PROBLEM OF ILLEGAL COSMETICS CONTAINING MERCURY IN INDONESIA

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ABSTRACT

BACKGROUND: Skin lightening products have an increasing demand in Indonesia despite its illegal and safety issue, including hazardous mercury-containing skin lightening creams. Misperception of beauty may result in a desire to have lighter skin instantly regardless of the ingredients of products. As a populous country, Indonesia becomes a promising country for this industry. Due to increasing demand from middle-class society and cosmetic trend change among men, this industry grows greatly in Indonesia. This study aims to investigate hair mercury concentration to the duration and estimated weight of skin lightening products applied.
METHOD: As much as 297 participants were given a questionnaire regarding their skin cream application. Hair and skin products were analyzed by particle-induced x-ray emission (PIXE).
RESULTS & DISCUSSION: The mean hair mercury concentration of users was 20.3±5.4 ppm, 10 times higher than non-users (2.12± 2.05 ppm). Of 27 samples of skin lightening creams, eight samples did not contain mercury while others contain mercury with the mean mercury concentration of 272.26 ppm (0-7834 ppm). Hair mercury concentration exhibited a statistically significant correlation with the duration of skin lightening cream application as well as the estimated weight of the cream applied.
CONCLUSION: This study exhibited the presence of hazardous skin lightening creams containing mercury as well as accumulation of mercury in the human body that has a significant correlation with the duration of exposure and weight of cream applied.

KEYWORDS: Illegal Cosmetics, Mercury, Human Problems

INTRODUCTION

Skin lightening products are cosmetics that very commonly used by people, especially women who believe that brighter skin will enhance their beauty. This beauty perception can produce the desire to have brighter skin instantly, regardless of the product ingredients they use.

According to Japanese cosmetics giant Shiseido, sales of skin- lightening products in Asia grew up to 25% in 2020. In Thailand, the lightening lotion segment accounts for more than 60% in the country's annual US$100 million facial skincare market. In Hong Kong, moisturizers accounts for 60% - 70% of the multi-million dollars skincare market, which is a 40 % covered by skin lightening products In Indonesia, the illegal cosmetics are economic value reach amounts of Rp 30 billion [US$ 2.1 million]. Inexpensive black-market products with powerful but illegal bleaching agents are selling briskly throughout the poorer parts of South and Southeast Asia. Indonesian officials have identified more than 53 banned cosmetics. Thailand's Food and Drug Administration has published a list of 70 skin- whitening creams circulating illegally around the country. Of the 549 tested products, 6 % (n=33) contained mercury above 1000 ppm, 45% (15/33) contained mercury in excess of 10000 ppm that found in products purchased in China 8.7%, 29% Thailand, and 3.3% in United Stated. These cosmetics containing mercury were produced in China 13%, 50% Jamaica, 6.9% Japan, 19% Thailand, The Philippines 6.7% and in regions not Indicated 5.5%. There are also some questions about legitimate of creams. The Indonesia Food and Drug Control Agency (BPOM) latest public warning was issued in 2017, when it identified 53 beauty products containing mercury and Rhodamine B color additive that were sold in markets across the country.

In January 2006, police announced they had seized 200 boxes of cosmetic products containing mercury from a small manufacturing company in West Jakarta. The company produced imitation Unilever products such as Dove skin lotion, and fake Procter & Gamble products like Olay skin moisturizer and Head & Shoulders shampoo. Many soaps historically manufactured in UK. In year 2003 EU export ban moved production overseas. Research suggests creams containing mercury are manufactured in Dubai, Thailand, China, Taiwan, and Mexico. Indonesia and S. Africa are thought to be large exporters of mercury cream. Indonesian Consumer Foundation has reported that it is very difficult to stop entry of products into the market. One of the problems in monitoring these products is that often they are transported to the country by individuals who carry the products in their luggage. For example, a trader at a traditional market, who sells unlicensed cosmetics priced from Rp 5,000 (55 U.S. cents) to Rp 50,000 (US$5.5), said a "friend" who regularly traveled to China provided him with the products. These products are used on the skin with large areas at the time, absorbed into the skin for several hours at the time and used multiple times for weeks, months or years.

In certain women and young African girl such as Senegalese, Malian, Togolese, South African, and Nigerian about 27%, 25%, 9%, 35%, and 77% respectively use lightening cream, while in Asian women and young girl such as Hong Kongese, Korean, Malaysian, Indonesian, Philipinese and Thaiwanese about 45%, 28%, 41%, 36%, 50%, and 37% respectively. Products are made in a variety of countries in Afrika, Asia and Latin America, which contain from 660-57.000 parts per million ppm mercury[1-6]. Taking into account the growing use of cosmetics as well as the reports on the presence of dangerous metals in the cosmetics currently available worldwide and the cases of unfavorable health effects due to their presence in cosmetics, it was warranted to pay special attention to problem related to metals occurrence in these products. Although Mercury is highly toxic human health but even relatively low dose of mercury containing compounds can have serious adverse impacts on the developing nervous system, and have recently been linked with possible harmful effects on the cardiovascular, immune and reproductive system (European Commission, 2005). Mercury and its compound affect the central nervous system, kidneys and liver and can disturb immune processes; cause tremors, impaired vision and hearing, paralysis, insomnia and emotional instability. During pregnancy, mercury compounds cross the placental barrier and can interfere with the development of the fetus and cause attention deficit and development delays during childhood (WHO, 2005). The aim of study is the problems of illegal cosmetics in Indonesia to use the lightening cosmetics containing mercury and the health problems.

MATERIAN AND METHODS

2.1. Cosmetic and hair samples collection

As much as 148 participants from university female students in Makassar consisted of 105 participants were cosmetic lightening users, and the other 43 students were selected as a control group which was non-cosmetics lightening users. The students were given a questionnaire regarding their socio-demographic, dietary habits, brands' name, duration and frequency

of use, and cosmetics consumption per month. Students in the control group were selected with the same range of age and similar dietary habits. From the students, we obtained 27 brands of skin lightening cosmetic products that are used exclusively for facial skin. Also, all participants were agreed to voluntarily give their scalp hair to be analyzed. The study was an agreement by the Province Government of South Sulawesi and Makassar District and the Ethical Committee of the author's institution in Indonesia.

2.2. Analytical Procedure

The skin lightening cosmetic products were obtained from the students. A small amount of their cosmetic cream was taken as a sample and placed it in a compact powder case, then took it to the laboratory for preparing samples test. To prepare a sample test, the cosmetics cream was treated by mixing with acetone and adding 1000 ppm of Indium solution. That mixture was homogenized using a vortex. After that, the samples were dropped on a thin backing film (4 μm prolene) then dried up.

The hair samples were made by cutting the scalp hair into four sections from the root to the tip. Each section was approximately 3 cm in length. To remove organic materials, the hair samples were cleaned using Milli-Q water and shaken in an ultrasonic bath for 5 minutes, then washed with acetone for 5 minutes. After that, they were washed again using Milli-Q. Finally, eight strands of the hair samples were attached in parallel to each other in the sample holder, then dried at room temperature.

Mercury concentration in the sample of skin lightening cosmetic and scalp hair was analyzed using particle-induced x-ray emission (PIXE) analytical instrument in the Cyclotron Research Center, Iwate Medical University, Japan. A cyclotron accelerated heavy charged particles to 2.5–3 MeV. The proton beam was collimated to a diameter of 6 mm in a graphite collimator system. The sample was set at an angle of 35° to the direction of the proton beam axis. When the sample was irradiated with the proton beam, the X-ray was emitted from the sample and detected by a Si(Li) detector. The X-ray energy spectrum which consisted of the characteristic of X-ray peaks for each element including mercury element are fitted to Gaussian functions by the least square method. X-ray counts are obtained concerning the peaks.

2.3. Health assessment

Health assessment was performed after mercury concentration in the scalp hair of students was obtained. The 64 students which their scalp hair showed a high level of mercury concentration (above 5 ppm) were invited to proceed with a test of mercury intoxicated symptoms. Only 15 students were agreed for the test. Also, we asked 15 students from the control group who were in alert level (1–5 ppm) to do the same test. There were 10 objective symptoms [16] diagnosed by a physician following the protocols for environmental and health assessment of mercury suggested by UNIDO [17]. The 10 neurological symptoms consist of: (a) signs of bluish discoloration of gums; (b) rigidity and ataxia (walking or standing); (c) alternating movements or dysdiadochokinesia; (d) irregular eye movements or nystagmus; (e) field of vision; (f) knee jerk reflex; and biceps reflex; (g) babinski reflex; and Labial reflex; (h) salivation and dysarthria; (i) sensory examination; and (j) tremor: tongue, eyelids, finger to nose, pouring, posture holding. To show the prevalent symptoms, the value 1 and 0 was given for positively and negatively observed symptoms, respectively.

2.4. Statistical Analysis

Statistical analysis of total mercury concentrations in the hair samples was conducted using SPSS version 16. Correlations between the mercury concentration in the scalp hair and skin lightening cosmetics as well as the cosmetics' weight were determined using *pearson* correlation analysis. A *p*-value of less than 0.05 was considered significant.

RESULTS

The demographic characteristic of lightening cosmetic user was presented in table 1. There are many groups of cosmetic users in this research such as students from state university we took samples in Hasanuddin university, students from private university we took in UMI university, gold workers, and inhabitants. The total samples in this research 323 participants. As many as 216 (66.9%) of them were cosmetic users and 107 (33.1%) were control groups (non-users). The mean of age student of use lightening cosmetics product was 22-year-old ranged from 19-28-year-old and the others user such us gold workers and inhabitants average of age is 35-year-old ranged from 18-60-year-old, 34-year-old ranged from 19-60-year-old, respectively. Base on duration of using cosmetic, the average of duration of the all group users were more than 20 months. This indicates that user groups of use lightening cosmetic are long time to use it.

Table 1. Total mercury in hair to cosmetic users

Group User	Age (year)		Total mercury			Duration (month)	
	Mean	Range (Min-Max)	Mean µg/g	Range (Min-Max)	HBM	Mean	Range (Min-Max)
UNHAS Students (n = 42)	21	19-22	3.5	0.5-29.3	Alert - high level	23	5-48
UMI Students (n = 63)	22	19-25	43.8	3.6-475.9	Alert – high level	28	6-60
Gold Workers (n = 66)	35	18-60	18.4	1.6-101	Alert – high level	26	5-60
Inhabitants (n = 45)	34	19-60	7.3	2.5-42.3	Alert – high level	28	6-60
Control group (n = 107)	29	18-64	2.1	0-12	Normal – high level	0	0

3.1. Hair mercury concentration to lightening cosmetics users

The average total mercury concentration in the hair of the cosmetics user from UNHAS students was 3.5 µg/g ranged from 0.5 to 29.3. µg/g, and was lower than the average in the hair of UMI students which was 42.7 µg/g ranged from 3.6 to 475.9 µg/g (Table 1). The difference between the mercury concentrations in the hair of UNHAS students and UMI students was statistically significant (t-test, P-value < 0.001). The other users, the average total mercury concentrations from the gold workers was 18.4 µg/g ranged from 1.6 – 101 µg/g and was higher than the average in the hair of inhabitants which was 7.3 µg/g ranged from 2.5 – 42.3 µg/g. The average total mercury concentration in the hair sampled of control group was 2.1 µg/g, which is considerably lower and significantly different (t-test, P-value <0.000) from that of users lightening cosmetics. This indicates that user groups of use lightening cosmetics are exposed to mercury. Comparison with the threshold limits for mercury of the Human Biomonitoring Commission of the German Federal Environmental Agency shows that the mercury level in the hair of the users lightening cosmetics fell within the alert to high level while participants from other sub-districts in control group have mercury level within normal to alert level (table 1).

3.2. Mercury concentration into skin lightening cream cosmetic products

Total of 27 samples of skin lightening cosmetic were examined (Table 2). Eleventh samples were unregistered and 16 samples registered in the food drug administration in Indonesian. Eight samples undetected contain mercury while others contain mercury. The mean mercury concentration in the skin lightening cream cosmetic products was 1102.9 µg/g ranged from 0.12-7834.4 µg/g. Almost of skin lightening cosmetics product have been registered have lower contain mercury in the products. While the skin lightening cosmetic products unregistered have higher contain mercury in the products.

Table 2. Mercury concentration of skin lightening cosmetic products

No	Name cream	Color	Registered	T-Hg conc.
1	Pixi cream	Japan	Registered	0.12
2	Soy Bean (Trisia) cream	Indonesia	Registered	0.35
3	Latulip	Indonesia	Registered	0.68
4	Fair and lovely	India	Registered	0.84
5	Garnier	Europe	Registered	1.27
6	Olay Cream	China	Registered	2.36
7	Up Cream	Unknown	unregistered	3.41
8	Ponds miracle night cream	Thailand	Registered	3.74
9	Plantiful	US	unregistered	72.25
10	Diamond	Unknown	unregistered	162
11	SP UV whitening	Indonesia	unregistered	257.58
12	Natural 99	Unknown	unregistered	342.59
13	Walet Cream	Unknown	unregistered	675.56
14	Beauty quent	Unknown	unregistered	1501.43
15	Sari Daily cream moisturizer WC	Indonesia	unregistered	1895
16	Cr Cream	Indonesia	unregistered	1986.58
17	WB cream	Unknown	unregistered	5112
18	Ester bleaching cream A	Taiwan	unregistered	7834.4
19	TJe Fuk	Taiwan	Registered	0. 25
20	Wardah	Indonesia	Registered	ND
21	Kelly	Indonesia	Registered	0.43
22	Citra Hazeline	Indonesia	Registered	ND
23	Sari Ayu	Indonesia	Registered	ND
24	U.B Mustika Ratu	Indonesia	Registered	ND
25	Crème 21	Arab Saudi	Registered	ND
26	Viva cream	Indonesia	Registered	ND
27	Macalana	Taiwan	Registered	ND

3.3 Health problem and medical history to cosmetic user

Exposure to mercury is known to have potentially damaging neurological effects on human health. A total of 30 cosmetics users were clinically examined. As to subject symptoms of all cosmetics users, such us headache, gastric pains, menstruation

diseases, acne vulgaris, blurred visions, anemia, nosebleed, allergy, asthma, hypertension and cholesterol shows in table 3. Meanwhile, as to objectives symptoms, we examined various neurological symptom, as shown in figure 5. The most prevalent symptoms among the gold smelter were tremor in tongue, eyelid, finger nose, pouring, posture holding and Romberg test reaching 40-60% occurrences in samples, whereas 20%–40% had positive findings for a lack of field of vision, slow knee jerk and bicep reflexes, sensory disturbance, unbalanced rigidity, and ataxia.

Table 3. Subject symptoms of cosmetics users

Subject of symptoms	n	%
Headache	46	21
Gastric pains	39	18
Menstruation disease	16	7
Acne vulgaris	4	2
Blurred visions	5	2
Anemia	25	12
Nosebleed	5	2
Allergy	19	9
Ashma	23	11
Hypertension	17	8
Cholesterol	17	8

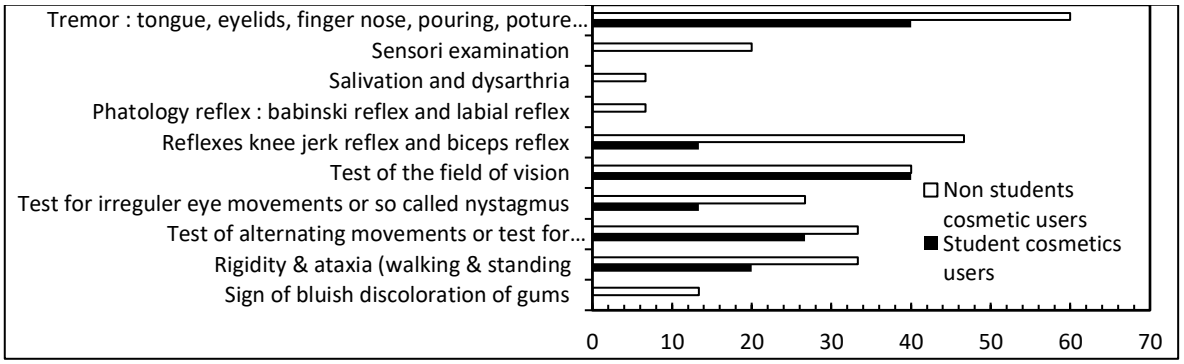

Figure 1. Occurrence of the 10 neurological symptoms in students and non-students

DISCUSSION

Mercury salts such as ammoniated mercury, mercury iodide, mercurous chloride, mercurous oxide, and mercuric chloride are the form of mercury in skin lightening products.[16][17] Mercury is added to skin cream because its effect in blocking production of melanin, which gives the color to hair and skin.[17] Some chemicals may perform the same effect as mercury, but mercury is inexpensive and effective.[18] This inorganic mercury is absorbed through the skin by the transport of mercury across the epidermis and also via sweat glands, sebaceous glands, and hair follicles.[16] Study of Friberg et al to animals exhibited that 8% of mercuric chloride applied to skin is absorbable in 5 hours.[6]

Mercury affect human body by some mechanisms like interruption of microtubule formation, changing intracellular calcium balance and membrane potential, altering cell membrane integrity, disturbing or inhibition of enzymes, inducing oxidative stress, inhibition of protein and DNA synthesis and disturbing immune functions.[19] The main adverse effect of the inorganic mercury contained in skin lightening soaps and creams is kidney damage.[17], [20] Kidney toxicity involves either renal tubular necrosis or autoimmune glomerulonephritis, or both. Immune dysfunctions include hypersensitivity reactions to mercury exposure, including asthma and dermatitis, various types of autoimmunity, and suppression of natural killer cells and disruption of various other lymphocyte subpopulations.[21][22] Clinical presentation of individual exposure depends on dose,

duration of exposure, and form of exposure.[12] In chronic exposure, early presentation may appear as fine tremor in extremities that will progress to entire limb.[12] Classic triad of chronic toxicity is tremor, gingivitis, and erethism (constellation of neuropsychiatric findings that includes insomnia, shyness, memory loss, emotional instability, depression, anorexia, vasomotor disturbance, uncontrolled perspiration, and blushing).[12]

Hair contain high sulfhydryl groups, a compound which mercury has high tendency to bind with.[19][12] Evaluation of mercury exposure using hair specimen is a well-established method in group studies.[13] Mercury has longer half-life in hair and it remains stable for long period in hair, make it useful to evaluate exposure since few months before and easy to transport. Hair adjacent to the scalp is indicative for exposure occurred 1-3 week earlier.[13] US Environmental Protection Agency (EPA) assigned 0-1 ppm of hair mercury concentration a normal, 1-5 ppm as alarm level, and >5 as high level for human biomonitoring for mercury concentration in human body.

More than half of participants in this study are lightening cream users. Similar to a study among students in Malaysia that exhibited 60.6% of their 104 participants were skin lightening cream users[23]. In this study, the mean hair mercury concentration among users was 40.03 ± 89.55, sixteen times higher compared to non-users (2.51± 1.11 ppm). It suggests that using skin lightening creams increase the body burden of mercury. This is also confirmed with correlation analysis of hair mercury concentration and skin lightening usage based on duration and weight of cream applied. The control group hair mercury concentration was varied from undetected to 5.46 µg/l, mostly under normal to alarm concentration for human biomonitoring suggested by US Environmental Protection Agency. Whereas the skin lightening user's hair mercury concentration was ranged from 4 to 476 µg/l, classified in alarm and high level of hair mercury for this EPA standard. Another study of comparative analysis of mercury content in human hair and cosmetic products exhibited similar results that hair mercury concentration of non-cosmetic users was generally low compared to cosmetic users[15].

The mean mercury concentration in the skin lightening cream cosmetic products was 861.72 ppm in this study, whereas Indonesian National Agency of Drug and Food Control limits 1 ppm for mercury in cosmetics[24]. Topically applied mercury compounds are more readily absorbed and are also most likely to accumulate in and cause damage to the kidneys.[25] One case report identified mercury-containing skin lightening cream (mercury level of 30,000 ppm) in 34 years old women who developed nephrotic syndrome. Her condition was gradually improved after stop using the cream.[26] Mercury in skin lightening products may also cause skin rashes, skin discoloration and scarring, as well as a reduction in the skin's resistance to bacterial and fungal infections. Other effects include anxiety, depression or psychosis and peripheral neuropathy[17]. In reproductive system, mercury toxicity can result in miscarriage, spontaneous abortion, stillbirth, and low birth weight. Fetal brain is more susceptible to mercury adverse effect than adult. It inhibits the division and migration of neuronal cells and disrupts the cytoarchitecture of the developing brain.[27] Neonates that exposed to mercury during pregnancy have been linked to neural tube defects, craniofacial malformations, delayed growth, and others.[28][29] a study evaluated transplacental mercury transfer exhibited newborns mean mercury lever were higher than mothers, implicated the importance of monitoring pregnant women from mercury exposure.[30] Considering that our skin lightening users sample are at reproductive age that hold the responsibility for childbearing as well as hazardous effects of mercury in fetus and newborn babies, the need for advance control by related parties as well as better awareness from users.

Hair mercury concentration had significant correlation with duration of skin lightening cream application as well as estimated weight of the cream applied. It reflected that longer and higher exposure lead to higher accumulation of mercury in the body. Application of average 1.22 g mercury for face, 4.42 g for body, and a product with 10,000 ppm mercury applied over the surface of the skin evenly lead to absorption up to 450 µg with just 1 application, 45 times the daily absorption of mercury from a dental amalgam, 9 times the mercury contained in a 2-part flu vaccine given 4 weeks apart, and 90 times the amount of mercury in a 4-oz steak of the most mercury-rich fish the world, a Mediterranean swordfish.[31]

This study exhibited presence of hazardous skin lightening creams containing mercury as well as accumulation of mercury in human body that has significant correlation with duration of exposure and weight of cream applied. Further study with larger sample is necessary in assessing effect of mercury in human body.

CONCLUTIONS

This study exhibited presence of hazardous skin lightening creams containing mercury as well as accumulation of mercury in human body that has significant correlation with duration of exposure and weight of cream applied. Further study with larger sample is necessary in assessing effect of mercury in human body.

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