Jurnal Info Kesehatan
Vol. 23, No. 1, March 2025, pp. 18-28
P-ISSN 0216-504X, E-ISSN 2620-536X
DOI: *10.31965/infokes.Vol23.Iss1.1904*
Journal homepage: *https://jurnal.poltekkeskupang.ac.id/index.php/infokes*

RESEARCH Open Access

Mercury Exposure in Pregnant Women Using Whitening Cosmetics and Potential Health Risks

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Received: 6 February 2025 Revised: 1 March 2025 Accepted: 10 March 2025

Abstract
Recently, women are increasingly using whitening cosmetics to beautify their skin. However, they are not aware that whitening cosmetics contain mercury. Several studies have reported high levels of mercury in skin whitening creams. Women, especially pregnant and lactating mothers, who use these creams are at risk of mercury poisoning because long-term exposure can cause permanent nerve damage, kidney disorders, fertility problems, and congenital disabilities. This study aimed to analyze mercury exposure in pregnant women using whitening cosmetics and potential health risks. This research method is an observational analytic, cross-sectional design. The instrument is a questionnaire. Sampling was carried out at Khadijah 1 Hospital, Makassar City. The sample in this study consisted of 20 pregnant women who used whitening cosmetics, 20 who did not use whitening cosmetics and 20 samples of whitening cosmetics used by pregnant women. The cosmetic samples analyzed were the concentration of mercury contained in the cosmetics. Mercury testing was conducted at The Indonesian Institute for Public Health Laboratories, Makassar (BBLK). Data analysis using SPSS software. This result study showed that 20 cosmetics used by pregnant women were detected with mercury. The highest mercury concentration was 86.1 ppm, and the lowest was 3.5 ppm. Those registered with the Food and Drug Administration (BPOM) were 11 cosmetics, and 9 were not registered with BPOM. Statistical analysis shows a correlation between the frequency, duration, and volume of cosmetic use and mercury concentration in pregnant women's hair, namely 0.008, 0.017, and 0.032, respectively. The potential health risks experienced by pregnant women who use cosmetic whitening creams are anemia of as much as 55%, the fetus not actively moving as much as 15%, and the weight of the fetus not increasing as much as 30%. The statistical analysis of the relationship between mercury exposure and potential health risk experienced by pregnant women, with a p-value of 0.039 < p-value of 0.05. The use of whitening cosmetics in pregnant women can have an impact on the fetus in the womb. Therefore, pregnant women should not use cosmetics containing mercury during pregnancy and should increase their knowledge about the contents of cosmetics.

Keywords: Mercury Exposure, Whitening Cosmetics, Pregnant Women, Potential Health Risk.

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1. INTRODUCTION

In general, the essential ingredients used in soap and whitening creams are hazardous chemicals in the form of preservatives and fragrances. Some of the preservatives and fragrances are toxic and prohibited from being used as ingredients because they can cause cancer, mutation, reproductive toxicity, and endocrine disruption. If the use of cosmetics containing hazardous chemicals, one of which is mercury, are used by pregnant women, then mercury exposure will impact pregnant women namely; methyl mercury from the mother will quickly penetrate the placental blood barrier, be distributed in the blood, and bind to hemoglobin in erythrocytes. Mercury levels in the fetus' blood will be higher than in the mother's blood because the fetus cannot excrete mercury metal. Mercury in pregnant women can also cause developmental disorders in babies, such as brain and nerve disorders (Block, 2004; Clarkson & Magos, 2006).

One of the hazardous chemicals mixed in whitening creams is mercury. This is true of whitening creams, eye makeup removers, and mascara products. The mercury mixed in whitening cosmetics is because mercury salts can inhibit the formation of melanin production, which provides pigmentation to the skin and hair to produce lighter skin color, removes age spots, and removes black spots. Cosmetics containing mercury are available in two forms, namely, inorganic and organic. Whitening soap and cream products generally contain inorganic mercury. Cosmetic preservatives in eye makeup removers and mascara products are organic mercury compounds (thiomersal [ethyl mercury] and phenyl mercury salts) (Balogun, Money-Irubor, & Umukoro, 2024; Kicińska & Kowalczyk, 2025; Mohammed et al., 2024; Offor et al., 2024).

The growth of the cosmetics industry averaged 4.5% per year in the last 20 years. This is because this industry is the most stable despite an economic downturn. The demand for the cosmetics industry worldwide continues to increase. The global beauty market is predicted to reach $ 265 billion in 2017. The increasing demand from Europe and the Asia Pacific region greatly influences the expansion of the worldwide beauty market (Arora & Amin, 2024).

Mercury-containing whitening cream products are manufactured in Thailand, China, Taiwan, Vietnam, and the United States. The most contaminated mercury-containing whitening cream is 12,590 mg/g. Cosmetic use in the United States by women and men reaches more than twelve cosmetic products used daily, and some unsafe cosmetic products used less than 20% (UNEP, 2024).

According to global cosmetic market data, there is predicted to be an increase in annual growth from 2016 to 2022 of more than 429.8 billion. In the United States, women use more than 12 cosmetic products daily, and several other types of products remain. Unsafe cosmetics are less than 20% (Abas et al., 2024). Based on data released by the Global Nielsen institution in 2016 in Indonesia, the use of cosmetics in Indonesia reached 45% of foreign brands supported by a relatively large number of Indonesian cosmetic enthusiasts, reaching 150 million people (Abas et al., 2024).

The Food and Drug Supervisory Agency found 115 billion illegal cosmetics containing prohibited or hazardous materials 2018. The discovery of cosmetic products was dominated by mercury, hydroquinone, and retinoic acid. The Indonesian Food and Drug Supervisory Agency also found six types that were indicated to contain prohibited or hazardous materials, namely dyes such as K3 and heavy metal lead, which can cause cancer, fetal abnormalities, and skin irritation, and also found more than 12 billion illegal cosmetics in the Jakarta area and 23 types of illegal cosmetics containing hazardous mercury in the Jakarta area in 2020 (BPOM RI, 2022).

Mercury in cosmetics is indeed not allowed as an ingredient in making facial creams, including whitening creams. However, mercury is allowed by BPOM to be used in the manufacture of cosmetics in eye makeup products and eye makeup removers as a preservative. According to BPOM regulations (2019), the lowest limit of mercury (Hg) in cosmetics is no more than 1 mg/kg or 1 mg / L (1 ppm) (BPOM RI, 2019).

Research from Abbas et al., (2019) examined 27 whitening cream cosmetic samples in South Sulawesi. 11 samples were not registered, and 16 samples were registered with BPOM. Eight samples that were not detected contained mercury, while others contained mercury. The mercury concentration in whitening cream cosmetic products was 1102.9 µg/g, ranging from 0.12-7834.4 µg/g. Almost all registered whitening cream cosmetic products have lower mercury content. In contrast, unregistered whitening cream cosmetic products have higher mercury content (Abbas et al., 2020; Hamann et al., 2014).

Exposure of pregnant women to combinations of heavy metals may pose more significant health risks, namely adverse effects on birth, compared to single-agent contamination (Liu et al., 2022; Shih et al., 2021), thus requiring increased public health awareness and public health measures.

The results of initial observations conducted at RSIA Sitti Khadijah 1 found that 70% of pregnant women used whitening cream but stopped using it during pregnancy after consulting a midwife, some pregnant women used whitening cream with the Ky and MsG brands, and 30% of pregnant women only used Vv brand powder cosmetics. Based on the results of these observations, the researcher aims to analyze the mercury concentration in whitening cosmetics and the potential health risks for pregnant women.

2. RESEARCH METHOD

The type of research is observational analytic with a cross-sectional study approach. The inclusion sample criteria for this study were pregnant women who used whitening cosmetics and gravid in the 3rd trimester. The exclusion criteria were pregnant women who stopped using cosmetics and gravid in the 1st and 2nd trimesters. Laboratory tests were carried out at BBLK (Balai Besar Laboratorium Kesehatan) Makassar to measure mercury levels in whitening cream. The sampling technique in this study was proportionate probability sampling from 74 pregnant women population in RSIA Siti Khadijah who were hospitalized at the time of sampling starting from August 26 to September 29, so that 20 were who entered the third trimester of gravid and used whitening cosmetics. For those who did not use whitening cosmetics, as many as 20 samples were used. While 34 were not willing to be used as research samples, the sample of research is 20 pregnant women who use whitening cream cosmetics and 20 samples of pregnant women who do not use whitening cream cosmetics.

Whitening cream taken from pregnant women at RSIA St. Khadijah 1 Hospital was given a sample code and then taken to the Indonesian Institute for Public Health Laboratories, Makassar (BBLK), to examine whether it was positive or negative for the content of facial whitening cream. The examination was carried out using the Atomic Absorption Spectrophotometry (AAS) method, where if positive, there was a color change in copper silver, while negative samples did not show a color change in the facial whitening cream sample. Statistical analysis of the correlation between independent and dependent variables by bivariate analysis with the chi-square test and the interpretation correlates when the p-value < 0.05 is the correlation. This study was approved by the Health Research Ethics Committee of Sekolah Tinggi Maluku Husada (Approval Number: RK.175/KEPK/STIK/VIII/2024). All participants provided informed consent before participating in the study. The confidentiality of all participants was strictly maintained throughout the research process.

3. RESULTS AND DISCUSSION

The study sample was pregnant women who used whitening cream cosmetics. The implementation of this study was conducted at RSIA Khadijah 1 Makassar. This study's sample was 20 pregnant women with trimesters one, two, and three. The independent variables studied were the concentration of mercury in cosmetics used by pregnant women registered in the Food

and Drug Administration, frequency of use, duration of use, volume of use, cosmetic brands, variations of cosmetics used by pregnant women, and potential health risks.

Table 1. Characteristics of Demography Variable of Pregnant Women Use Whitening Cream Cosmetics and Do not Use Whitening Cosmetics.

Demographic Variable	**Pregnant women use whitening cream cosmetics**		**Pregnant women do not use whitening cream cosmetics**	
	n	%	n	%
Age (year)				
< 35	15	75	18	90
≥ 35	5	25	2	10
Frequency of use				
≤ 2 times per day	4	20	0	0
> 2 times per day	16	80	0	0
Duration of use (month)				
≤ 12	3	15	0	0
> 12	17	85	0	0
The volume of use (gram)				
≤ 10	6	30	0	0
> 10	14	70	0	0
Variation of cosmetic use				
Non variation	7	35	0	0
Variation	13	65	0	0
Total	20	100	20	100

Table 1 shows the demographic characteristics of pregnant women. The group of pregnant women aged less than 35 years is 75%, and those over 35 years are 25%. The frequency of cosmetic use in a day is more than 2 times as much as 60% and less than 2 times as much as 40%. The use of whitening cream cosmetics is over 12 months or as much as 85%. The volume of whitening used in a month is more than 10 grams or as much as 70%. At the same time, the variation of whitening cream cosmetics used by pregnant women varies as much as 65%.

Cosmetics and ointments using inorganic mercury function as antiseptics. However, recently, several countries have produced cosmetics using inorganic mercury compounds. These products usually contain mercury salts such as ammoniated mercury, mercury iodide, mercury chloride, mercury oxide, and mercuric chloride. Young women use skin whitening products and cosmetics to lighten their skin and provide anti-freckle effects; these products and cosmetics are standard in some African and Asian populations and dark-skinned populations in Europe and North America (UNEP, 2018).

Approximately 40% of Korean women are reported to use skin lighteners. In addition, other cosmetics, such as eye makeup, cleansing products, and mascara, contain mercury as an ingredient. Inorganic mercury is absorbed through the skin through the transport of mercury across the epidermis and also through sweat glands, sebaceous glands, and hair follicles.. Mercury salts inhibit melanin formation by competing with copper in tyrosinase, resulting in skin whitening cream cosmetics (Chan et al., 2011).

Table 2. Mercury Concentration in The Whitening Cream Cosmetics.

Brand of Cosmetics	Registered (BPOM)	Cream color	Hg Concentrations
SF	Yes	White	86.1
KY	Yes	Olive	42.0
MA	Yes	Olive	9.1
NV	Yes	White	14.5
Dr P	Yes	Olive	9.7
SJ	Yes	Olive	12.6
PO	Yes	Pink	14.5
TD	Yes	Olive	8.2
TN	Yes	White	8.2
WD	Yes	White	25.1
PW	Yes	White	19.1
ZZD	No	Yellow	11.4
ZZN	No	White	8.6
ND	No	Yellow	8.2
NN	No	White	8.1
DC	No	Pink	3.5
SP	No	Olive	9.8
CC	No	Yellow	31.9
TWC	No	Yellow	27.3
NN	No	Yellow	80.7

Based on Table 2, there are 20 whitening cream cosmetics used by pregnant women. Each pregnant woman's frequently used whitening cream cosmetics were taken to analyze the concentration of mercury content. The highest concentration of mercury content in whitening cream cosmetics used by pregnant women is 86.05 ppm, and the lowest is 3.5 ppm. The number of cosmetics registered with the Food and Drug Administration is 11, and those not registered are nine. The colors in whitening cream cosmetics are white, olive, pink, and yellow.

Table 3. Classification of Mercury Level Concentration Base on World Health Organization.

Level *Hg Conc* (ppm)	Pregnant women use whitening cream cosmetics		Pregnant women do not use whitening cream cosmetics	
	n	%	n	%
Normal < 1	10	50	18	90.0
Alert (1-5)	8	40.0	2	10
Hight (> 5)	2	10.0	0	0
Total	20	100	20	100

Based on Table 3, the classification of mercury level concentration based on the World Health Organization is divided into three types: normal level <1 ppm, moderate 1-5 ppm, and high above five ppm. In this study, the mercury concentration level in cosmetics used by pregnant women is included in the high category above five ppm, as much as 95%, while the moderate category is as much as 5%.

This study found that pregnant women who use whitening cream cosmetics in the high and medium categories have the highest mercury concentration of 86.1 ppm and the lowest with a concentration of 3.5 ppm. The concentration of mercury used by pregnant women is high, so this causes potential health risks for pregnant women. The potential dangers of pregnancy felt

by pregnant women are 55% anemia, The fetus is not actively moving, and The weight of the fetus does not increase.

Studies in Iraq showed that mercury concentrations in maternal hair as low as 20 ppm affected the fetus at birth (Dack et al., 2024). Mothers who consume mercury foods will transmit the toxin to the fetus (Myers & Davidson, 1998) and to the infant through breast milk (Jensen et al., 2005). It has been reported that children exposed to mercury levels n with maternal hair concentrations of 10–20 μg/g experienced decreased performance in motor function and memory (Grandjean, 1997; Jensen et al., 2005; Vigeh et al., 2018). Subtle effects that can be detected on brain function in language, memory, and motor domains appear in prenatal methylmercury exposure, especially during the second trimester. Neurobehavioral dysfunction has been reported even when maternal hair mercury levels are 6 μg/g. The corresponding value for blood is about 24 μg/L (Grandjean, 1997; Jensen et al., 2005). Autism is a disorder caused by a gene mutation that occurs due to environmental influences, causing lifelong disabilities. The environment in question is mercury poisoning. Although not yet proven, there is a possible link between mercury poisoning and autism in children (Lee et al., 2003). Prenatal exposure to organic mercury may show cerebral and cerebellar cortical dysplasia, neuronal ectopia, and several other developmental disorders. However, a neuropathological examination of the brains of children exposed to mercury is needed (Geelen et.al., 1990).

Table 4. Health Problem of Pregnant Women's Use of Whitening Cream Cosmetics and do not use Whitening Cream Cosmetics.

Health risk problem	Pregnant women use whitening cream cosmetics		Pregnant women do not use whitening cream cosmetics	
	n	%	n	%
Anemia	11	55.0	5	25
The fetus is not actively moving	3	15.0	2	10
The weight of the fetus does not increase	6	30.0	2	10
Normal	0	0	11	55
Total	20	100	20	100

Based on table 4. The potential health risks experienced by pregnant women are anemia as much as 55%, the fetus is not actively moving as much as 15%, and the weight of the fetus does not increase as much as 30%. The use of whitening cosmetics in pregnant women can have an impact on the fetus in the womb. Therefore, antenatal care examinations must be increased to reduce the effects on the fetus.

Several countries have reported skin whitening products containing mercury poisoning, including Africa, Europe, the US, Mexico, Australia, and China. For example, a 34- year-old Chinese woman developed nephritic syndrome after using a skin whitening cream. After chelation therapy with D-penicillamine, her blood and urine mercury levels returned to normal with the resolution of proteinuria (Chan et al., 2020; Ji et al., 2025; Tang et al., 2006). In Mexico, a 30-year-old woman who had been using cosmetic creams for 5 years was found to have high levels of mercury in her urine and blood, resulting in skin rashes, erythema of the palms and soles, hypersalivation, involuntary tremors, emotional lability, weakness, and insomnia (Hamann et al., 2014; Tlacuilo-Parra et al., 2001). In the US (Arizona, California, New Mexico, and Texas), 317 women who used a cream (Crema de Belleza-Manning) self-reported a high prevalence of symptoms associated with mercury poisoning, including fatigue (67%), restlessness, and/or irritability (63%), severe headaches (61%), insomnia (51%), memory loss (44%), loss of strength in the legs (44%), tingling or burning sensation (39%), tremors or shaking hands (38%), depression (31%), and a metallic taste in the mouth (20%) with high

levels of mercury in the urine (Mercan et al., 2024; Offor et al., 2024; Taylor et al., 2015; Wu et al., 2024; Abbas et al., 2020; Peregrino et al., 2011). Therefore, it is necessary to prevent mercury exposure and strictly prohibit the use of mercury in cosmetic products, comprehensive assessment of mercury contamination in imported products, and health education about the adverse health effects of cosmetic products containing mercury.

The neurodevelopmental period extends from embryonic to adolescence. Different behavioral functions (e.g., sensory, motor, and cognitive functions) are served by other brain areas. Development during neurotoxicant exposure can result in an accelerated decline in function related to age. Developmental neurotoxicity with minor effects can significantly impact society when amortized across populations and the human lifespan (Rice & Barone, 2000). The difference in sensitivity between the fetus and the adult organism is that the fetus is more susceptible to methylmercury toxicity (Dutta & Ruden, 2024). Fish contaminated with methylmercury consumed by mothers during pregnancy in Japan and bread contaminated with methylmercury in Iraq caused psychomotor retardation in their offspring (Abera & Adimas, 2024; Kicińska & Kowalczyk, 2025; Munir et al., 2022; Rumiantseva et al., 2024).

Table 5. Relationship Between Frequency of Use, Duration, and Volume with the Concentration of Mercury in the hair of Pregnant women**.**

Variable Independent	Hg Hair Concentration of Pregnant women						p-value < 0.005
	Normal	%	Alert	%	High	%	
Frequency							
≤ 2 times	4	14.3	0	0	0	0	
> 2 time	6	21.4	8	80	2	100	0.008
Do not use	18	64.3	2	20	0	0	
Duration							
≤ 12 months	3	10.7	0	0	0	0	
> 12 months	7	25.0	8	80	2	100	0.017
Do not use	18	64.3	2	20	0	0	
Volume							
≤ 10 grams	2	7.1	0	0	0	0	
> 10 grams	8	28.6	8	80	2	100	0.032
Do not use	18	64.3	2	20	0	0	
Total	28	100	10	100	2	100	

Table 5 shows a relationship between the frequency, duration, and volume of cosmetic use with mercury concentration in hair in pregnant women. The results of statistical test analysis showed a significant correlation between the application of whitening cosmetics and mercury concentration in the hair of pregnant women with p-values of 0.008 and < p-value of 0.05. Meanwhile, the duration of cosmetic use is also correlated with the concentration of mercury in the hair of pregnant women; the results of statistical analysis showed a significant correlation with a p-value of 0.017 < 0.05 and the volume of use of whitening cosmetics correlated with the mercury concentration in hair in pregnant women. Statistical analysis results showed a correlation with a p-value of 0.032 < 0.05. Based on research conducted by Wang et al., (2024), skin absorption of Hg is controlled by dose, means of application (vehicle), polarity, solubility, pH, frequency, and duration of the application (Abbas et al., 2020; Sulami et al., 2024; Wang et al., 2024).

The use of whitening cream containing mercury on the skin's surface will enter the blood vessels, which can eventually cause disorders in the nervous system, kidneys, and other organs (Ji et al., 2025). The time needed for inorganic mercury to cause adverse effects is around 30-

60 days of continuous use. Meanwhile, the human body cannot process all derivatives of methyl mercury compounds, so mercury compounds that enter will remain in the body for a relatively long time they can cause disorders of the health system (Dack et al., 2024; Geier & Geier, 2024; Ji et al., 2025; Miller et al., 2025).

Table 6. The Relationship Between Mercury Exposure and Pregnant Women's Potential Health Risks.

Hg Hair Concentration of Pregnant women	Potential Health Risk of Pregnant Women used cosmetic Whitening Cream and did not Use Cosmetic Whitening Cream				p-value < 0.005
	Normal	%	Abnormal	%	
Normal	11	100	17	58.6	0.039
Alert level	0	0	10	34.5	
High Level	0	0	2	6.9	
Total	11	100	29	100	

Based on table 6 shows the statistical chi-square analysis of the relationship between mercury exposure (mercury concentration in hair) and health problems experienced by pregnant women, is correlation with a p-value of 0.039 < p-value of 0.05, due to the prolonged use of cosmetics can lead to the accumulation of potentially toxic metal(loid)s in the body, either through adsorption or absorption through the skin, eventually entering the bloodstream. There are different exposure scenarios for cosmetics: some cosmetics disappear immediately after application, such as shampoo and toothpaste, while other cosmetics, such as body lotions, face masks, and lipsticks, remain on the skin for a long time (Ahmed et al., 2024; Ji et al., 2025; Taylor et al., 2015).

4. CONCLUSION

Mercury exposure during pregnancy can be through the use of whiting cream cosmetics. This study found that the mercury concentration in whitening cream used by pregnant women was in the medium and highest concentration categories. The frequency, duration, and average volume of use were high so that they could affect the fetus in the womb. The potential health risks experienced by pregnant women are anemia, lack of fetal movement in the womb, and the baby's weight does not increase. It is still assumed that there is a possibility of mercury accumulation in the body of pregnant women. Therefore, in the future, biomarker examinations must be carried out to determine whether pregnant women are exposed to mercury.

ACKNOWLEDGMENT

The authors would like to thank the Universitas Muslim Indonesia and the South Sulawesi government of Indonesia for permitting them to conduct research. I would like to thank KEMENDIKBUD DIKTI for the grant research. I would like all authors to contribute to the manuscript and provide critical analyses and commentary during its development.

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