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CORRELATION BETWEEN CHARACTERISTICS WITH HEAVY METAL CHROMIUM (Cr) LEVELS IN URINE OFMETAL COATING WORKERS IN SIDOARJO EAST JAVA INDONESIA

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ABSTRACT*--Metal coating process involves several chemicals, one of them is chromium. Chromium plating workers have a high risk of chromium exposure. The effects of chromium on health include carcinogenicity, immune system disorders, nervous system disorders, kidney disorders and damage, effects on breathing.****s****the research analyzed the correlationbetween characteristics (age, working period, use of PPE masks, and use of PPE gloves) with heavy metal chromium (Cr) levels in urine on metal coating workers in Candi DistrictSidoarjothis was an observational descriptive research with cross sectional design. The sample number of metal coating workers was 15 people. Chromium levels in the urine of workers were analyzed by the laboratory with Atomic Absorption Spectrophotometry (AAS). Analysis of descriptive data analysis used coefficient contingency to determine the strength of the correlation between variables. showed that as many as 53% of workers had chromium levels in urine that exceeded the normal range. The results of the cross tabulation of the characteristics of respondents with chromium levels in urine of workers showed that there was a correlation between age and chromium levels in urine with a coefficient contingency value of 0.447. The correlationbetween working period above 10 years with chromium levels in urine with coefficient contingency value of 0.478. The use of Personal Protective Equipment (PPE) masks had a coefficient contingency value of 0.259 and the use of gloves with chromium levels in urine had a coefficient contingency value of 0.225. of this research was production workers had higher chromium levels in urine than non-production workers. The strength of the correlationbetween characteristics with chromium levels in the urine of workers was the working period with a moderate level of strength of the correlation. It is advisable to exercise control over waste management and compliance with the use of appropriate PPE, especially masks and gloves for workers.*

Keywords*:metal coating,workers characteristics,urine chromium*

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I. INTRODUCTION

In the current era of globalization, the government is aggressively looking at industry to increase competitiveness. The Ministry of Industry has established five priority industrial sectors including the food and beverage industry, the automotive industry, the electronics industry, the chemical industry and the textile industry (1).

The five production sectors, especially in the terms of automotive and electronics, cannot be sepavalued from the need for components to support the products produced. Metal coating can be done by methods such as electroplating, fish rolling, cladding, and porcelain melting on a steel surface (2). The method most often used in an industry is the electroplating method. Electroplating is a process of metal coating by electrolysis that occurs because electrical charged ions move from an electrode. The metals used in coatings are chromium, nickel, silver, cadmium and the its similar metals.

Metal coating is an activity to provide treatment on a material surface, so that the material will experience an increase in quality in terms of structure, material resistance and physical properties (3). Producing to coating certain materials is done to maintain the quality of components. Metal coating is done with the aim to prevent the occurrence of corrosion, and refine the object surface. Objects that require the process of metal coating among metal household appliances such as stove furnaces, door handles, jewelry and parts of motorcycles as well as the seat ornaments coating (4,5). So in this case, the metal coating industry services are needed.

One of the materials used in the metal coating process is chromium. Chromium is a hard white metal and unstable. Chromium (Cr) is classified as a heavy metal element that is poisonous to humans (6).American Conference of Governmental Industrial Hygienist (ACGIH) recommends measurement of total Cr in urine as the biological exposure index for Cr (VI). This index is based on reduction of Cr (VI) to Cr (III) after its transportation from the cell membrane(7).

Chromium entry in humans can be through inhalation, ingestion and skin contact.Inhalation of chromium-containing aerosols is therefore a major concern with respect to exposure to chromium compounds. The concentration of chromium in water varies according to the type of the surrounding industrial sources and the nature of the underlying soils (8). Occupational exposure to chromium occurs mainly through inhalation and dermal absorption in the working environment, including chromium compound manufacturing, electroplating, leather tanning, and welding (9).

Chromium which is a toxic element in humans when it enters the body will have an impact on individual health. Those health effects such as, the appearance of carcinogenicity, immune system disorders, nervous system disorders, kidney disorders and damage, the effect on breathing. Chromium cumulation in the kidneys causes kidney tubular abnormalities. The total chromium that enters the body through the mouth is only 2-3% that can be absorbed by the intestine. The rest accumulates in the kidneys which are then excreted by the body through urine. Chronic exposure to chromium compounds can cause sores or ulcers in the skin (6).

There are some reports on the occupational chromium intoxication in workers at risk. the effects of chromium on the lymphocyte subsets and immunoglobulins from the normal population and exposed workers. Exposure to chromium also has a significant effect on the immune system and strongly related to cancer(10,11).

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The level of chrome poisoning in humans is measured by the level of chromium in the urine. The effect can cause increased chromium levels in the blood and urine. Examination of chromium levels in urine can reflect chromium contamination for 1-2 days. Increased chromium in urine can be used to confirm exposure to kidney function. This is evident in the research also shows that the chromium level in urine is higher than the chromium level in the blood (5,12).

The industrial sector in Sidoarjo Regency is developing quite rapidly. One of them is the metal coating industry located in the Durungbanjar Village, Candi District, Sidoarjo Regency. This home industry uses chromium chemicals in its metal coating process. This metal coating industry coats all types of metals as order, such as iron chairs and motorcycle spare parts.

Data from Shaw Environmental estimates that around 1,045,500 workers are exposed to chromium. The highest number of workers exposed to chromium are welding (269,379 workers), painting (82,253 workers), and electroplating (66,859 workers) (13).

Exposure to water-soluble Cr(VI) may affect renal function. In long-term exposure, a correlation between the Cr content of the renal cortex and the Cr clearance has been reported. The acute effect of Cr(VI) on the kidney seems to be reversible even after high exposure(14).

The results of a research conducted by EkaSudarsana (2013) showed that there are 15 people (50%) with kidney damage, and there is a correlationbetween chromium exposure in urine and kidney damage in workers. The kidneys are often the target of various hazardous substances. Despite having a small size, the kidneys receive 25% of cardiac output and potentially exposed to large amounts of toxic substances, because its function as osmotic absorption place, especially the medulla, so various toxic agents are found more in the kidneys than other organs (15).

II. METHODS

This research used descriptive observational method because the researcher only observed directly and did not give specific treatment to the object researched and the researcher only described the condition of the research object. The research design used in this research was cross sectional. Sample obtained method used the total population. The population used was all workers in the metal coating home industry in the Candi District Sidoarjo as many as 15 people.

The variables in this research consisted of the dependent variable which was the level of chromium in the urine of metal coating workers in the Candi District Sidoarjo. The independent variables were the characteristics of the workers (age, working period, use of PPE masks, and use of PPE gloves).

Measurement of chromium levels in urine of workers was done by respondent treatment which taking 50-100 mL of urine. Furthermore, urine samples were analyzed by the laboratory with Atomic Absorption Spectrophotometry (AAS) to determine its chromium levels. Information on the characteristics of workers was done by filling out questionnaires to workers using observation sheets to see the habit of using PPE (masks and gloves).

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Data obtained from measurement results and laboratory tests were analyzed descriptively which aimed to describe the distribution of each variables. Measurement data of chromium levels in urine were compared with threshold limit values based on the Agency for Toxic Subtances and Disease Registry. The data was then interpreted using coefficient contingency to determine the correlation strength between variables.

III. RESEARCH RESULTS AND DISCUSSION

METAL COATING PROCESS

Electroplating process involves several chemicals, one of them is chromium. The result of this coating makes the object shiny and sparkling with a layer thickness ranging from 0.25 to 0.5 microns. Metal coating with this method is widely used in the coating of motor vehicle spare parts, household appliances, and medical tools. Decorative metal coating can make coated work tools resistant to water (16).

Chrome electroplating workers are highly exposed to Cr (VI). Exposure occurred because of airborne chrome electroplating vapors in breathing zone. Work steps and tasks include degreaser workers, placement into the chrome plating vat (Near bath workers) and washing workers(17).

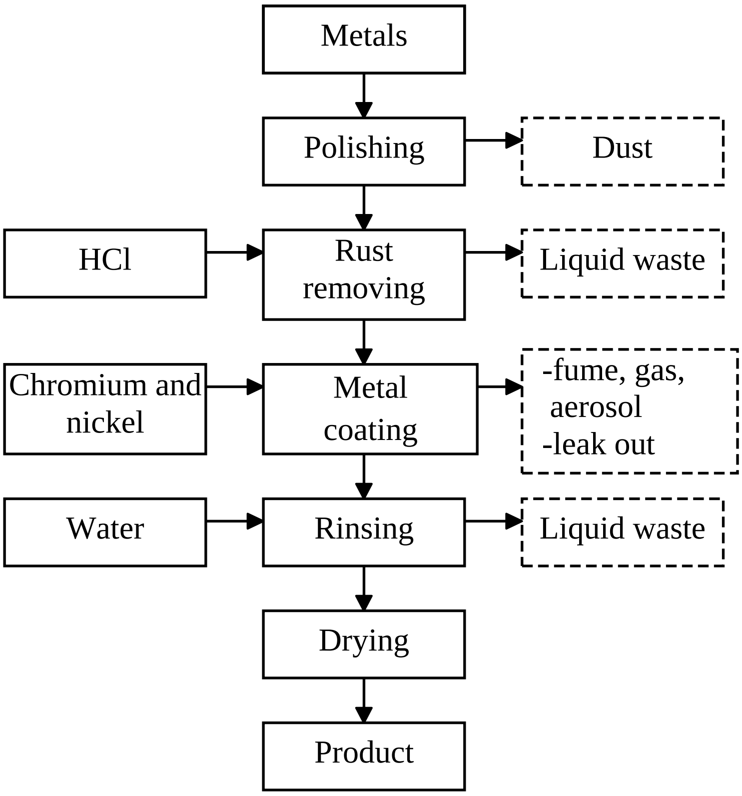

Figure 1: Metal Coating Process

The metal coating process in the home industry began with removing of residual paint that was still attached to the metal material submitted by the customer using acidic liquid. Then soakingwas carried out on the HCl solution to remove rust. After drying for a while, metal objects were brought to the polishing room to be polished so that the surface of the object was flat. After the surface of the object was smooth, soakingwas done again

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using HCl to remove the residual from the polishing process. Objects that had been soaked in HCl solution were rinsed with water and then followed by soaking using soda to remove oil and other dirt. Rinsing with soapy water was done to ensure the object was clean from rust, oil and dirt.

Entering the main process that was the object that had been dried, soaked into nickel liquid by using a hook for 1 hour. The object was rinsed with water first before dipping it into the chromium tub. Metal object was dipped in chromium liquid for about 5-7 seconds using a long hook that functioned to dip objects into the chromium tub. When lifted, the metal turned golden yellow. Metal object was rinsed and then dried in the sun. The object which was originally golden yellow became shiny silver white.

IV. CHROMIUM LEVELS IN URINE OF WORKERS

Measurement of chromium levels in urine was done by taking urine samples of workers who were accommodated in sterile urine cups which were then analyzed by the laboratory.

Table1: Result of Chromium Levels Test onMetal Coating Workers in Sidoarjo

Chromium Levels	Number (n)	Percentage (%)
Normal	7	47
Exceed Normal Limit	8	53
Total	15	100

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The Agency for Toxic Subtances and Disease Registry (ATSDR) sets the normal chromium in urine to be 0.24-1.8 µg / L (18). Table 1 showed that 53% or 8 workers had chromium levels exceeding the normal limit determined of ATSDR. These eight workers consisted of 2 workers in the non-production section namely the polishing process. Whereas the other 6 workers were workers in the production section which include coating and rinsing processes.

Chromium levels in human body fluids such as urine, serum, and even erythrocytes are a marker of the level of chromium exposure. Chromium that enters the body will accumulate in the kidneys and then excreted by the body through urine (18). The excretion of absorbed chromium and nickel compounds occurs mostly via urine. Urinary levels of chromium and nickel usually reflect recent occupational exposure, and the relatively short initial half-lives allow the effect of improved exposure controls to be quantified in a relatively short time period (19).

Table2: Result of Chromium Levels Test on Metal CoatingWorkersinSidoarjo

No.	**Workers**	**Sections**	**Chromium Levels inUrine** (µg/*L*)	**Quality Standard**	**Category of Chromium Levels**	
					Normal	**Exceed Normal Limit**
1.	Worker1	Nonproduction	6,5	Agency for		v

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2.	Worker 2	Nonproduction	6,7	Toxic Subtances and Disease Registry on 2012 sets normal limit ofchromium levels in urine is 0,24-1,8 µg/*L*		v
3.	Worker 3	Nonproduction	0,7		v	
4.	Worker 4	Nonproduction	0,4		v	
5.	Worker 5	Nonproduction	0,4		v	
6.	Worker 6	Nonproduction	0,5		v	
7.	Worker 7	Nonproduction	0,5		v	
8.	Worker 8	Production	6,6			v
9.	Worker 9	Production	6,5			v
10.	Worker10	Production	4			v
11.	Worker11	Production	7,1			v
12.	Worker12	Production	7,3			v
13.	Worker13	Production	8,6			v
14.	Worker14	Production	0,6		v	
15.	Worker15	Production	0,5		v	

Measurement of chromium in the urine of workers was at rest. Workers were divided into two sections, namely the non-production section where the polishing and drying process did not directly contact with chromium and the production section which occurs in the metal coating process (nickel and chromium) and the rinsing process. Table 2 showed the non-production section of workers having chromium levels that exceeded the normal limit of 6.5 µg / L and 6.7 µg / L.

Based on the results of the questionnaire with the workers related, these two workers had age of more than 40 years and a work period of more than 10 years. They were residents around the industry who had been working since the metal coating industry was established. Workers with more than 40 years of age accumulated more chromium in their urine. In addition, based on observation, the two workers did not use a complete Personal Protective Equipment (PPE) while working. So it could increase the risk of exposure and high levels of chromium in urine.

In the research by Bhakti (2016) also found 2 workers who has chromium levels exceeding the normal limit. The first worker is a worker who has worked more than 2 years in the industry related, work in a section that is not directly contact with chromium. Whereas the second worker is a worker who has worked for more than 5 years and has worked in sections that is directly contact and in section that is not directly contact with the metal (20).

This indicates that heavy metal chromium exposure through air containing chromium can be inhaled by workers which directly contact with chromium and can also be inhaled by workers who are not directly contact with chromium. The longer a person works on a job, the greater the potential exposure to the dangers of pollutants in this industry, namely chromium (21). The respondent's department showed direct contact workers with the exposed to air chromium and most direct contact with the electroplating process. So, workers have a high risk of direct exposed to chromium and high risk of experiencing health disorders.Worker's working time indicates the length of the worker is exposed to chromium and complies with predefined standards (22).

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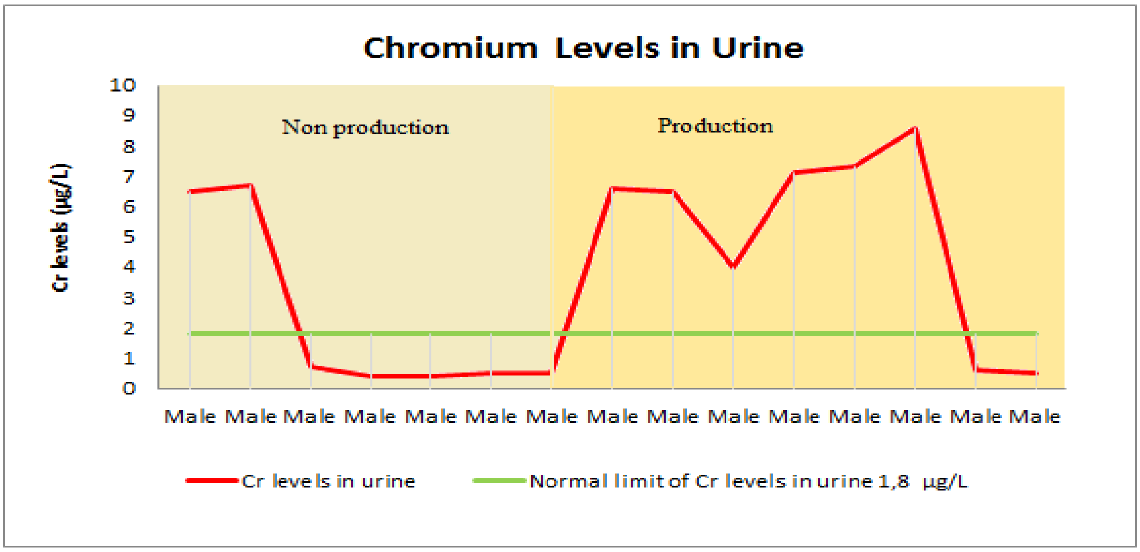

Figure 2: Chromium in Urine Based on Work Sections

All workers in the metal coating industry were male. All workers in this industry had the same working time of 8 hours a day in Monday-Saturday. Figure 2 showed that workers whose chromium levels exceed normal limit were mostly workers in the production section consisting of coating and rinsing activities. The highest level of chromium was found in workers 13 who were production section workers who were doing metal coating and rinsing activities at 8.6 µg / L. Subsequently, high chromium levels of 7.3 and 7.1 µg / L were at workers doing chromium and nickel coating processes. The high level of chromium in urine was affected by the position of work that was close to the source of chromium, besides that the use of PPE of the workers was not quite good. The process of coating and rinsing which were production section of workers would more often directly contact with chromium liquid thereby increasing the risk of chromium being more easily absorbed into the body and causing high levels of chromium in urine.

However, there were 2 workers in the production section who had normal chromium levels in urine. The two workers were the production section who were doing the rinsing process. Based on the questionnaire, the first worker was less than 20 years old and just had a work period of 1.5 years working in the industry. The second worker was 21 years old and had a work period of about 2 years in the industry. The age range that was still young and the work period that was not too long could be a cause of low levels of chromium in urine even though they work in sections that were directly contact with chromium.

In the research by Wulaningtyas (2018), chromium level is found in workers and do not exceed the normal limit of 0,000-0,025 µg / L (11). Chromium can enter through food and is ingested through the mouth into the body which can cause stomachaches and vomit with chromium level of 5-25 µg / kg (23). Consider the presence of other factors that affect the absorbtion of chromium during metabolism, such as the good excretion system in workers body, good immunity, and always eat nutritious foods such as vegetables and fruit.

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Table 3: Cross Tabulation ofWork Sections withChromium in Urine

Work Sections	**Chromium in Urine**				**Total**	
	Normal		**Exceed Normal limit**			
	n	**(%)**	**n**	**(%)**	**n**	**(%)**
Nonproduction Section	5	71,4	2	28,6	7	100%
Production Section	2	25	6	75	8	100%
Total	7	47%	8	53%	15	100%

Based on the table above it could be seen that workers who had chromium levels in urine exceeded the normal limit (> 1.8 μg / L), were namely workers who work in the production section as many as 75%. So there was correlation between variables work sections with chromium levels in urine with coefficient contingency value of 0.408 which meant the level of strength of the correlation between these variables included in the moderate category.

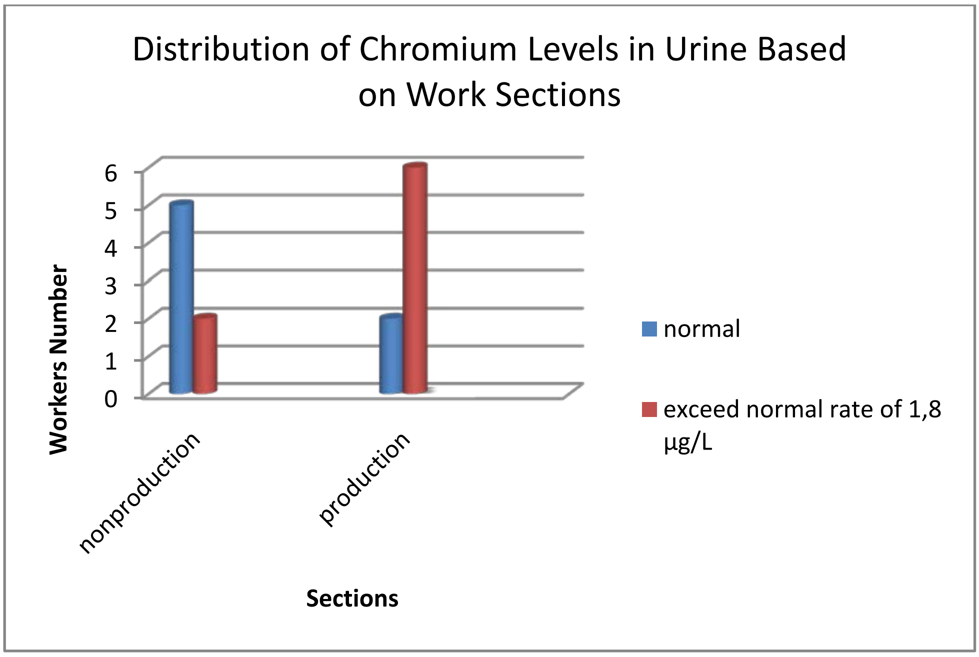

Figure 3: Distribution of Chromium Levels in Urine Based on Work Sections

Workers who had chromium levels exceeded the normal limit were 6 workers in production section as shown in figure 3. In line with research (24) which shows that chromium-exposed workers have higher chromium levels than workers who are not directly exposed.

Chromium is absorbed through inhalation through the lungs into the blood system which then collects in the kidneys. Same thing happens through ingestion and absorption through skin contact. Absorption through ingestion can have an impact when acute exposure occurs (25). Various variables may influence the level of chromium in the urinary including diet, the individual physical state to reduce the chromium and the type of occupational exposure. Individual differences in reducing chromium have also been confirmed, so that the concentration of urinary chromium varies between individuals with different physical states(26).

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Correlation between characteristics with chromium levels in urine

Strong correlations derived from the value of coefficient contingencyof cross tabulation of worker characteristics (age, working period, the use of masks and gloves PPE) with the levels of chromium in urine then interpretation is classified according to de Vaus as follows (27):

Table 4: Interpretation of Correlation Coefficients According to de Vaus

Coefficient	Correlation Strength
0.00	No correlation
0.01 - 0.09	Less meaningful
0.10 - 0.29	Weakcorrelation
0.30 - 0.49	Moderate
0.50 - 0.69	Strongcorrelation
0.70 - 0.89	Very strongcorrelation
> 0.90	Perfectcorrelation

Source: De Vaus, 2002

Age with Chromium Levels in Worker's Urine

The age of respondents was measured based on the year of birth until the time of the research. The results of age cross tabulation calculations in the metal coating home industry are as follows:

Table 5: Cross Tabulation Between Age and Chromium Levels in Urine

Variable	Chromium Levels in Urine			
	Normal		Exceeds normal limit	
	N	%	N	%
Age				
<20 years old	1	100.0	0	0.0
21-30 years	1	33.3	2	66.7
31-40 years old	4	66.7	2	33.3
>40 years old	1	20.0	4	80.0

The results of the cross tabulation showed that all worker’s urine contain chromium. The highest number of workers whose chromium content exceeds thenormal limit in the age group of >40 years is 4 workers while the normal one in the age group of less than 20 years. There are 4 workers in the age group of >40 years, namely coating and polishing workers who exceed the normal limit of chromium in urine with a range of 6-7 µg/L.

The correlation between the age variable and the chromium in urine among workers variable in the home industry metal coating with a coefficient contingencyvalue of 0,447, which means the strength level of the correlation between the variables included is in moderate category. In line with the research of Wisnstein and Anderson (2010), workers with more than 40 years of age accumulate more chromium in their urine. Increasing

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age causes a decrease in the workings of body organs such as kidneys and enzyme mechanisms that can cause a person more easily exposed to harmful chemicals (21).

Working Period with Chromium Level in Worker's Urine

The work period is calculated based on the length of work time in the metal coating to the time of research is done in a matter of years. The results of cross tabulation calculations during the working period of metal coating workers are as follows:

Table 6: Cross Tabulation Between Working Period and Chromium Levels in Urine

Variable	Chromium Levels in Urine			
	Normal		Exceeds normal limit	
	N	%	N	%
Working Period				
0-5	3	100.0	0	0.0
6-10	2	40.0	3	60.0
> 10	2	28.6	5	71.4

The result of cross tabulation showed chromium that exceed the normal number found in workers with the longest number of working period of more than 10 years as much as 71.4% which exceeds the normal limit of chromium in the urine. Workers with tenure of more than 10 years as much as 71.4% which exceeds the normal limit of chromium in urine that was working on the process of coating and finishing with chromium levels in the range of 6-7 mg/L followed by workers with a work period of 6-10 years as many as 3 workers. While the normal limit of urine are found in workers with a work period of 0-5 years.

The correlation between the working period variableand the chromium levels in urine on workers variable in the home industry metal coating with a coefficient contingency value of 0,478 which means the strength level of the correlation between these variables included in the moderate category. In line with Wulaningtyas research (2018), it was found that workers with more than 12 years of working periodhad highest urine in chromium than workers with less than 12 years of workng periof (11). In this study workers who work for more than 10 years are spread out in the production department so as to increase the risk of exposure to chromium. The longer a person works on a job, the greater the potential for exposure to hazardous substances. The longer exposure to the material, affects the toxic effects and the severity of the impact (28).

Use of PPE Masks with Chromium Levels in Worker's Urine

Measuring the use of PPE for workers used questionnaires and observation sheets. The results of cross tabulation calculations on the use of metal coating home industry worker PPE masks are as follows:

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Table 7: Cross Tabulation Between Use of PPE Mask and Chromium Levels in Urine

Variable	Chromium Levels in Urine			
	Normal		Exceeds normal limit	
	N	%	N	%
Use of PPE Mask				
Always	2	50.0	2	50.0
On Off Use	4	57.1	3	42.9
No	1	25.0	3	75.0

Cross Tabulation indicated that workers who levels of chromium in urine exceeds thenormal limit are mostly in workers who do not use the mask as much as three workers and on off use mask as much as 3 workers while the normal chromium levels can be found in workers which wear the mask on off. The correlation between variable PPE Mask usage with chromium levels in workers urine variable in the home industry metal coating with a coefficient contingencyvalue of 0,259 which means the strength level of the correlation between these variables was included in the weak category.

The reason workers don't use PPE mask was because they don't feel comfortable and have difficulty breathing. Workers who wear masks mostly use cloth masks. Industry owners say that they have provided fiber masks for their workers. The use of masks is an obligation for all workers who must be obeyed while in the home industryarea, especially when the production process is in progress. The metal coating industry has the potential for exposure to chromium in the form of fume.Therefore masks are personal protectors that must available in industrial areas that produce dust, fume gas, and chemicals (29).

Use of PPE Gloves with Chromium Levels in Worker's Urine

Measuring the use of PPE gloves for workers usedquestionnaires and observation sheets. The results of cross tabulation calculations on the use of metal coating home industry workersPPE gloves are as follows:

Table 8 : Cross Tabulation Between Wearing of PPE Gloves and Chromium Levels in Urine

Variable	Chromium Levels in Urine			
	Normal		Exceeds normal number	
	N	%	N	%
Use of PPE Gloves				
Always	2	33.3	4	66.7
On Off Use	2	50.0	2	50.0
No	3	60.0	2	40.0

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The results of the cross tabulation showed that workers whose chromium levels in urine exceed normal limit were found in workers who always use gloves as much as 4 workers, use of gloves on off as much as 2 workers and workers who do not use gloves as much as 2 workers. The correlation between the use of PPE gloves variable with chromium in urine among workers variable with a coefficient contingencyvalue of 0,225 which means the strength level of the correlation between these variables was included in the weak category.

Workers say the reason for not wearing gloves was becauseuncomfortableness and so far have not caused problems. In addition to the use of masks, Personal Protective Equipment (PPE) that must be used when working is gloves. Apart from inhalation, chromium exposure can also be absorbed through oral or skin with an intermediary hand. All metal coating processes in this home industry have the potential for chromium exposure. Rochmatika research (2011) showed that there is a correlation between the use of Personal Protective Equipment (PPE) with chromium levels in the urine of workers. So if workers do not use PPE properly and completely, there will be a risk of health effect due to chromium exposure (30).

Using PPE regularly can reduce direct contact with toxic chemicals and protection from dust containing respirable metal particles during electroplating. Using PPE in the form of safety gloves, masks, and aprons (work suits) during daily working hours. In the current study, use of PPE significantly decreased the levels of chromium and nickel (22).

Periodic assessment is necessary to early detection of the presence of health problems in workers. Periodic medical checkups (MCU) are conducted on workers with certain periods. The examination of this period is intended to maintain the degree of workers' health after being in its work according to the type of work, and assess the likelihood of influence from early work that may need to be controlled by preventive efforts(22,31) .

Table 10 : CorrelationStrength of Characteristics with Chromium Levels in Urine

Variable	**Chromium in Urine**	
	Coefficient Contingency	**Strength ofCorrelation**
Age	0.447	Moderate
Working Period	0.478	Moderate
Use of PPE Mask	0.259	Weak
Use of PPE Gloves	0.225	Weak

The level of chromium toxicity was influenced by the characteristics of workers who are potentially exposed to chromium. The results of research on chromium levels in the air in the industry showed the value in production room was 0.01 mg/m^3 and in polishing room (non-production) was 0.005 mg/m^3. The results did not exceed the maximum limit imposed by the Ministry of Health Regulation Number70 of 2016 with a limit of 0.05 mg/m^3 (32). While the level of liquid waste in the industry is 16,394 mg/L. The total chromium levels exceed the limits according to Minister of Environment Regulation Number 5 of 2014 on Wastewater Quality Standard which states that the highest level of chromium metal coating is 0.5 mg/L (33).

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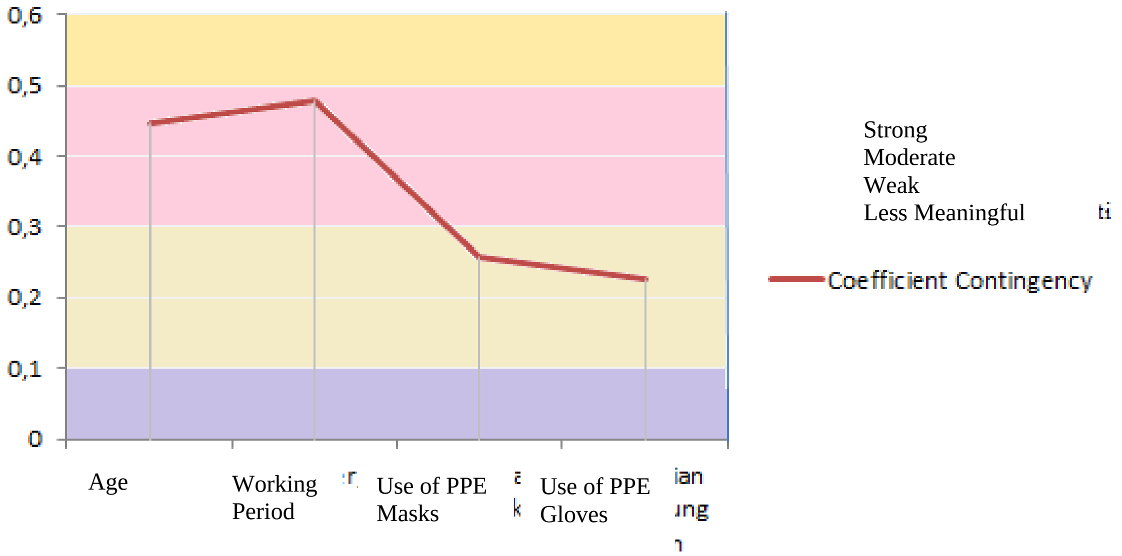

Figure 4: Correlation Strength of Characteristics with Chromium Levels in Urine

The characteristic that has the strongest level of correlationwith chromium levels in workers' urine was the workingperiod as shown in the figure. The higher and longer the level of heavy metal exposure, the higher the concentration of heavy metals in the body of organisms including humans and the greater the toxic effects (34). In general, the higher the chromium especially in industrial environments and the duration of exposure influences toxic effects (23). High levels of chromium in the environment and worker characteristics affect chromium in the urine of workers.

In line with Ambreen's research (2012) which showed a significant correlation of working period with chromium accumulation in the body. The longer a person works in a chromium-exposed environment, the greater the risk of the worker getting greater accumulation of exposure. In simple and multiple correlation analysis, chromium level shows a significant correlation with the duration of exposure in the exposed group(35).

Efforts are needed to control chromium levels in the environment from both liquid and air wastes. Efforts to suppress heavy metal chromium can be done with waste management methods that are easy and environmentally friendly in various ways, one of which is natural adsorbents such as chitosan. Use of this compound in industry is recommended because it is environmentally friendly (36). In addition, it can also be done with an ultrafiltration membrane which has good prospects for use as an electroplatingwastewater treatment unit (37).

There is reliance on good working practices, engineering controls and Personal Protective Equipment (PPE) to control worker exposures. Improved risk awareness among workers will be an important component in achieving control of exposur*e* (38). So there is a need for supervision of compliance with the use of PPE on metal coating workers.

V. CONCLUSION AND SUGGESTIONS

As many as 53% of workers had chromium levels in urine exceeding the normal limit of above 1.8 μg/L. Workers in production section had chromium levels higher than workers in section of non-production. The older

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the age and the longer the working period had a correlation to the high levels of chromium in the urine of workers. The strength of the characteristics sub variablecorrelationwith chromium levels in workers' urine which holds the highest strength level of the correlation included in moderate category was working period.

The industrial owner, assisted by the district government, can monitor the management of the resulting waste. Doing control of exposure as their compliance with the use of appropriate PPE, especially a mask and gloves.

REFERENCE

1. Industrial Ministry of Republic of Indonesia. Making Indonesia. Mak Indones. 2019;1–8.
2. Hadi S. Toxicology Advanced Materials. Yogyakarta: ANDI; 2018.
3. Miaratiska N, Azizah R. Correlation of Nickel Exposure to Skin Health Disorders in Metal Coated Home Industry Workers in Sidoarjo Regency. Perspekt J Kesehat Lingkung. 2015;1(72):25–36.
4. Directorate of Occupational Health and Sports Development Ministry of Health RI. Guidelines for the Management of Occupational Diseases for Health Workers. Jakarta: Directorate of Occupational Health and Sports Development Ministry of Health RI; 2012.
5. Mirasa Y. Blood Chromium and Urine Levels of People who Eat and Don't Eat Crackers. Universitas Airlangga; 2004.
6. Alsuhendra. Toxic Ingredients in Food. Bandung: Remaja Rosdakarya; 2013.
7. ACGIH. Threshold limits values for chemical substances and physical agents. Biological exposure indices. Cincinnati: ACGIH; 2014.
8. WHO Regional Office for Europe. Air Quality Guidline - Second Edition. Denmark: WHO Regional Office for Europe; 2000.
9. Zhang XH, Zhang X, Wang XC, Jin LF, Yang ZP, Jiang CX, et al. Chronic occupational exposure to hexavalent chromium causes DNA damage in electroplating workers. BMC Public Health. 2011;11(Vi).
10. Wiwanitkit V. Minor heavy metal: A review on occupational and environmental intoxication. Indian J Occup Environ Med. 2008;12(3):116–21.
11. Wulaningtyas FA. Environmental Health Risk Assessment of NO2 Ambient Level and Toll Collectors Officer'S Health Complaints. J Kesehat Lingkung. 2018;10(1):127.
12. Khairani N, Azam M, Sofjan KF, Soeleman. Textile Waste With Analysis Method. Berk Fis. 2007;10(1):35–43.
13. Shaw Environmental. Industry profile, exposure profile, technological feasibility evaluation, and environmental impact for industries affected by a proposed OSHA standard for hexavalent chromium. United States: Department of Labor NIOSH; 2006.
14. Verschoor MA, Bragt PC, Herbert RFM, Zielhuis RL, Zwennis WCM. Renal function of chrome-plating workers and welders. Int Arch Occup Environ Health. 1988;60(1):67–70.
15. Sudarsana E, Setiani O. Correlation of Chromium Exposure History and Impaired Kidney Function in Metal Coating Workers in Tegal Regency. J Kesehat Lingkung Indones. 2013;12(1):34–41.
16. Setyahandana B, Christianto YE. Effect of Hard Chrome Plating on Increasing the Hardness of Ferris Wheel Steel. J Teknol. 2017;12(1):26–35.
17. Mozafari P, Azari MR, Shokoohi Y, Sayadi M. Feasibility of biological effective monitoring of chrome

DOI: 10.37200/IJPR/V24I4/PR201089
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electroplaters to chromium through analysis of serum malondialdehyde. Int J Occup Environ Med. 2016;7(4):199–206.

18. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chromium. Georgia: Agency for Toxic Substances and Disease Registry; 2012.
19. Beattie H, Keen C, Coldwell M, Tan E, Morton J, McAlinden J, et al. The use of bio-monitoring to assess exposure in the electroplating industry. J Expo Sci Environ Epidemiol [Internet]. 2017;27(1):47–55. Available from: http://dx.doi.org/10.1038/jes.2015.67
20. Bhakti AN, Dewi A, Sujoso P. Chromium (Cr) Exposure and Lung Disorders Workers in the Chrome Villa Electroplating Industry Jember Regency Exposure Chromium (Cr) and Lung Function Disorders of Workers in Villa Chrome Electroplating Industry Jember. J SRA-Medical. 2016;143–4.
21. Weinstein JR, Anderson S. The Aging Kidney: Physiological Changes. J Adv Chronic Kidney Dis. 2010;17(4):302–7.
22. Suhendi D, . K, Sulistyadi K. Monitoring Strategy of Chrome Electroplating Workers' Health at Company XYZ. J Educ Soc Behav Sci. 2019;32(1):1–11.
23. Ardani. Exposure to Chromium Heavy Metals in Dental Blood Technicians in Surabaya Laboratory. Universitas Airlangga; 2013.
24. Islam F, Hatono B. Exposure to chromium and kidney damage in metal coating workers. J Ber Kedokt Masy. 2018;32(8):257.
25. National Institute for Occupational Safety and Health. Occupational Exposure to Hexavalent Chromium. Washington DC: NIOSH; 2013.
26. Khadem M, Golbabaei F, Rahmani A. Occupational Exposure Assessment of Chromium (VI): A Review of Environmental and Biological Monitoring. Int J Occup Hyg. 2017;(Vi):118–31.
27. de Vaus D.A. Survey in Social Research 5th Edition. New South Wales: Allen and Unwin; 2002.
28. Suma'mur. Corporate Hygiene and Occupational Health (HIPERKES). Jakarta: CV Sagung Seto; 2009.
29. Rofiqi D. Factors Associated with Complaints of Respiratory Tract Disorders in Workers in the Sandblasting Section. Universitas Airlangga; 2011.
30. Rochmatika Y. Correlation Between Work Period, Use of Personal Protective Equipment and Personal Hygiene with Chromium Content in Urine in Metal Coating Workers in Kaligawe Semarang. Universitas Diponegoro; 2011.
31. Yuliana. Analysis of Copper and Chromium (VI) Content in Winongo River Water Samples by Spectrophotometer Method. Universitas Islam Negeri Sunan Kalijaga; 2014.
32. Ministry of Health. Regulation of Health Ministry No. 70 About Standards and Requirements for Industrial Environmental Health. Health Ministry of Republic of Indonesia. 2016;3(1):56.
33. Environmental Ministry of Republic of Indonesia. Minister of Environment Regulation No. 5 Year 2014. 2012;(345):1–10.
34. Adhani R, Husaini. Heavy Metals Around Humans. Banjarmasin: Lambung Mangkurat University Press; 2017.
35. Ambreen. Genotoxicity and oxidative stress in chromium-exposed tannery workers in North India. J Toxicol Ind Heal [Internet]. 2012; Available from: https://www.ncbi.nlm.nih.gov/pubmed/22933550
36. Natalina N, Firdaus H. Decreased Hexavalent Chromium (Cr6 +) Levels in Batik Waste Using Shrimp

DOI: 10.37200/IJPR/V24I4/PR201089
Received: 02 Oct 2019 | Revised: 30 Sep 2019 | Accepted: 15 Jan 2020

Waste (Chitosan). J Tek. 2018;38(2):99.

37. Hendro M, Sulastiningrum R. Separation of Chromium and Nickel from Electroplating Liquid Waste by Ultrafiltration Process. J Tek Kim. :1–7.

38. Keen C, Tan E, Mcalinden J, Woolgar P, Smith P. Exposure to hexavalent chromium , nickel and cadmium compounds in the electroplating industry [Internet]. 2013. 1–32 p. Available from: www.nationalarchives.gov.uk/doc/open-government-licence/,

39. Pinzon, r. T. & sanyasi, . R. D. L. R. (2018) is there any benefit of citicoline for acute ischemic stroke ? Systematic review of current evidences. Journal of Critical Reviews, 5 (3), 11-14. doi:10.22159/jcr.2018v5i3.24568

40. Koçaslan, G. The role of distance in the gravity model: From the view of newton, international economics and quantum mechanics (2017) NeuroQuantology, 15 (2), pp. 208-214.

41. Song, D. Comment on information and dualism (2017) NeuroQuantology, 15 (2), pp. 141-144.