การรับสัมผัสตะกั่วและสุขลักษณะของพนักงานโรงพิมพ์ในภาคใต้ของประเทศไทย

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บทคัดย่อ

วัตถุประสงค์ของการศึกษานี้เพื่อตรวจระดับตะกั่วในเลือดและอากาศ ซึ่งจะอธิบายพฤติกรรมสุขภาพ ผลกระทบต่อสุขภาพและหาความสัมพันธ์ระหว่างระดับตะกั่วในเลือดของพนักงานและตัวอย่างอากาศในโรงพิมพ์ เป็นการศึกษาภาคตัดขวางโดยการสัมภาษณ์ด้วยแบบสอบถามในพนักงานโรงพิมพ์จำนวน 75 คนจากโรงพิมพ์ 16 แห่ง และ 75 คนในกลุ่มที่ไม่รับสัมผัส ทำการสุ่มตัวอย่างแบบเจาะจง (Purposive sampling) ทำการวิเคราะห์ระดับตะกั่วโดยเครื่องอะตอมมิคแอปซอปชั่นที่ความยาวคลื่น 283.3 นาโนเมตร วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา ได้แก่ ค่าเฉลี่ย ค่าเบี่ยงเบนมาตรฐาน วิเคราะห์เปรียบเทียบค่าเฉลี่ยด้วยสถิติ Independent t-test และวิเคราะห์ถดถอยพหุคูณ กำหนดระดับนัยสำคัญที่ 0.05 ผลการศึกษาครั้งนี้พบว่า พนักงาน ร้อยละ 65.3 เป็นเพศชาย ร้อยละ 53.3 อายุระหว่าง 20-30 ปี ร้อยละ 72.0 มีประสบการณ์ทำงานมากกว่า 10 ปี ระดับตะกั่วในอากาศของกลุ่มรับสัมผัสมีค่าเฉลี่ยเท่ากับ 15.00 ± 4.54 $\mu g/m^3$ (ช่วง 10-25 $\mu g/m^3$) ระดับตะกั่วในเลือดของกลุ่มรับสัมผัสมีค่าเฉลี่ยเท่ากับ 6.61 ± 3.71μg/dL ซึ่งมีค่าสูงกว่ากลุ่มควบคุม (2.07 ± 1.03 μg/dL) อย่างมีนัยสำคัญทางสถิติที่ $p < 0.01$ ระดับตะกั่วในเลือดและอากาศมีความสัมพันธ์อย่างมีนัยสำคัญทางสถิติ ($r = 0.570, p < 0.01$) พฤติกรรมสุขลักษณะมีความสัมพันธ์อย่างมีนัยสำคัญกับระดับตะกั่วในเลือด ($p < 0.001$) ดังนั้นการอบรมความรู้ด้านอาชีวอนามัยและสภาพการทำงานจึงมีความความจำเป็นเนื่องจากความสัมพันธ์ดังกล่าว

คำสำคัญ: พฤติกรรมสุขภาพ การรับสัมผัสตะกั่ว พนักงานโรงพิมพ์ ภาคใต้ ประเทศไทย

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การรับสัมผัสตะกั่วและสุขลักษณะของพนักงานโรงพิมพ์ในภาคใต้ของประเทศไทย

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Lead Exposure and Hygiene in Printing Workers in Southern, Thailand

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Abstract

The objectives of this study were to determine the lead levels in blood samples from printing workers and airborne samples. For describe the workers' hygiene behavior, adverse health effects and ascertain and describe any correlations between lead levels in blood samples and airborne samples. A cross-sectional study conducted by interviewing 75 printing workers in 16 printing factories. Comparison was made with a reference group of 75 non-exposed persons. The sampling was selected by purposive selection. Lead levels were determined by atomic absorption spectrometry, at a wavelength of 283.3 nm. Descriptive data were analyzed by descriptive statistics such as percentage, mean, and standard deviation. Comparative data analysis used independent t-test and inferential statistics with a multiple linear regression with a level of significance at 0.05. The results in this study showed that most subjects were male (65.3%) and aged between 20-30 years (53.3%). Most printing workers (72.0%) had worked ≥ 10 years. The exposed group has mean airborne lead level 15.00 ± 4.54 $\mu g/m^3$ (range 10-25 $\mu g/m^3$). The mean blood lead level of the exposed group (6.61 ± 3.71µg/dL) was significantly higher than the reference group (2.07 ± 1.03 µg/dL, p<0.001). A statistically significant positive correlation was found between airborne lead levels and blood lead levels (r = 0.570, p < 0.01). This behavior had a significant correlation to their blood lead levels (p < 0.001). Improvements to occupational health education, and working conditions are required due to these correlations.

Keywords: Hygiene Behaviors, Lead Exposure, Printing Workers, Southern Thailand

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Introduction

In Thailand, printing enterprises share similar characteristics with those in other developing countries in Africa, Asia, and the rest of the world. Printing is one line of business that has traditionally high occupational exposure to health hazards[1]. Currently, Thailand has 1,208 printing factories, with about 16,200 employees[2]. The printing industry operates by five separate and distinct processes, lithography, letterpress, flexography, gravure, and screen printing[3-4]. The "lead" used in printing factories is an alloy of lead, tin, and antimony. It is the lead contained in this alloy that is of interest in this study[5-6]. Lead exposure occurs when lead dust or fumes are inhaled, or ingested via contaminated hands, food, water, cigarettes or clothing. Lead enter to the respiratory and digestive systems and was released into the blood and distributed throughout the body. More than 90% of the total body burden of lead is accumulated and stored in the bones and released into the blood, re-exposing organ systems, long after the original exposure[7]. Lead levels in adults between 10 and 25 μg/dL, indicate lead is building up in the body and some exposure has occurred[8-9]. The symptoms of lead poisoning include neurological problems such as reduced intelligence quotient (IQ), nausea, abdominal pains, irritability, insomnia, excess lethargy or hyperactivity, headaches, and in extreme cases such as seizure, and coma. There are also associated gastrointestinal problems such as constipation, vomiting, poor appetite, weight loss, kidney and reproductive problems[8].

The aims of this study were to investigate the occupational airborne lead levels that printing workers were exposed. To determine lead level in blood, describe the hygiene behavior, health symptoms and to make clear whether relationships between airborne lead and blood lead levels would be useful for assessing printing workers level of exposure to lead.

Materials and Methods

Study Site and Study Subjects

Data for this cross-sectional study was collected by sampling printing workers in southern part of Thailand from January to September 2014. Seventy-five printing workers (49 males; 26 females) were recruited from 16 printing factories. The printing factories located in Nakhon Si Thammarat province. The sampling was selected by purposive selection and agreed to participate in this study. In this study, the printing process included prepress process; digitization, preflight, imposition, digital proofing, process film making, plating making, and plate proofing, press process; print preparation and printing, after press process; surface decoration, coating, hot stamping, embossing, forming, book making packing. Inclusion criteria for the study subjects were as follows: engaged in printing work, aged 20-54 years, indirect contact with heavy metals, and working in printing factories for at least one year prior to the study; persons who had been in occupational contact with lead and chromium dust during printing production; persons who agreed to participate in the study and who signed the informed consent form. The non-exposed group (75 persons) was selected by purposive selection from the general population living in the same area, and was made up of people who did not have occupational contact with these metals. These were matched for age and sex with the exposed group. The study protocol was approved by the Ethics Committee of the Research and Development Institute Thaksin University (RDITSU).

Sample Collections

The 150 subjects, 75 exposed (58 workers who worked in press process, and 17 workers who worked in others positions), and 75 non-exposed were interviewed using a questionnaire. General information was collected by face-to-face interview using a survey form. "Whole blood were collected at the end of the work shift.

Questionnaire

In the questionnaire interviews, detailed descriptive information was collected, including personal descriptive characteristics, occupational life styles, working positions, working environment, and personal hygiene. Direct observations were also made and recorded to confirm the questionnaire interviews.

Airborne Lead Collection

Personal breathing samples were taken from the 75 printing workers from January to September 2014. The instruments used for air sampling were personal pumps (Model 224-PCXR8; SKC Inc., Eighty Four, PA, USA) which were calibrated at 2 L/min before and after sampling, containing a mixed cellulose ester membrane filter (pore size 0.8). Sampling was carried out for the regular work duration of 8 h. The air sampling equipment was fitted to the subject on starting their work, removed or switched off during the break and finally removed at the end of the day. The procedure was specified by the NIOSH method 7082/1994[10]. Air samples were collected at the breathing zone and at the printing workplace.

Whole Blood

Whole blood samples (2 mL) were obtained by venipuncture, and kept in metal-free tubes with heparin as anticoagulant. The whole blood samples were mixed immediately and placed in containers with ice packs to maintain a temperature of approximately 4°C, prior to analysis.

Sample Preparation

Airborne Sample Preparation

The cassettes filters were held and the samples were transferred to clean beakers. Three mL (30% H_2O_2 + concentrated HNO_3) were added to 1 mL of samples. Each sample was then heated at 140°C on a hotplate until the volume is reduced to about 0.5 mL. This step was repeated 2 times. Each beaker was then cooled and the residue dissolved in 1 mL concentrated HNO_3 before transferring the solution quantitatively to a 10 mL volumetric flask and diluting to a volume with distilled water.

Blood lead Sample Preparation

Two mL of whole blood was placed into a culture tube. A reagent blank was also started at this point with 2 mL of deionized water in a separate tube, and 0.8 mL of diluted ammonium pyrrolidine dithiocarbamate solution was added to both tubes. The samples were mixed on a rotary vibration mixer for 10 seconds. Then, 2 mL of water saturated with methyl isobutyl ketone (MIBK) was added to each mixture. Each culture tube was capped and rotated on a rotary vibration mixer for 2 minutes. Next, the samples were centrifuged at 2000 rpm for 10 minutes. The samples were then analyzed with Lead Ammonium pyrrolidine dithiocarbamate (Pb-APDC) solution in MIBK within 2 hours of extraction.

Sample Analysis

Airborne Lead and Blood Lead Analysis

Airborne lead levels were measured by Hitachi Model Z-8200 (Hitachi Ltd, Tokyo, Japan) flame atomic absorption spectrophotometer, according to NIOSH method 7082/1994[10]. Lead levels in whole blood were measured using the same apparatus, according to NIOSH method 8003/1994[11]. Whole blood lead concentration was measured by graphite furnace atomic absorption spectrophotometer (GFAAS). All samples were measured at a wavelength of 283.3 nm, with a slit width of 1.30 nm. Electricity was supplied to the lead hollow-cathode lamp at 12 nm. The temperature stages comprised drying at 50-140°C, ashing at 400-500°C, atomizing at 2000°C, cleaning at 2400°C, and cooling at room temperature.

Statistical analysis

Descriptive statistics were used to present the airborne and whole blood lead concentration results. The independent t-test was used to compare the means of continuous variables. Pearson's test was used to test the association of airborne and blood lead levels. Normally distributed data (Gender, monthly income, positions, occupational life style, personal hygiene behavior, and chronic symptoms) were compared using the Student's t-test or ANOVA for 2 more than 2 groups, respectively. Statistical significance was defined as $p < 0.05$. Multiple linear regression analysis was used to evaluate the effects on blood lead levels of the general characteristics, work characteristics, occupational lifestyle, personal protective equipment (PPE), and personal hygiene of workers. Used PPE and personal hygienic practice were treated as dummy variables (yes/no and always/sometimes) in the model. A p-value < 0.05 was considered statistically significant.

Ethical Approval

This study was approved by the ethical committee of Thaksin University Review Board. All of participants received a clear explanation of the purpose of this study and agreed to participate using signed consent forms.

Results

Most subjects of 150 participated in the research study were male (65.3%), 53.3% were aged between 20-30 years. Most subjects had bachelor degree or higher. Most exposed subjects had income < 9,000 Baht per month, while control subjects had income ≥ 9,000 Baht per month. Most control subjects (57.7%) smoked cigarettes and drank alcoholic beverages (61.3%). The mean airborne lead level was 15.00 ± 4.54 $\mu g/m^3$ (range 10-25 $\mu g/m^3$) which was below the standard Occupational Safety and Health Administration (OSHA) level (50 $\mu g/m^3$)[12]. The mean blood lead levels of the exposed and control subjects were significantly different at p-values of < 0.001. The blood-lead levels of all exposed printing workers were below 40 µg/dl threshold recommended by the Occupational Safety and Health Administration (OSHA).

For general characteristics, male workers had significantly higher blood-lead levels than those female workers at p-values of < 0.001. The smokers had significantly higher blood lead levels than non smokers at p-values of < 0.001 (Table 1). Most printing workers (48.0%) worked > 8 hours per day, and 78.7% worked > 6 days per week. Some of them (30.5%) started working at the age less than 17 years old and 46.7% worked in printing process. While 77.3% were prepress process workers and 22.7% in other positions (prepress and post press process workers). Most printing workers (72.0%) had worked ≥ 10 years in the industry. Printing workers who worked in the printing process had significantly higher blood-lead levels than those who worked in other positions at p-values of < 0.001. Printing workers who had worked > 8 hours had significantly higher blood-lead levels than

Table 1 Comparison between general characteristics and biological monitoring of printing workers

Characteristics	**Number of exposed printing workers (*n*) (%)**	**Mean blood-lead level (μg/dl)**	***p*-value**
Gender			< 0.001*
Male	49 (65.3)	7.96 ± 5.00	
Female	26 (34.7)	4.06 ± 2.71	
Age (year)			0.056
20-30	40 (53.3)	8.10 ± 3.26	
31-40	24 (32.0)	9.01 ± 4.33	
41-50	11 (14.7)	10.68 ± 3.01	
Education level			0.362
Secondary school	15 (20.0)	6.80 ± 4.43	
Vocational school	29 (38.7)	7.36 ± 3.80	
Bachelor degree or higher	31 (41.3)	5.52 ± 5.83	
Monthly income (Baht)			0.951
< 9,000	48 (64.0)	6.56 ± 5.06	
≥ 9,000	27 (36.0)	6.65 ± 4.11	
Behavioral			
Smoke cigarettes			0.001*
No	35 (46.7)	5.03 ± 4.75	
Yes	40 (53.3)	10.36 ± 4.32	
Consume alcohol			0.493
No	43 (57.3)	6.93 ± 4.73	
Yes	32 (42.7)	6.17 ± 4.71	

*Significantly different

those who had worked ≤ 8 hours. Printing workers who had worked > 6 days had significantly higher blood lead levels than those who had worked ≤ 6 days. Workers who had worked ≥ 10 years had significantly higher blood lead levels than those who had worked < 10 years (Table 2).

Most printing workers (72.0%) used cotton masks to protect themselves from heavy metal dust, and 60.0% of workers did not used gloves. Printing workers who used both mask and gloves had significantly lower blood-lead levels than those who did not (*p*-values < 0.001).

Table 2 Comparison of blood lead, and working parameter of printing workers

Parameters	**Number of exposed printing workers (*n* = 75)**	**Mean blood-lead level (µg/dl)**	***p*-value**
Specific position			< 0.001*
Press or printing process	58 (77.3)	9.88 ± 4.35	
Other positions (prepress and post press process)	17 (22.7)	4.26 ±1.22	
Hours worked per day			< 0.001*
> 8	48 (64.0)	11.36 ± 3.33	
≤ 8	27 (36.0)	3.94 ± 2.93	
Days worked per week			< 0.001*
> 6	59 (78.7)	12.61 ± 2.14	
≤ 6	16 (21.3)	4.98 ± 3.81	
Duration of work (years)			< 0.001*
1-9	54 (72.0)	3.76 ± 2.14	
≥ 10	21 (28.0)	7.72 ± 4.98	

*Significantly different

Many printing workers (53.3%) often ate snacks during working. Most printing workers (80.0%) washed their hands sometimes before eating snacks. Printing workers who always ate snacks had significantly higher blood-lead levels than those who sometimes did (*p*-values 0.012). Printing workers who always washed their hands before lunch and took a shower at the end of the work hours had significantly lower blood lead levels than those who sometimes did and did not (Table 3). The result shows a correlation between the airborne lead levels (personal sampling) and the blood lead levels of printing workers. The relationship between airborne and blood lead levels was significant (r = 0.570, $p < 0.01$) (Fig. 1).

Most non-exposed subjects reported no acute symptoms. Among the exposed subjects, 34.7% reported irritability, 48.0% loss of memory, and 73.4% muscular tremor, respectively. The blood lead levels of printing workers who reported, and who did not report, acute symptoms were compared. The printing workers who reported irritability, loss of memory, and muscular tremor had significantly higher blood lead levels than those who had no symptoms (Table 4).

Table 3 Comparison of blood lead, PPE-used, and personal hygiene by printing workers

Characteristics	Number of exposed printing workers (n = 75)	Mean blood-lead level (μg/dl)	*p*-value
Wearing mask			< 0.001*
No	21 (28.0)	11.89 ± 2.82	
Yes	54 (72.0)	4.56 ± 2.56	
Wearing glove			< 0.001*
No	45 (60.0)	10.67 ± 4.45	
Yes	30 (40.0)	3.52 ± 1.18	
Eating during work			0.012*
Sometime	35 (46.7)	5.03 ± 4.12	
Always	40 (53.3)	8.41 ± 4.75	
Washing hands before lunch			< 0.001*
Sometime	15 (20.0)	10.83 ± 4.44	
Always	60 (80.0)	5.55 ± 4.182	
Taking a shower after work			< 0.001*
No	54 (72.0)	10.59 ± 2.61	
Yes	21 (28.0)	3.50 ± 2.46	

*Significantly different

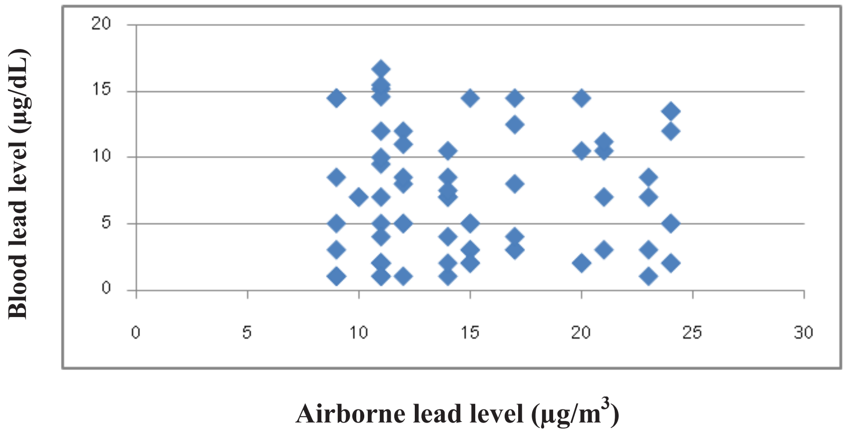

Figure 1 The association between blood lead levels and airborne lead levels in printing worker groups

Table 4 Comparison between blood lead levels and reported symptoms (lasting 3 months or longer)

Parameter	Number of exposed printing workers (n) (%)	Mean of blood lead levels (µg/dl)	*p*-value
Headache			0.215
No	48 (64.0)	6.89 ± 2.82	
Yes	27 (36.0)	7.56 ± 2.56	
Dizziness			0.324
No	40 (66.7)	7.52 ± 1.18	
Yes	25 (33.3)	8.67 ± 4.45	
Nausea			0.100
No	62 (82.7)	7.03 ± 4.12	
Yes	13 (17.3)	6.41 ± 4.75	
Irritability			< 0.001*
No	49 (65.3)	5.55 ± 2.18	
Yes	26 (34.7)	12.23 ± 3.14	
Loss of memory			< 0.001*
No	39 (52.0)	5.55 ± 2.18	
Yes	36 (48.0)	10.83 ± 4.44	
Muscular tremor			< 0.001*
No	20 (26.6)	4.55 ± 2.18	
Yes	55 (73.4)	11.57 ± 3.24	

*Significantly different

To predict the blood levels of printing workers, a multiple regression model was constructed, as shown in Table 5. Significant predictors of blood lead levels included duration of work (years), work position, use of PPE (mask and gloves), and personal hygiene behavior (ate snacks or drank water at work, washed hands before lunch, and taking a shower at the end of the work hours), as in equation 1, the entire R^2 was 0.421, indicating that blood lead levels could be interpreted into 42.1% of the independent variable. In equation 2, the entire R^2 was 0.456, indicating that blood lead levels could be interpreted into 45.6% of the independent variable. In equation 3,

Table 5 Multiple regression occupational life style, used PPE, and personal hygiene behavior on blood lead levels in printing workers

Dependent variable-Independent variable	Adjusted R^2	Standardized Beta Coefficient	*t* value	Significance
Equation 1	0.421			
Duration of work		0.085	0.875	0.421
Position		0.449	5.210	0.001*
Wearing mask		-0.851	-8.875	0.001*
Equation 2	0.456			
Duration of work		0.080	0.755	0.325
Position		0.459	3.200	0.001*
Wearing gloves		-0.551	-4.875	0.001*
Equation 3	0.567			
Duration of work		0.078	0.854	0.258
Position		0.095	0.854	0.312
Eating and drinking at work		-0.598	-4.241	0.012*
Equation 4	0.721			
Duration of work		0.021	0.420	0.520
Position		0.604	6.851	0.001*
Washing hands before lunch		-0.445	-4.432	0.001*
Equation 5	0.789			
Duration of work		0.656	6.954	0.001*
Position		0.614	6.952	0.001*
Taking a shower after work		-0.515	-5.230	0.001*

*Significantly different

the entire R^2 was 0.567, indicating that blood lead levels could be interpreted into 56.7% of the independent variable. In equation 4, the entire R^2 was 0.721, indicating that blood lead levels could be interpreted into 72.1% of the independent variable. In equation 5, the entire R^2 was 0.789, indicating that blood lead levels could be interpreted into 78.9% of the independent variable.

Discussion

The mean factory airborne lead level was 15.00 ± 4.54 $\mu g/m^3$ (range 10-25 $\mu g/m^3$) which did not exceed the 200 $\mu g/m^3$ defined by the Ministry of Labor, Thailand[13], or the 50 $\mu g/m^3$ by Occupational Safety and Health Administration (OSHA)[12]. In the present study, the mean blood lead level of printing workers was found to be significantly higher than that of the control group ($p < 0.001$). Blood lead level is commonly used to evaluate the degree of lead exposure among humans[14]. All the printing workers had blood lead levels less than 60 µg/dL[13], the minimum level for concern by the Ministry of Labor, Thailand[13], and also below the 40 µg/dL recommended by OSHA[12].

This study found a correlation between airborne lead levels and blood lead levels ($r = 0.570$, $p < 0.01$). This result agree with Decharat *et al* who reported a correlation between the airborne and the blood lead levels of the nielloware workers[15]. A recent study found that many factors influence blood lead level increasing. The main pathway for raising blood lead levels among printing workers is probably inhalation route. This is supported by Chuang *et al*[16]. However, lead contamination of hands, clothes, and work surface can occur. Cigarette smoking and its relationship to blood lead levels, showed a statistically significant difference between the two groups. The smokers had significantly higher blood lead levels than the non smokers. Smoking in workplaces where material containing lead is used, can cause contamination by direct hand-to-mouth contact. Thus, lead intake is realized via digestive route[7,17]. Some studies reported a high prevalence of lead poisoning in printing workers[18-20].

Working duration in the industry also appears to make a significant impact. It was found that the mean blood lead levels of printing workers who had worked ≥ 10 years was significantly higher compared to those who had worked < 10 years. This is supported by Karri [21], who reported that lead poisoning can cause a variety of symptoms and signs which vary depending on the individual and the duration of lead exposure. Among printing workers, a face mask as personal protective equipment is generally unwanted because it makes breathing difficult and forms moisture within the mask space. Long caoutchoucor plastic gloves are recommended for lead protection[22]. At present, the type mainly in use are PPE gloves which are inappropriate for this type of work. Lead can accumulate on the surfaces of the PPE used by the printing workers. In addition, dust lead may penetrate a cotton mask and enter a worker's airway. From observation in this study, approximately half of the printing workers wore gloves, and only 1/3 used a mask. It was found that the printing workers who used cotton masks and gloves had significantly lower blood lead levels that those who did not. Without masks and gloves at work, with inappropriate masks and gloves and poor hygiene may therefore be associated with elevated blood lead levels. This is supported by Askin and Wolkmann[23], who reported the effect of hygiene behavior on the blood lead levels of printing workers at a lead processing facility. Printing workers who ate snacks or drank water while working had significantly higher blood lead levels than those who did not (p = 0.012). Printing workers who had the habit of hand and face washing, showed lower lead levels compared to printing workers who did not have those habits (p < 0.001). Printing workers who showered at the end of work had significantly lower blood lead levels than those who did not (p < 0.001). These results indicate the importance of good hygiene behavior to lower blood lead levels. Some other studies also reported that low blood lead levels in workers were associated with good personal hygiene habits[18, 24-26].

Printing workers who always taking a shower at the end of the work hours (r = -0.0582) had significantly lower blood levels than those who sometimes did. Printing workers normally did not change clothes before going home. These poor protective practices meant that workers were likely to carry lead contamination elsewhere, potentially exposing their homes and families. Para-occupational or take home exposure among workers' families may cause lead poisoning among family members[27-28]. All this evidence indicates elevated blood lead levels can result from inappropriate behavior, such as hand-to-mouth contact, contamination of hands, food, drinking water, cigarettes, etc. In addition, irritability[28,], loss of memory[29-30], and muscular tremor[31] at least once per week were significantly higher among those with elevated blood lead level ≥ 10 μg/dL. However, the safe level of lead is extremely low, and the majority of adults have blood lead levels less than 3 μg/dL[32]. Therefore, printing workers who had blood lead levels > 10 μg/dL should strive to identify and reduce lead exposure sources, review their work or hobby habits and use suitable personal protective equipment.

Conclusion

It appears that printing workers are exposed to lead in printing processes. Blood lead level, a marker of lead exposure, has a long half-life and a high correlation with even low level of lead exposure. Thus, printing workers exposed to environmental lead and with high levels of blood lead are at increased risk of developing lead poisoning symptoms. Further research may be appropriate to identify other ways to reduce lead exposure to worker.

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Conflicts of interest

No potential conflict of interest relevant to this article was reported.

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