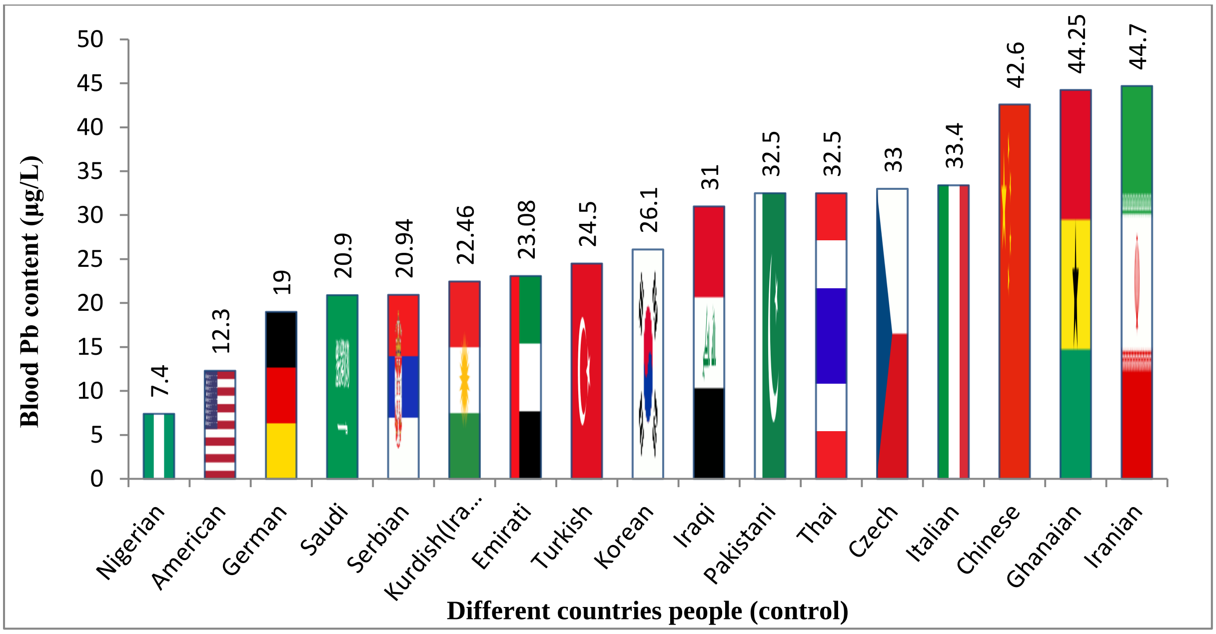

Figure 3: shows a comparison of the recorded average of BPb level (µg/L) of different countries control people

Statistical data (One-Sample t-test) showed that there is no significant difference (p-value = 0.315) between the whole compared controls (16 world controls) with this study control group for the recorded average of BCd level. A comparison of statistical data showed that there is also no significant difference (p-value = 0.058) between the recorded contents of BPb level in this study (Kurdish people) with all the sixteen mentioned world controls. Thus, results verify that there is a good agreement between the recorded mean of

BCd and BPb contents in the control group in this study with the recorded data of sixteen previously reported controls in the world. Consequently, the recorded average of each BCd and BPb contents in the present study for the experimental control group can be seen as a normal resident baseline, reference value for healthy Kurdish residents and used to monitor heavy metals exposure, compare purposes, and evaluate occupational risk behaviors.

The detected average for BCd and BPb contents in the participated study painters were compared with that previously reported data in the other different countries worker and are shown in **Table 7**. According to data in the **Table 7**, the detected mean for BPb content in the present study was lower than that previously reported content from painters (Vitayavirasuk et al., 2005), welders (Mierna et al., 2015), sanitary landfill (Decharat, 2016), spray painters, battery chargers, mechanics (Ishola et al., 2017), metal workers (Sani and Abdullahi, 2017), leather (Junaid et al., 2017), smelting (An et al., 2017) e-waste (Wittsiepe et al., 2017), and painting, printing, rubber, mining and mechanics (Nakhaee et al., 2019) workers occupation.

However, the recorded mean for BCd content in the overall examined painters in this study was higher than that content previously reported from (**Table 7**) welder workers (Mierna et al., 2015), sanitary landfill workers (Decharat, 2016), spray painters, battery chargers, mechanics (Ishola et al., 2017), metal workers (Sani and Abdullahi, 2017), e-waste workers occupation (Wittsiepe et al., 2017). High BCd contents (8.39 µg/L and 10.53 µg/L) were detected from leatherworkers (Junaid et al., 2017) and smelting workers (An et al., 2017) occupation respectively.

Table 7: Comparison of the recorded BCd and BPb contents (µg/L) for various occupational workers

Location	Study subjects Worker	Cd	Pb	References
Erbil, Iraq	Overall Painters Painters (PNWR) Painters (PWR)	2.93±2.35 3.72±2.60 1.76±1.40	32.19±16.95 37.3±17.90 22.00±10.10	This study
Hat Yai Thailand	Painters (PWR)	0.57±0.26 †	86.2±27.2	(Vitayavirasuk et al., 2005)
	Painters (PNWR)	0.76±0.54 †	104.2±40.7	
Benin, Nigeria	Spray Painters	1.16 ± 0.67	47.2 ± 19.2	(Ishola et al., 2017)
	Battery Chargers	0.97 ± 0.33	62.0 ± 21.2	
	Mechanics	1.17 ± 0.52	47.4 ± 23.5	
Khorasan, Iran	Painting, printing, rubber, mining & mechanics	NT	65.0±81	(Nakhaee et al., 2019)
Ulsan, Korea	Smelting worker	10.53	58.39	(An et al., 2017)
Kano, Nigeria	Metal worker	2.50±1.4	190.7±16.9	(Sani and Abdullahi, 2017)
Songkhla, Thailand	Sanitary landfill workers	2.95±0.58	85.8±25.8	(Decharat, 2016)
Ghanian	e-waste worker	0.55	101.9	(Wittsiepe et al., 2017)
Jakarta, Indonesia	Welder worker	0.9	45.12	(Mierna et al., 2015)
Sialkot, Pakistan	Leather worker	8.39 ± 4.87	119.04 ± 59.32	(Junaid et al., 2017)

PWR: painters wearing a respirator, PNWR: painters not wearing a respirator, NT: not tested, †: urinary cadmium (mg/Kg creatinine) for painters

The results in the present study (**Table 6 & 7**) showed that the detected averages for both BCd and BPb contents in the participated painters wearing a respirator (PWR) were higher than that contents in the subjected painters not wearing a respirator (PNWR). Vitayavirasuk et al. (2005) also reported that the detected blood lead and urine cadmium contents were increased in the subjected automobile painters who were not wearing a respirator (PNWR) during spray painting (**Table 7**). The presented high amount of BCd and BPb contents from participated painters could come from their occupation because the paint can easily cause aerosolization, disperses in the air, and consequent inhalation exposure to these ingredients by painters during spray painting. Thus, painters in automobile painting services may inhale paint and are potentially exposed to toxic chemical and safety hazards during spray painting at their workplace (Kim et al., 2013). Tahir et al. (2010) stated that the process of spray painting is continuously deposited and affects the environment including workers, air, plants, and exposed soil. Thus, the soil around the auto body refinishing services is exponentially contaminated with the released chemicals. Tahir et al. (2010) announced that 36 soil samples collected around 26 different auto body refreshing workplaces were generally contaminated due to the exposure of metals pigment. Thus, the study confirms that more precaution needs to be taken by painters during spray painting.

4. CONCLUSION

Occupational exposure at a workplace can be classified as one of the most important diverse forms to exposure of heavy metals to humans. This study revealed that pigment spray of the automobile body is such a kind of occupation that can affect car dye workers, and cause to the presence of high symptom diseases on painters. The results confirmed that the levels of BCd and BPb contents from the subjected painters were higher than that contents from the control group. The study suggested that more precaution needs to be taken by painters during spray painting.

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