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Level of Lead Contamination on Electrical Equipments Electronic Devices Repairmen and Working Environment in the Area of Nakhonratchasima Province, Thailand

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Abstract: A study of the electrical equipment and electronics repaired shops, where in the areas of local government of Khamsakaesang, Nonthai, Nonsoong and Khong SubDistrict, Nakhonratchasima Province, which were in the total amount of 24 repairshops 39 repairmen. Data collection has been done by doing questionnaire and inspecting the levels of blood lead contamination and environmental lead contamination with Graphite Furnace Atomic Absorption Spectrophotometer (GFAAS) found that the average level of blood lead was at 8.58 μg dL^{-1}, which the lowest blood lead level was at 1.26 μg dL^{-1} and the highest blood lead level was at 25.54 μg dL^{-1}. The repairmen, who have different education and work experience levels were statistically having different blood lead level ($p<0.05$), apart from that there was a found of dust with lead contamination in working areas in the average level of 173.26 g kg^{-1}, which the lowest level was at 49.6 g kg^{-1} and the highest level was at 354 g kg^{-1}, which is much higher than the specified standard of US EPA. Apparently, repairmen are in risk of health threaten from their unsafe work condition, do not use personal protective equipments, while welding lead their working environment have highly dust lead contamination and terminating hazardous in incorrect way, which cause an effect for their family member, especially childhood and environment could be contaminated directly and indirectly. Then, the related government sectors should be actively operating, solving and managing occupational health and sanitation services for this career.

Key words: Lead contamination, blood lead level, repairmen, working environment, electrical equipment and electronic devices repair shops, Nakhonratchasima Province

INTRODUCTION

Lead poisoning is regularly found in people, who are closely work with lead such as lead fusioning, lead welding, vehicle battery production, vehicle spraying work and as well as vehicle radiator mending. The percentage of lead poisoning in Thai vehicle menders, by 1999, was 3.4% (Benjawang, 1998) and in the past 10 years between 1997-2006 were accordingly reported from the epidemiology ministration information of lead poisoning, which found that patients with lead poisoning were 459 people, which is averagely 46 people per year and the case rate were 0.08 per population of 100,000 people. There is tendingly reported to be increased (Bureau of Epidermiology, 2007). There were a found of lead contamination in working environment was in range of the level of 0.050-0.099 mg m^{-3}. When it comes to specified standard comparison of lead in the air was 0.05 mg m^{-3}, which was found over the standard of specification were in 4 manufactories, where producing and fitting electronic microchip, electronic component and television and also the working environments were unsafe.

From the said information, people, who work in the area of electric equipment and electronic device mending are risky from toxic substance especially from a high lead contamination because of lead is highly composed in electronic microchips and used in welding electronic devices, which the contaminated lead may enter into human body in 3 ways through inhalation, ingestion and skin absorption as working in the areas of lead fusioning or welding, which causes a lead effluvium, which easily enters into human body through inhalation and people, who work closely to this toxic substance may receive into their body by not cleaning their hands before eating foods (Levy and Wegman, 1995). Moreover, family

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members might receive lead contamination if they do not appropriately manage cleaning their living and workplaces, where contaminated lead as well as the surrounding environments around their repairshops and communities. According to the survey, there was observed that the electrical equipment and electronics repaired shops, where in the areas of local government of Khamsakaesang, Nnonthai, Nonsoong and Khong, Sub District, Nakornratchasima Province, which were in the total amount of 24 repairshops and repairmen were 39 people. All repairshops use lead to be a welder and have not had danger protection from lead contamination by leaving lead fragment on the ground and throwing away the waste of electronic devices into the local garbage bins.

The lead contamination level in blood indicates the quantity of contaminated lead, which received into human body and used to be as a protection poisoning sickness, which caused from contaminated lead also. Then, researcher began to be interested to age educate the working environment and repairman's problem conditions and the level of contaminated lead in blood in order to be aware of situation and risk of receiving contaminated lead from their profession and this will lead to the knowledge planning in order to reduce a future environmental impact promotions, the behavior of danger protection from work place and the appropriated management of restriction of hazardous substances hence forwardly.

MATERIALS AND METHODS

This research achieved ethics approval the ethics research Committee of Mahasarakham University.

Population: The used population in this research were the electrical equipment and electronic devices repairmen, who are in the areas of local government Khamsakaesang, Nonthai, Nonsoong and Khong Sub-Districts, Nakhonratchasima Province, which were in the total amount of 24 repairshops and repairmen were 39 people.

Example group: The used example groups in this research were as following:

- The electrical equipment and electronic devices repairmen, who are in the areas of local government of Khamsakaesang, Nonthai, Nonsoong and Khong Sub Districts, Nakhonratchasima Province, which were in the total amount of 24 repairshops and repairmen were in the amount of 39 people by particularly selected an example group and volunteered to join in this research project
- The examples have been brought to analyzed in laboratory were divided into 2 types as following:
  - The blood example which came from 39 repairmen in the amount of 3 mL each person, the total amount was 39 examples
  - The example of soil and dust lead around working areas were particularly collected from working floors after work finished such as the most regular working location and longest time, which were collected in the area of 1 m^2 by randomly draw lots in the amount of 11 places, total 11 samples
- The instrument for gathering information in this research and the finding of instrumental quality were contained as following:
  - Questionnaire was contained of general information of repairmen's population characteristic, job description, behavior of danger protection from contaminated lead and assessing quality by 5 specialists. The values of IOC index were in rage of 0.6-1.00 and brought to try out with the similar repairmen in the amount of 37 examples. Its indication was discrimination value that also, using in the point of Pearson Coefficient Correlation by choosing the items with positive discrimination value. Which having a score >0.02, the discrimination value in range of 0.20-0.80, the reliability value that using the Cronbach α-coefficient and the reliability is equally to 0.92
  - The instrument was used to experimentally analyzing the level of lead in blood by using the method of Graphite Furnace Atomic Absorption Spectrophotometry (GFAAS) in laboratory of the fifth prophylactic control office, Nakhonratchasima Province and Flame Emission Atomic Absorption, Spectrophotometry (brand: Perkin-Elmer, model: Analyze 300), using standard method of Perkin Elmer to experimentally analyzes lead chemical in the example dust lead at the laboratory of Department of Environmental Engineering, Faculty of Engineering, Khonkaen University

Information of general information of repairmen's population characteristic, job description, behavior of danger protection from contaminated lead was obtained form questionnaire. The blood example form venous blood was drawn, transferred to a test tube and kept in an ice-box. The samples kept at 4°C until used for analysis, which was within a week of sample collection.

Data analysis: They were analyzed for collecting data by mean ($\bar{X}$) Standard Deviation (SD) and compares the

blood lead levels of repairmen with different age, education levels, time experiment and time worked load by t-test (Independent t-test).

RESULTS AND DISCUSSION

General characteristic of the studied population: The operators, who work in the electrical equipment and electronic devices repairshops, where are in the areas of local government Khamsakaesang, Nonthai, Nonsoong and Khong Sub-Districts, Nakhonratchasima Province are orderly in the amount of 14, 11, 8 and 6, total 39 people from 24 repairshops. There was a found that all of them are male and still in workforce age in range of 20-59 years old, which is averagely at 38 years old (SD = 8.82), in case of marriage status, which most of them are married in the percentage of 66.70 and next below are single, most of education levels are lower than diploma, which in the percentage of 64.10 and higher than diploma is in the percentage of 35.9. All of the example groups profession are mainly working as an electrical equipment and electronic devices repairman which in the percentage of 89.70 and secondly working as a farmer, trader and others. Which is orderly in the percentage of 5.1, 2.6 and 2.6 for the income per person per month is in range of 2,000-20,000 baths ($\bar{x}$ = 8,548.71 baths).

Work history, work condition work responsibility: People who work as an electrical equipment and electronic devices repairman from 24 repairshops are an employer and at the same time they repair by themselves in the amount of 24 people and 15 people are employees, total 39 people. These repairshops have been operating in range of 1-22 years, which is averagely 8.82 years. Before the workers came to work at the present repairshops, they recently used to work as an electrical equipment repairman, which in the percentage of 53.80, never worked as repairman before in the percentage of 46.20 have been having had an experience as a repairman till now averagely 12.77 years (range of 1-35 years), mostly 51.28% have work experience >10 years, next down are every days opening 61.50%, 6 days opening per week 12.80% and 5 days opening per week 25.6%. Most of workers who have time worked load <8 h a day, which in the percentage of 92.30 and have time worked load >8 h a day, which in the percentage of 7.70. The workers, who have time worked load >40 h a week in the percentage of 56.40 and <40 h a week in the percentage of 43.60. The quantity of electrical equipment repairing work mostly 1-2 equipments per person per day in the percentage of 64.10, secondly 3-4 equipments per person per day in the percentage of 28.20 and >5 equipments per person per day, which in the percentage of 7.70. Mostly, workers have never received training of work safety which is 82.10% and workers, who have received training of work safety is just 17.90%.

Personal behavior which is risky of touching lead substance: People who have their profession in repairing electrical equipments and electronic devices were in the amount of 39 people, 9 of them have a congenital disease history, which in the percentage of 23.10 mostly are breathing allergy, hypertension, diabetes and hearth disease, the percentage of 76.90 mostly do not have a congenital disease.

All workers have daily drinking behavior of energy drinks such as coffee and energy drink such as red-bull or others, 19 people, which in the percentage of 48.70 do smoke cigarette and 20 people in the percentage of 51.30 do not smoke, all smokers have smoking behavior as working which is 100%. The percentage of 97.40 of workers, who had their foods in work place area and never cleaned their hands before having foods. In case of putting on a hygienic mask in order to prevent a poisonous gas and fume of chemical lead as welding, which 30 people or 76.90% never had a hygienic mask on, 12.80% put on sometimes and 10.30% had a hygienic mask on every times.

Hundred percent workers have never wore hand gloves as holding or touching chemical lead or other chemicals and 69.23% of workers do not have a particular working uniform to ware, all workers have washed their working uniforms mixed with other family members' clothes without classifying. And most of them sat on working floor in the percentage of 79.50 and 20.50% sat on the arranged sitting areas. Hundred percent workers every times threw chemicals waste on theirworking floors after finished welding and 14 workers, which in the percentage of 35.90 burned hazardous waste that caused from chemical lead and electronic devices (Table 1).

Hazardous waste collection and environment at the electrical equipment and electronic device repairshops in the amount of 24 repairshops, 19 of them are rented, which in percentage of 79.16 and the rest of them are just 5 repairshops which in the amount of 20.84 are the private buildings.

Most of the workers use their work places to live as well as their homes which in the percentage of 95.83, the amount of 67 people living in the same house, which classified as 19 children, who have ages between 1-14 years old are in the percentage of 28.36, 47 people or 70.15% are workforce ages, which in range of 15-59 years old and just 1 person or 1.49%, who is >60 years old. In general, repairshops conditions was divided shop

Table 1: Practice for lead prevention

Variables	No. (n = 39)	%
Health condition		
Have a congenital disease	9	23.10
Do not have a disease	30	76.90
Drinking energy drink		
Drink	39	100.00
Smoking cigarettes		
Smoke	19	48.70
Do not smoke	20	51.30
Smoke as working	(n = 19)	
Smoke	19	100.00
Having foods at work place		
Did	38	97.40
Did not	1	2.60
Cleaning hands (before lunch)		
Did	38	97.40
Did not	1	2.60
Personal protection		
Use only	4	10.30
Sometimes	5	12.80
Do not use	30	76.90
Do not use hand glove	39	100.00
Use particular working uniform		
Use	13	28.20
Do not use	28	71.80
Sitting as working		
Sitting on the arranged areas	31	79.48
Sitting on working floors	8	20.52
Throwing chemicals waste on their working floors after finished welding	39	100.00
Burning hazardous waste of chemical lead and electronic devices		
Did	14	36.90
Did not	25	63.10

Table 2: Hazardous waste collection and work environment

Variables	No. (n = 24)	%
Building ownership		
Private	5	20.84
rented	19	79.16
Building usage		
Work only	1	4.17
Work and live	23	95.83
Residents in the same house	(N = 67)	
Children 1-14 years	19	28.36
15-59 years	47	70.15
>60 years	1	1.49
Providing an eating area		
Have	22	91.66
Have not	2	8.34
Providing a drinks service		
Have	23	59.83
Have not	1	1.49
Toilet and hands washing area	24	100.00
No hazardous waste collection	24	100.00
No hazardous garbage bin	24	100.00
Leaving lead powder around shop	24	100.00
Throwing waste into the local government's garbage bins	24	100.00

Table 3: Blood lead contamination level on repairmen

Blood lead contamination level (μg dL^{-1})	No. (n = 39)	%
0-5	15	38.50
5.1-10	10	25.60
10.1-15	8	20.50
15.1-20	3	7.70
20.1-40	3	7.70

* $\bar{X}$ = 8.58 μg dL^{-1}, SD = 6.37, Min.-Max. 1.26-25.54 μg

front for operating works and have no windows and ventilators for air circulation because most of repairshops are a detached house. Working seats and eating areas have been provided for all repairmen in the amount of 91.66% and repairshops, where have not provided in the amount of 8.34%, drinks service provided is 95.83% and have no drinks service is 4.17%, all repairshops have toilet and hands washing area which are in a fairly condition.

Lead and electronic wastes collection, which is caused from electronic equipments repairing, all repairshops did not manage to classify this waste type from the general waste and have no particular garbage bins for hazardous waste at their working places. All repairshops have been throwing their lead and electronic waste into the local government's garbage bins which all 4 local governments still have not got a method of restriction of hazardous substances then they still burning mixed with the general waste from communities (Table 2).

The promotion for reasearchers is to have their research places installed a ventilators and use personal safety equipments such as putting on hygienic mask, when welding which is easily to buy and also reducing the risk of lead ingestion (Chareaunluck *et al*., 2001). In addition, the behavior change of binning lead fragments into a provided hazardous garbage bin in stead of throwing lead fragments on work floor would help reducing dust lead dispersion, direct hands touching, lead contamination in food and water or children's unawareness of putting lead fragments into their mouth (Levy and Wegman, 1995).

The level of lead contamination in blood of repairmen and the level of lead contamination in electrical equipments and electronic devices repairshop environment, from blood tests of repairmen found that the average value of blood test was 8.58 μg dL^{-1} SD 6.37 μg dL^{-1} min-max between 1.26-25.54 μg dL^{-1}, when classified the intensity level of lead found that the level of lead contamination in blood was in range of 0-5 μg dL^{-1} for the amount of 15 people or 38.50%, secondly was in range of 10.1-15 μg dL^{-1} for the amount of 8 people or 20.50%, in range of 5.1-10 μg dL^{-1} for the amount of 10 people or 25.60%, in range of 15.1-20 μg dL^{-1} for the amount of 3 people or 7.70% and in range of 20.1-40 μg dL^{-1} for the amount of 3 people or 7.70%. This showed that repairmen have the highest value of blood lead level was 25.54 μg dL^{-1} and also the lowest value of blood lead level was 1.26 μg dL^{-1} (Table 3). When comparing with other occupations there was a higher average level of blood lead than the one, who working in a repair shops and vehicle spraying shops, where in the area of northern, which found the average level of blood

lead in the amount of 6.0 μg dL^{-1}, in range of 1.6-26.4 μg dL^{-1} has found the average level of blood lead according to the working characteristics such as a mechanical repairing, welding, dynamo repairing, rapping, spraying and vehicle modifying works, which have the blood lead value at 6.3, 6.2, 6.3 and 4.9 μg dL^{-1} orderly (Nantarat and Kamenkhetkarn, 2001), although, they are lower than the specified standard of US EPA (30 μg dL^{-1}) then the responsible government sectors should be actively looking after and following solution continuously. Comparing repairmen's age, education level, work load per week and work experience with repairmen's blood lead contamination level and found that electrical equipment and electronic device repairmen, who are even or <40 years old have blood lead level averagely at 7.12 μg dL^{-1}, in case of the ones, who are >40 years old have the average blood lead level at 10.47 μg dL^{-1}. When comparing the average value differences there was a found that t = -1.564 and p = 0.131 this shows that the repairmen who have different ages and they have indifferent average value of blood lead. The blood lead level of the electrical equipment and electronic device repairmen has found that repairmen, who have education level lower than diploma have had an average blood lead value at 10.00 μg dL^{-1}, for repairmen who have education level more than diploma have had an average blood lead value at 6.04 μg dL^{-1}. When comparing a difference of average values has found that t = 2.348 and p = 0.025, this shows the difference of both education levels have a different blood lead value statistically at the level of 0.05 by the repairmen, who have education level lower than diploma having a higher blood lead value than the ones, who have education level more than diploma because of repairmen who have a clean, big and greatly air ventilated work place are highly educated.

The repairmen who have work experiences till now, which is 1-5 years have had an average blood lead value at 6.07 μg dL^{-1} for others who have work experiences >5 years have had an average blood lead value at 9.69 μg dL^{-1}, when comparing the difference of average value there was a found that t = 2.072 and p = 0.046 this shows that the repairmen, who have different both education levels have different average blood lead values statistically at the level of 0.05 by the repairmen, who have research experiences >5 years have a higher blood lead value than others, who have research experiences <5 years, which is the same as Nantarat and Kamenkhetkarn (2001) that found the high level of blood lead is depended on working time period. Incase of the electrical equipment and electronic devices repairmen, who have time worked load <40 h a week have had an average blood lead value at 7.40 μg dL^{-1}, for the others who have time worked load >40 h a week have had an average blood lead value at 9.48 μg dL^{-1}. When comparing the difference of average blood lead values has found that t = 1.013 and p = 0.381 this shows repairmen, who have different time worked loads have slightly different average blood lead values (Table 4).

Table 4: Comparison of mean value between education levels

Variables	Blood leads level $\bar{X}$ (μg dL^{-1})	SD	t	p-value
Age				
<40 years	7.12	4.04	1.564	0.131
>40 years	10.47	7.83	-	-
Education				
Lower than diploma	10.00	7.26	2.348	0.025*
More than diploma	6.04	3.23	-	-
Work experiences				
1-5 years	6.07	3.87	2.072	0.046*
>5 years	9.69	6.98	-	-
Time worked load h/week				
<40 h	7.40	6.32	1.013	0.381
>40 h	9.48	6.40	-	-

*Statistically have a value level at 0.05

Table 5: Contamination of leads level in work environment

Repair shops	Lead level (g kg^{-1})
Selected sample 1	268.0
Selected sample 2	170.0
Selected sample 3	49.6
Selected sample 4	62.5
Selected sample 5	104.0
Selected sample 6	153.0
Selected sample 7	204.0
Selected sample 8	271.0
Selected sample 9	354.0
Selected sample 10	68.5
Selected sample 11	201.0

* $\bar{X}$ 173.26 g kg^{-1} SD 98.31 Min.-Max. 49.6-354 g kg^{-1}

The particular soil and dust collection result around the area of working seats 1 m^2/1 repairshop found that the soil powder characteristic have lead fragment, which caused from welding and fusioning of an electronic Printed Circuit Boards (PCB) greatly contaminated.

The test result of lead concentration in soil powder at the worker's seat areas found that the average value of lead was 173.26 g kg^{-1} SD 98.31 g kg^{-1} min-max between 49.6-354 g kg^{-1}.

Table 5 showing that contaminated dust lead in workers' working environment are higher than the specific standard, which directly causes a risk of touching lead for workers and their family members as well. Children typically spend significant amounts of time inside playing in their work place, which the specified standard of US EPA equal to 400 parts per million (ppm) of lead in bare soil in children's play areas (US EPA, 2001) and could ingest lead contaminated soil and dust through hand to mouth activities (Varduhi, 2004).

Additionally, the very dry climate, the strong winds and the presence of bare soil can create conditions for resuspension of settled lead contaminated dust into the air, contributing to its dispersion and potential increase of human exposure (Kurkjian *et al*., 2002).

CONCLUSION

All the electrical equipment and electronic device repairmen are male and research in this career as a major career, working characteristic is a family business, which situated in the crowded city areas, which having building characteristic as a commercial buildings, where hardly finds window for air ventilation and have no ventilator installed which is highly risky to exposures gas fume and dust lead form welding, which is caused from the inappropriate management and directly have an effect on researchers, which the average blood lead level was at 8.58 μg dL^{-1} and the highest blood lead level was 25.54 μg dL^{-1}. The researchers, who have a different education level and work experience, statistically have the different blood lead levels ($p<0.05$) even thought blood lead level is lower than the specified standard if the researchers still have their risky working condition and have average dust lead level at 173.26 g kg^{-1} accumulated in research places, which is much higher than the standard, which may causes a danger for health. Moreover, if there has no inappropriate method of lead termination then there still have an effect on family members and surrounding areas especially childhood in the families if the level of blood lead value is >10 μg $days^{-1}$, which is dangerous to health. The promotion for researchers is to have their work places installed a ventilators and use personal safety equipments such as putting on hygienic mask when welding.

RECOMMENDATIONS

The electrical equipment and electronic device repairmen still have an unsafe working condition, characteristic and environment, which risky to ingest lead contamination through breathing in both of mouth and skin, including the inappropriately terminating and throwing a hazardous waste, which causes a lead contamination effect on workers and environments. The research result reflected that most workers are lack of understanding and awareness of danger and have an unsafe working characteristic, which may causes lead affection from working in a long period of time. Therefore, the related organizations such as public health officers, Ministry of Public Health and local government sectors must be actively operate safety knowledge, awareness and behavior reinforce by providing the observation system of lead affection and the operation of sanitation on workers as well as they system planning of hazardous waste termination appropriately in all areas. All these for a people's good health and sanitation and reducing an impact of lead contamination through food chain.

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