J. Environ. Res. 32(2) (2010): 13-24

RELATIONSHIP OF THE QUANTITY OF BLOOD LEAD LEVELS AND THE KNOWLEDGE, WORK PRACTICE, AND ATTITUDE OF WORKERS IN A RECYCLING BATTERY FACTORY IN NAKHONSAWAN PROVINCE

การศึกษาความสัมพันธ์ระหว่างความรู้ พฤติกรร ม และทัศนคติกับปริมาณตะกั่วในเลือด ของคนงานในโรงงานรีไซเคิลแบตเตอรี่ จังหวัดนครสวรรค์

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received : January 12, 2010 accepted : July 27, 2010

Abstract

This research was a cross-sectional study. The purpose was to study relationship between knowledge, work practice and attitude of workers toward quantity of lead in their blood. The study took place during January-December 2008 in a recycling battery factory in Nakhonsawan Province by means of purposive sampling. Relevant data were gathered by structured questionnaire which was tested for reliability by means of Cronbach's alpha coefficient. Analysis of the relationship was performed via Pearson's product-moment correlation coefficient. The statistical significance was considered when $p<0.05$.

The results of the study of total 72 workers were as followings: average score of knowledge was 12.8 out of 15 with the SD of 1.6, max score of 15 and min score of 9; average behavior score of workers was 12.9 out of 15 with SD of 1.3, max score of 15 and min score of 9; average score on attitude was 22.7 out of 30 with SD of 0.94, max score 25 and min score of 21. Hence, majority of them were in good knowledge (86.1 %) and had good work practice (93.1%). As well, all workers (100%) had good attitude.

Significant ($p<0.05$) relationship between levels of lead in blood and behavior of workers was found. The workers with high quantity of lead in their blood stream took more precaution on their work practice. This might be the fact that they knew that lead in blood could naturally be released by mechanism of body. Furthermore, the condition could be improved if they do not obtain further lead. On the other aspect, the relationship between age and level of lead in blood is also significant ($p<0.001$). The workers with older age had more

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quantity of lead in blood than young workers. However, there was no relationship among quantity of lead in blood toward attitude or knowledge of the workers.

From the study, it is suggested that annual blood test and physical examination of all workers should be implemented. Furthermore, it should emphasize on the campaign of good work practice. Especially, smoking during working hour must be strictly prohibited, since the protection mask has to be taken off and open the chance of taking the lead in.

Keywords: Recycling battery factory, blood lead levels, good working practice, attitude

บทคัดย่อ

การศึกษานี้เป็นการวิจัยเชิงสำรวจแบบตัดขวาง มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ของปริมาณตะกั่วในเลือดกับความรู้ พฤติกรรม ทัศนคติของคนงานในโรงงานรีไซเคิลแบตเตอรี่ จังหวัดนครสวรรค์ โดยใช้วิธีการเลือกตัวอย่างแบบเจาะจง ระยะเวลาในการทำวิจัยตั้งแต่ มกราคม – ธันวาคม 2551 เก็บข้อมูลโดยการใช้แบบสอบถามคนงาน แบบสอบถามได้รับการทดสอบเพื่อหาค่าความเชื่อมั่น โดยใช้สูตรสัมประสิทธิอัลฟาของครอนบาช (Cronbach's alpha coefficient) วิเคราะห์หาความสัมพันธ์ของปริมาณตะกั่วในเลือดคนงาน กับความรู้ พฤติกรรม ทัศนคติ โดยใช้สถิติสัมประสิทธิ์สหสัมพันธ์เพียร์สัน (Pearson product-moment correlation coefficient) ใช้ค่า p< 0.05 เป็นเกณฑ์พิจารณาระดับนัยสำคัญทางสถิติ

ผลการศึกษาจำนวนตัวอย่าง 72 คน พบว่า คะแนนความรู้เฉลี่ยเท่ากับ 12.8 จากคะแนนเต็ม 15 คะแนน ส่วนเบี่ยงเบนมาตรฐานเท่ากับ 1.6 ส่วนใหญ่มีคะแนนอยู่ในระดับดีมากร้อยละ 86.1 โดยมีคะแนนต่ำสุด 9 คะแนน และมีคะแนนสูงสุด 15 คะแนน คะแนนพฤติกรรมเฉลี่ยเท่ากับ 12.9 จากคะแนนเต็ม 15 คะแนน ส่วนเบี่ยงเบนมาตรฐานเท่ากับ 1.3 คนงานปฏิบัติตัวระดับดีร้อยละ 93.1 โดยมีคะแนนต่ำสุด 9 คะแนน สูงสุด 15 คะแนน ทัศนคติเฉลี่ยของคนงานเท่ากับ 22.7 จากคะแนนเต็ม 30 คะแนน ส่วนเบี่ยงเบนมาตรฐานเท่ากับ 0.94 คนงานมีทัศนคติดีมากร้อยละ 100.0 โดยมีคะแนนต่ำสุด 21 คะแนน และสูงสุด 25 คะแนน จากการศึกษาความสัมพันธ์ของปริมาณตะกั่วในเลือดกับพฤติกรรมคนงาน พบว่า มีความสัมพันธ์ในทิศทางเดียวกันอย่างมีนัยสำคัญทางสถิติ (p<0.05) คือ คนงานที่มีปริมาณตะกั่วในเลือดสูงจะปฏิบัติตัวถูกต้องในระดับดี อาจเพราะคนงานได้รับความรู้ที่ว่าตะกั่วที่อยู่ในเลือดจะถูกกลไกของร่างกายค่อยๆ ขับออกมาตามธรรมชาติได้หากไม่ได้รับตะกั่วเพิ่มเข้าไปสู่ร่างกาย อายุของคนงาน พบว่า มีความสัมพันธ์กับปริมาณตะกั่วในเลือดอย่างมีนัยสำคัญทางสถิติ(p< 0.05) คือ กลุ่มคนงานอายุมากจะมีปริมาณตะกั่วในเลือดมากกว่าคนงานในกลุ่มหนุ่มสาว ส่วนทัศนคติและความรู้ของคนงานพบว่าไม่มีความสัมพันธ์กับปริมาณตะกั่วในเลือด

ข้อเสนอแนะจากการทำวิจัย คือ การเจาะเลือดคนงานอย่างสม่ำเสมออย่างน้อยปีละครั้งเป็นสิ่งซึ่งโรงงาน และหน่วยงานที่เกี่ยวข้องพึงดำเนินการให้ครอบคลุมในบุคลากรทุกคนที่ปฏิบัติการในโรงงานตลอดจนควรรณรงค์ในด้านการปฏิบัติตัวให้ถูกต้อง โดยเฉพาะควรห้ามการสูบบุหรี่ในขณะทำงานอย่างเด็ดขาด เนื่องจากขณะสูบบุหรี่ต้องถอดหน้ากากทำให้ตะกั่วในบรรยากาศเข้าสู่ร่างกายคนงานได้

คำสำคัญ: โรงงานรีไซเคิลแบตเตอรี่, ระดับตะกั่วในเลือด, การปฏิบัติที่ถูกต้องในการทำงาน, ทัศนคติ

Introduction

The study was conducted at a battery recycling factory which was established in 1991, in Nakhonsawan Province. During 1994, the factory caused a round of protest by of the people living nearby fearing of its pollution and was ordered to be shut down for 3 months (November 1994 - January 1995). Then it was allowed to reopen. Later, in 2001, the public filed complaint to the government authorities on releasing of contaminated waste to the area around the factory. To further investigate the impact, this study focused on level of lead in the blood of the workers and its relationship toward key factors of good working practice in the factory. The results of the investigation should give background for proper planning and handling of the issue - lead contamination and health safety of the workers.

Materials and Methods

The study was a transversal survey research (cross-sectional research) by examination of health and lead-related health awareness of workers in the battery recycling factory.

1. Population and samples

Seventy-two workers were selected, in October 2008, based on selective purposive sampling. They were informed on principles, rationale and objectives of the research and all were willing to collaborate in the study.

2. Tools used in the study

A questionnaire was designed with the following components;

Section 1: Personal information – gender, age, education, work history, work description, living environment, history of blood testing for lead.

Section 2: General knowledge – self answering questions cover general information

Section 3: Questions on work practice – 15 questions on activities of workers during work hours, and chance of contact with family members.

Section 4: Questions on attitude toward protection from lead toxic – 15 questions. The criteria of scoring were based on Best (5) system of limited answering choices. Then, the scores were categorized by taking maximum score subtracted with minimum score and the result was divided into 3 ranks; very good, good and not good.

Section 5: Questions on health – 20 health related questions of workers.

3. Accuracy and certainty of the tools

a. Accuracy of the questionnaires was verified by 3 occupational health experts. The criteria in each question must be agreed by at least 80 percent by the experts.

b. The questionnaire was pre-tested in another recycling battery factory, in the nearby area, Krokphra District of the same province. 30 samples were tested on the workers who were in similar risk of lead toxic. Cronbach's alpha coefficient were 0.53 on knowledge of the issue, 0.61 on work practice, and 0.56 on attitude of the workers.

4. Statistical analysis

General description of the sampled population was analyzed. Their knowledge, work practice and attitude toward lead toxin; and, their health were characterized. Statistical characters i.e. frequency, mean, maximum (max.), minimum (min.), standard deviation (SD), and percentage were determined.

Pearson correlation coefficient was used to find relationships among knowledge, work practice, attitude, and health of workers toward quantity of lead in bloodstream. The analysis was made at 95% certainty ($p<0.05$).

Results

Characteristic of the samples

Table 1 Age and work history of the workers

Population characteristics	(N = 72)			
	mean	SD	min	max
Age (yr)	42.15	9.8	19	65
Working Age (yr)	7.02	4.4	0.03	16.0

The samples were composed of 72 workers in a recycling battery factory. Sixty of them or 83.3 percent were male, whereas, twelve of them or 16.7% were female. Their average age was 42.15 yr. Average work history with the company was 7.02 yr.

Based on their tasks, the workforces were organized into the following groups: office workers 6.9%, melting pot 52.8%, used battery disassemble unit 11.1% and maintenance 29.2%. Residence of the workers; 15.3% stayed within the factory, 84.7% lived outside. Education of the

workers; 6.9% had no school, 72.2% primary school, 12.5% lower secondary school, 4.2% higher secondary school, 2.8% diploma and 1.4% other degree. In term of history of work, 95.8% never work in the factory of the same kind before joining the recycling battery factory and equal number of them had history of blood testing as an on guard for the lead toxic.

Blood test

Table 2 Results of blood test for lead contamination

Population characteristics	(N = 72)			
	mean	SD	min	max
Quantity of lead in blood levels (µg/dL)	27.3	6.3	7.1	38.4

From the blood test, the average lead in blood was 27.3 µg/dL with the min of 7.1 µg/dL and the max was 38.4 µg/dL. The Thai standard for lead in blood in the workplace was no more than 40 µg/dL. These were secondary data taken from the records of the annual monitoring program of lead in blood by Nakhonsawan Office of Labour Protection and Welfare [1]

Knowledge, work practice and attitude of the workers

Table 3 Results from analysis of knowledge, work practice and attitude of the workers

	Variables	N = 72	Percentage
Knowledge			
	Not good	2	2.8
	Well	8	11.1
	Very good	62	86.1
	Mean ± SD.	12.8 ± 1.6	
	Min - Max	9 -15	
Work Practice			
	Not good	5	6.9
	Well	67	93.1
	Very good	0	0.0
	Mean ± SD.	12.9 ± 1.3	
	Min - Max	9 -15	

Table 3 (continue)

Variables		N = 72	Percentage
Attitudes			
	Not good	0	0.0
	Well	0	0.0
	Very good	72	100.0
	Mean ± SD.	22.7 ± 0.94	
	Min - Max	21-25	

Knowledge of the workers

The average score of the workers on knowledge was 12.8 out of 15 with SD of 1.65, max score of 15 and min score of 9. Most of them, 86.1% scored in the range of "very good". Some of them, 11.1% scored "good" and just 2.8% fell to "not good".

The survey indicated that 72.2% of them understood that Lead could enter one's body via breathing only; 100% understood the necessity of washing hands thoroughly before lunch; 63.9% believed that Lead could not enter the body via cuts; 98.6% understood that masks should be worn at all time in the workplace; 94.4% claimed that smoking can be done during work time; 98.6% understood that hair washing and shower were necessary before leaving the factory and going home; 72.8% believed that Lead in blood will not decrease naturally and will maintain its concentration for long period; 65.3% indicated that Lead protection mask could be used 3-5 yr until it is worn out; 100% understood that they have to wear work-uniform during work time; 88.9% realized that lead poisoning could be lethal; 100% knew that in case of unable to breath freely, the protection mask must be changed to a new one; 72.2% thought that if they had been treated by physicians, the practice to protect them from lead was no longer necessary; 100% cleaned their uniforms every time after being used; 97.2% brought snacks to eat during work time; and, 100.0% trimmed their nails regularly.

Activities during work hour

The workers scored 12.9 from total of 15 with the SD of 1.3, max score of 15 and min score of 9. From the survey it could be summarized as followings: none of them followed the rules of good practices the whole time; most of them, 93.1%, followed most of the rules of good practices; and, there was 6.9% of them did not follow the rules of good practices. Specifically, the

percentages of the workers who responded to each criterion were as followings: 94.4% washed their hands before meal; 83.3% took shower and washed their hair before leaving the factory and returning home; 84.7% smoked during work; 93.1% used the proper protection masks; 97.2% wore the factory uniform during work; 91.7% changed factory uniform to other clothes as soon as arriving home; 95.8% changed clothes before and after starting each day work; 41.7% brushed their teeth during their time at the factory; 100% had their uniform or work clothes cleaned after each use; 86.1% had their underwear cleaned separately; 8.3% ate snacks during work; 88.9% protected their cuts with bandage; 95.8% cleaned their hands before meal; 94.4% sometimes cleaned their mouth with the sleeves of their shirts.

Attitudes of the workers

The workers scored on average 22.7 of 30 with SD of 0.94, max of 25 and min of 21. In overall, all the workers had very good attitude. Additionally, details information on each criterion could be summarized as followings: 100% cleaned their hands before lunch; 90.3% took shower twice daily, in the morning and evening; 98.6% protected cuts with bandage to prevent lead entering their bodies; 68.1% did not agree that any kind of masks could be used in their work; 100% agreed to wear factory uniform during work; 100% agreed to change clothes before leaving or starting work; 20.8% indicated that clothes worn to work could be cleaned in the same batch with regular clothes; 91.7% agreed with the statement that lead toxic is not dangerous if handle properly; 97.2% did not agree with smoking during work; 100% did not agree with eating snack during work; 98.6% agreed with wearing masks all the time during work; 100% agreed with necessarily cleaning clothes everyday; 100% agreed with shampooing their hairs after work; 100% did not agreed with cleaning mouth with shirt sleeves after lunch.

Health of the workers

From health records, these are percentage of workers who had the history of these symptoms: headache 79.2%, dizziness 68.1%, numb 58.3%, fatigue 73.6%, bored with food 40.3%, nausea 30.6%, tongue feel the taste of metal 31.1%, muscle weariness 94.4%, weakness of arms and legs 37.5%, dysentery 22.2%, constipation 45.8%, sleepless 66.7%, nightmare 38.9%, stimulation 44.4%, short temper 56.9%, forgetful 70.8%, lost concentration 50.0%, numb of arms and legs 41.7%, lost sexual desire 15.3%, and there was no history of convulsion.

Relationship with lead in blood

The average of lead levels in blood and relationship with the symptoms were analyzed. However, it was found that there was no significant relationship between lead levels in blood and those symptoms. Correlation analysis of lead levels in blood with knowledge, work practice and attitude of the workers

Table 4 Correlation Coefficient Analysis (N=72)

Variables	Pearson's correlation coefficient	p value
Knowledge	- 0.110	0.366
Work Practice	0.276	0.019 *
Attitudes	0.035	0.771
Age	0.547	0.001**

** Correlation is significant at the 0.001 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

The coefficient of Pearson's correlation between lead levels in blood and related factors were as following; Work practice of the workers was correlated with the blood lead level significantly ($p<0.05$). The workers with high blood lead levels increased their good work practice to prevent further lead taken up. Besides, they also knew that the lead in their blood will be secreted out naturally. Age of the workers was correlated with the blood lead levels significantly ($p<0.001$). That was older workers had higher blood lead levels (Figure1).

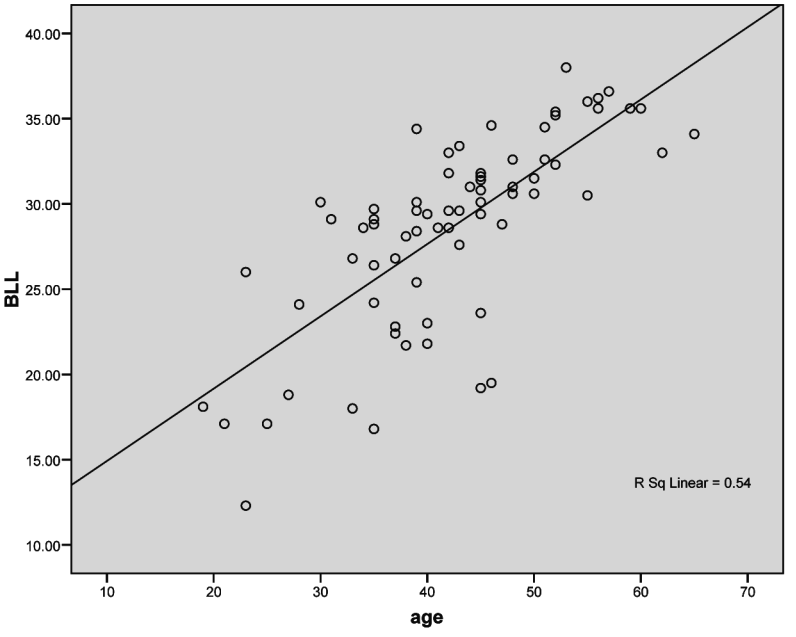

Figure 1 Graph of scatter plot between age and blood lead levels in 72 workers

Discussions

General information on workers

The average work history with the factory was 7.02 yr; this considered to be long enough to subject to the continuous blood lead levels monitoring. Most of the workers, 95.8%, had never worked in this type of work previously. Therefore, if there was evidence of lead in their blood, it must be from working in this factory. There was 15.3% of the workers living in the boundary of the factory; they should receive special awareness due to their vulnerability to lead suspension in the air. These workers, 98.5%, had been tested for lead in blood, indicated that the factory was aware of the issue.

Blood lead level

The average blood lead level of the workers was 27.3 μg/dL, with the max of 38.4 μg/dL and the min of 7.1 μg/dL. The numbers were considered lower than the standard number of the Ministry of Labor which is 40 μg/dL. There was correlation of the age of the workers and the level of the lead in blood, the older the workers, the higher the blood lead level. This agrees with other study[1] but contradicts to a result from car colour changing factory[2] which claimed that there was no relationship between ages of the workers and lead level in blood.

Relationship of the lead level in blood with knowledge, work practice and attitude of the workers

Among factors under consideration, the work practice had correlation with lead level in blood significantly ($p<0.05$). This finding agrees with a study in Taiwan[3]. However, the lead level in blood of workers in this study is significantly higher (5.59 µg/dL) than that of the Taiwanese. This could be from smoking or drinking during work. On the other hand, there is no relation of the knowledge of the workers and the lead level in blood which is in line with a study in Buriram Province[4].

Knowledge of the workers

It is found out that workers had good knowledge on protection themselves from lead poison, except, the perception on smoking during work. Most of them (94.4 %) did not realize that smoking during work could also take lead from the air into their body because they remove mask during smoking. However, the workers scored well in the test, 12.8 out of 15 with SD of 1.6, max score of 15 and min of 9. These could be further analyzed that 86.1% workers had very good knowledge, 11.1% good knowledge, and only 2.8% poor knowledge. The results agrees with a study about lead toxic of the workers in Lumphun Industrial Park[5] and it is found out ¾ of the workers had very good knowledge on protection themselves.

Work practice

From the study, the work practice of the workers scored 12.9 out of 15 with SD of 1.3. Noteworthy, 84.7% of the workers smoke during working and none of them fitted into the category of very good work practice. The results agreed with the study of Kidjawan and Kongthong[6] which found that less than half of the workers had good work practice. The study of Vinidjakul G[7] at Lumphun Industrial Park, indicated that there is significant relationship between work practice of the workers and level of lead in blood.

Attitude of the workers

The study showed that all of the workers had good attitude and scored at the max of 25, and the min of 21, average score of 22.7 out of 30 and SD of 0.94. Worth mentioning, 97.2% of them did not support smoking during working. This agreed with the study of Phatumanon C, Thavidsri C [8].

Health of the workers

From the history of workers' health, it was found as followings: 79.2% of the workers had history of headache; 68.1% of them had history of vertigo; and, 58.3% of

them had history of numbness. The results agreed with the study of workers of a ceramic factory by Tongplungvijit K[9].

Connection of the level of lead in blood and toxic symptom

The analysis showed no connection between level of lead in blood in various quantities and the symptom of lead toxic. It was suspect that the levels of lead in blood of all the workers were under the standard threshold of 40 μg/dL.

Suggestions

Smoking during work should be strictly prohibited and firmly enforced. There should be clear rule on the issue.

Health check up should be practiced regularly, including education on protection from and handling the lead toxic issue among all the workers.

Level of lead in blood of all the workers should be monitor on a regular basis. Training knowledge about lead poisoning should be every year for all the workers.

Acknowledgements

This work was supported by Department of Disease Control, Ministry of Public Health through the budget of fiscal year 2008.

References

(1) Rungsritrakul, V. and Thadsiri T. 1998. The analysis quantity blood lead levels of risk workers by Atomic Absorbtion Spectrophotometry. Khon Kaen. 3(1):30-37.

(2) Kongthon, S. 1998. The study of blood lead levels of workers in factory change colour car in area of Environmental Health Center Region 11. Master's Thesis, Kasetsart University.

(3) Hung, Y., Wen-Chia, C., Chiu-Ying, C., Ya-Hui, Y., Fung-Chang, S., Chun-Yuh, Y., et al. 2008. A follow-up comparison of blood lead levels between foreign and native workers of battery manufacturing in Taiwan. Sci. Total Environ. 52-56.

(4) Penpaibunsatiun, R. 2005. Factors effecting blood lead levels in workers of factory risk lead poisoning District Muang, Buriram Province. Master's Thesis, Mahasarakham University.

(5) Danphiboon, A. 1997. Blood lead levels of workers in Industrial Estate Authority the North Lamphun Province. Master's Thesis, Chiang Mai University.

(6) Kidjawan, P. and Kongthong, S. 1999. The study of blood lead levels of workers in change colour car in Province of Environmental Health Center Region 11. Journal Kasetsart (social). 20(2):126.

(7) Vinidjakul, G. 2005. Behavior Protect lead poisoning of workers in factory Industrial Estate Authority the North Lamphun Province. Master's Thesis, Chiangmai University.

(8) Phatumanon, C. and Thavidsri, C. 1997. A change risk factor relation blood lead levels of workers touch with lead. Master's

Thesis, Chiangmai University.

(9) Tongplungvijit, K. 1999. Reducing quantity blood lead levels by adjust behavior hygiene of workers in factory ceramic case study: District Muang, Chainat Province. Master's Thesis, Khon Kaen University.