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Evaluation of Cr, Cd, Ni and Pb Levels in Commonly Used Cosmetics and Some Adverse Reactions in Ibadan Metropolis, South-West Nigeria

[1]OJEZELE, OJ; *[2]OJEZELE, MO; [3]ONYEAGHALA, AA

[1]Chemistry Unit, Department of Science Laboratory Technology, Federal College of Animal Health and Production Technology, Moor Plantation, U.I. P.O. Box 20711, Ibadan, Nigeria
*[*2]Department of Pharmacology & Therapeutics, Delta State University, Abraka, Delta State, Nigeria.*
[3]Unit of Chemical Pathology, Department of Medical Laboratory Science, Afe Babalola University, Ado-Ekiti, Nigeria
**Corresponding author Email: matlar2002@gmail.com Tel: +2348033923332*

ABSTRACT: Skin absorption remains a major source of heavy metal toxicity in humans. This study determine the heavy metals content of selected cosmetics frequently used in Ibadan South-west Nigeria using AAS model ICE 3000 and some adverse reactions. Questionnaires administered to people of different age groups and classes in the society informed the choice of representative cosmetics for heavy metals analysis. The questionnaire revealed gender distribution usage of 84.7% and 15.3%; for female and male respectively. Cosmetics use was observed to be highest among the age bracket 21-25years (30.7%). Unmarried (single) females (58.9%) used cosmetics more than the married (40.6%). While 5.9% used it for bleaching, 21.3% had various adverse effects arising from cosmetics usage. All the various cosmetics brands contained Cr, Ni and Cd. Cr levels in eyeliner (12.7ppm) and face-powder (2.5ppm) were higher than EPA limit (1ppm). Pb levels in eyeliner (87.8ppm) and hair-dye (21.6ppm) were higher than WHO limits (10ppm). Cd levels in eyeliner (0.8ppm), lip-gloss (0.5ppm) and face-powder (1.8ppm) were higher than WHO limits (0.3ppm). The cumulative exposure to heavy metals in cosmetics products as a result of prolonged use could be a possible source of heavy metals toxicity.

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Cosmetics are beauty complementary substances of the human body (Millikan, 2001). The enhancing effects of such substances target appearance and aroma. In the light of this, they come in different forms as solid, liquid to gaseous (or aerosol) substances. While some natural substances have found use as cosmetics, a number of the cosmetics in use today, are synthetic or semi-synthetic. At the extreme, such substances can serve as façade, masking the real architecture or scent of the human body. Virtually all parts of the external human body have substances that can enhance the appearance, texture, structure or odour.

While some are fixatives (decorative) and needs an occasional application, it is required that care cosmetics are applied to the human body on a regular basis for effect (Winter, 2005). Some cosmetics cleanse the skin of dirt and dead layers (Partha, 2011). The vitamins content in some cosmetics nourishes the human skin. Cosmetics are not without adverse effects (Qu *et al*., 2014). Microbiota may be removed on the prolonged application of cosmetics (cleansers) to the skin. This may lead to the development of opportunistic infections (Ananthapadmanabhan, 2004). Some cosmetics contain heavy metals which can be absorbed with attendant consequences on the prolonged application (Orisakwe, 2013). The use of cosmetics cuts across race, gender, age, social-economic strata. This has implication on exposure to any toxic component in the cosmetics. For instance, the way the human body handles and metabolises xenobiotics vary with the age, race and gender. This accounts for variation in the amount of some substances based on age or body weight. In the case of application of cosmetic, such factors are not considered.

The aftermath is the toxic effect on children and other vulnerable individuals. Furthermore allergic reactions and idiosyncrasy are factors that are not often considered in reaction to cosmetic (Partha, 2011). If at all, an individual may have suffered some adverse effects before they are traced to the cosmetics. The aim of the study was to determine the heavy metal content in commonly used cosmetics in Ibadan (South-west, Nigeria) metropolis: probable source of human exposure and toxicity

**Corresponding author Email: matlar2002@gmail.com Tel: +2348033923332*

MATERIALS AND METHODS

Questionnaires were administered to people of different age groups and classes in the society at randomly selected locations. Types of commonly used cosmetics were derived from the administered questionnaires. Representative samples were purchased from a central market in the metropolis noted for whole/retail sales of such products.

Sample digestion: About 1g of solid samples and 2mL of liquid samples were measured into digestion tubes. 5ml of a mixture of HNO_3 and $HClO_4$ in the ratio 3:1 was added to the mixture and heated at 90^0C for 3hours after which 3ml of the acid mixture was added again and heated for another 3hours to complete the digestion. It was allowed to cool and filtered. The filtrate was made up to 25ml with distilled water (Chauhan *et al*., 2010).

Atomic absorption spectrophotometer analysis: The concentrations of selected heavy metals were determined in the samples and in the blank with a computerized Thermo Fisher Scientific model ICE 3000 Atomic absorption spectrophotometer. For quantitative analysis of each metal, a calibration curve was obtained from standard solutions.

RESULTS AND DISCUSSION

The questionnaire revealed that out of the 202 respondents, 84.7% were female while 15.3% were male (fig. 1), this followed the observation in the study carried out by Duarte and Campos (2007) where out of the total respondents, 154 (87.5%) were women and 22 (12.5%) were men. It can, therefore, be inferred that cosmetics use is more common among women than men.

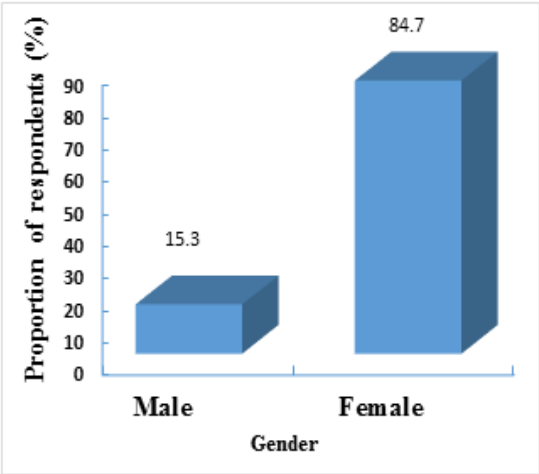

Fig 1: Gender distribution of respondents

Cosmetics use was observed to be highest among the age bracket 21-25years (30.7%), followed by those within 26-35years (29.7%) while age bracket 15-20years was 26.2%. This shows that cosmetics use is more common among the younger age (Figure 2). This result agrees with the work of Ramshida and Manikandan (2014) that stated that respondents within age group 19-23years loved and used cosmetics most. Figure 2 shows the age distribution of the respondents regarding cosmetics use. It was observed that highest proportion of cosmetics use (30.7 %) was by the age bracket 21-25 years. Table 1 shows the correlation analysis between respondents' age on the effect of heavy metals in cosmetics and the level of use. As the age increases the level of use increases and as the knowledge increases the level of use decreases. The results give credence anecdotal belief that individuals who fall within this age grouping tend to be more conscious of their appearance; they pay so much attention to their outlooks because their self-confidence and satisfaction are attached to it.

TABLE 1: Correlation analysis between respondents' age and knowledge on the effect of heavy metals in cosmetics and the level of use

Variable	R	P	Decision
Age	0.188	0.010	Significant
Knowledge	-0.987	0.001	Significant

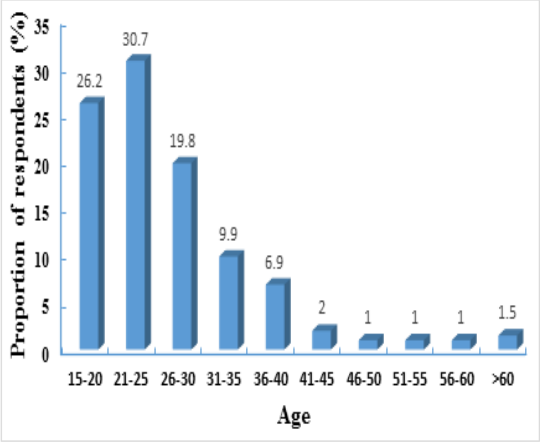

Fig 2: Age distributions of respondents

Figure 3 shows the relationship between cosmetics usage and marital status and gender. Unmarried (single) females (58.9%) used cosmetics more than the married (40.6%). While this agrees with the findings of Ramshida and Manikandan (2014), it showed that the unmarried female like cosmetics to a greater extent than the married. This may be due to the fact that after marriage, some female tend to pay less attention to their appearance, hence the decrease in cosmetics usage.

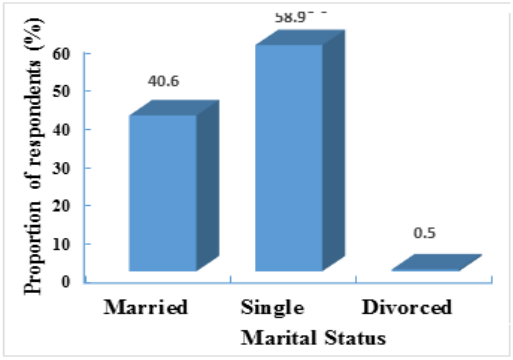

Fig 3: Cosmetics usage and marital status

The results presented in figure 4 showed that both male and female (83.7%) prefer to use cosmetics primarily for beautification or to improve their appearance which helps to increase social approval as well. However, 5.9% said they use it for bleaching. This percentage is lower compared to 39.2% reported by Kuffour *et al*. (2014).

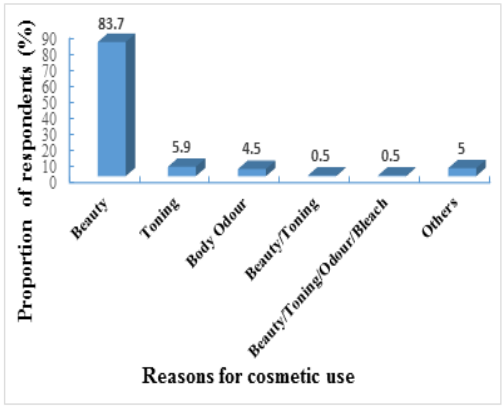

Fig 4: Reasons for cosmetics use

Dark-skinned sub-Saharan African women use some cosmetic for bleaching (Godlee, 1992). In Mali, this was its use 25% of adult women (Mahe *et al*., 1993), in Ghana, 39.2% of the 120 women in a study engaged in the use of skin lighteners (Kuffour *et al*., 2014). Most of the bleaching cosmetics products contain hydroquinone which United State of America Food and Drugs Administration in September 2006 recommended to be sold only with a prescription. This was because hydroquinone has been linked with Ochronosis (thick and dark skin). It was also confirmed to cause cancer when applied to rodents (FDA, 2006). The use of bleaching agents in a hot climate in the tropics, like the locations under study, may make the users vulnerable to ultraviolet rays. Report of a study showed that 7.5% of the experienced cosmetics related untoward effects (Kuffour *et al*., 2014). In the present study, 41.6% of the respondents did not have any observable negative effect associated with cosmetics use, 21.3% had various effects arising from cosmetics usage while 56.9% of the women had no knowledge of the side-effects of cosmetics usage (Figure 5). Also, 20.3% do not know the composition of the various cosmetics products they use (Figure 6). Figure 7 shows that the observable effects reported by the respondents to include pimples (10.9%), skin rashes (6.9%) and eczema (5.4%).

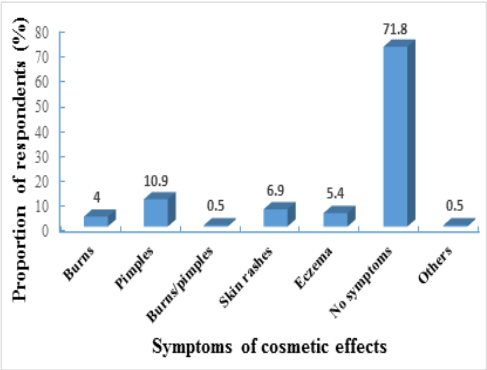

Fig 5: Symptoms of cosmetics effect

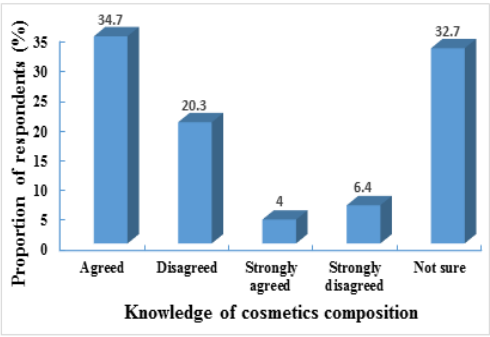

Fig 6: Knowledge of cosmetics composition

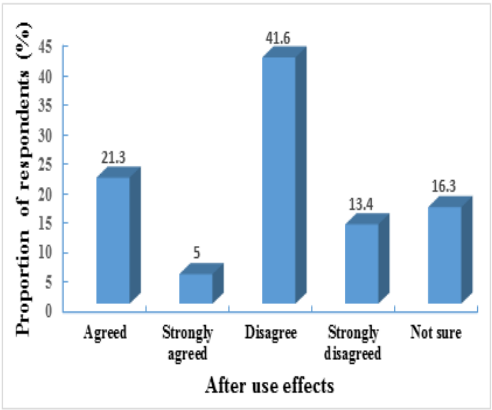

Fig 7: Observable negative effects of cosmetics usage

Some components of cosmetics have been linked to diseases like cancer, birth defects, developmental and reproductive harm (Hussain *et al*., 2013). Hence studies are being carried to determine heavy metals concentrations in various cosmetic products (Nnorom

et al., 2005; Chauhan *et al*., 2010). Oluremi and Oluyemi (2014) studied the heavy metals (lead and cadmium) concentrations in lipsticks and nail polish reported 42.14 µg/g and 5.90 µg/g-8.12 µg/g respectively.

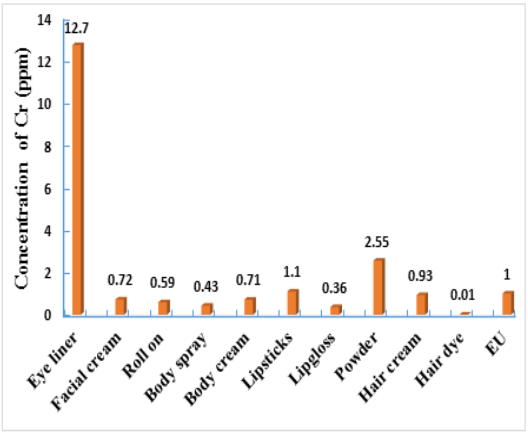

Fig 8: Comparison of Cr levels in cosmetics with EU limit

In this study, all the various cosmetics brands contained Cr (Figure 8). The mean concentration of Cr in each of the cosmetics brand is less than the EU standard of 1ppm except for lipsticks and powder. This may be as a result of Cr being added as a colorant in lipsticks. According to EPA the safe level of chromium is 1 ppm (Corazza *et al*., 2009).

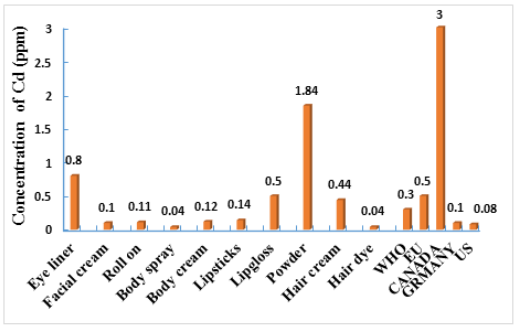

Fig 9. The concentration of Cadmium in cosmetics

Cadmium is a component of many cosmetics products but mostly present in lipsticks and face powders. Its color is deep yellow to orange. It is used as a color pigment in many cosmetics industries (Chauhan *et al*., 2010). From figure 9, it was observed that all the cosmetics contained some concentration of Cd. Cadmium levels in eyeliners, lip-gloss, powder and hair cream exceeded WHO safe limit of 0.3ppm, whereas all the cosmetics except body spray and hair dye exceeded Germany and US limits of 0.1ppm and 0.08ppm respectively. This implies that the use of these cosmetic is not safe while the continuous use of these cosmetics over a long period of time might lead to threats to the health of the users. As a toxicant, Cd target blood vessel and heart tissue as well as the kidneys, lungs, and brain. These results in heart disease, hypertension, liver damage, and suppressed the immune system. Cadmium also causes bone degradation because it affects calcium metabolism (Al-Saleh *et al*., 2009). Khalid *et al.* (2013) showed that Cd content in all brands of lip-sticks was within the range of 0.20ppm to 0.50ppm; this was higher than that of this study of the mean concentration of 0.14ppm. Nnorom *et al.* (2005) also reported that the average concentration of Cd level in several cosmetics samples was approximately 1ppm, this agrees with the level found in eyeliner and face powder, in this study.

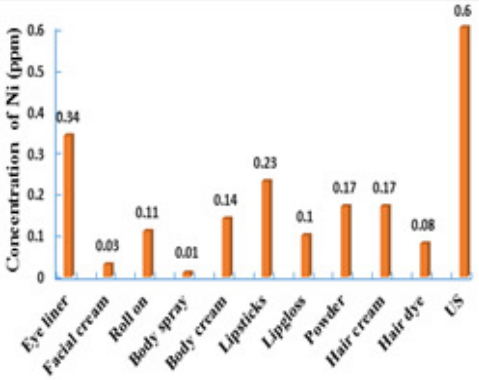

Fig 10: Comparison of Nickel concentration in cosmetics with US standard

Nickel has been implicated in skin allergic reactions. The one most commonly reported condition is allergic contact dermatitis. Presentations include erythema and lichenification of affected parts of the skin (WebMD, 2009). From this study, all the cosmetics contained Ni (fig. 10), this is in agreement with the observation of Health Canada that 100% of all cosmetics product tested positive for Ni (Health Canada, 2011; Orish and Jonathan, 2013). In this present study, the mean concentrations of Ni in all the cosmetics were below the US standard of 0.6ppm (fig. 10). This implies that the cosmetics are still safe for use as far as Ni is concerned but continuous use of these cosmetics over a long period of time could be dangerous to human health. Nickel levels in the various cosmetics were lower than that observed in the study carried out by Orisakwe and Otaraku (2013) who detected Ni concentrations in creams and lotions from Nigeria with concentrations, ranging between 1.09 mg/kg to 6.41mg/kg.

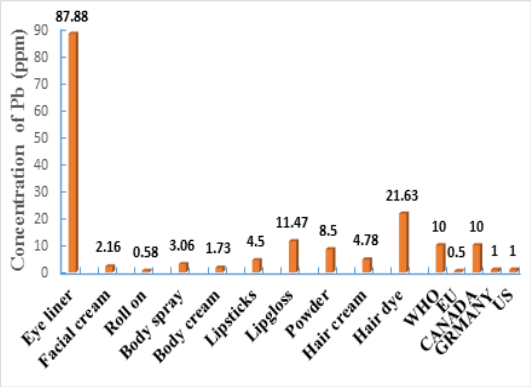

Fig 11: Comparison of Pb concentrations in cosmetics with standards

Comparing the concentration of heavy metals in each cosmetic, eyeliner had the highest concentration of Pb, 87.88ppm (fig. 11). All the cosmetics had Pb levels above the EU limit of 0.5ppm while only eyeliner, lipgloss and hair dye had Pb levels higher than WHO and Canada safe limit of 10ppm. However, all the cosmetics samples except roll on had Pb levels above Germany and US safe limit of 1ppm. The study conducted by Nourmoradi *et al.* (2012), on cosmetics, showed that the value of Pb in all tested brands of lip-sticks samples was within the range of 0.008ppm-5.2ppm while the mean concentration of Pb in the lip-stick samples of the present study is 4.5ppm. Lead adversely affects major organs in the body including the nervous and renal systems. Reports suggest that lead is linked to a deficiency in cognitive acuity and intelligence quotient deficits (Waalkes, 1991). Lead is capable of crossing the placenta with attendant problems like low birth weight and intra-uterine fetal death in extreme cases (Onwordi *et al*., 2011).

*Conclusion***:** This study revealed that cosmetics products are a possible source of heavy metals exposure to a human being and continuous use of these cosmetics could result in an increase in the metal levels in the human body above the acceptable limit. Effort should be made to enlighten the users and the general public about the inherent dangers associated with the use of cosmetics. Furthermore there is need for appropriate regulatory agencies to monitor the levels of these metals in the products and ensure compliance with acceptable safe limits.

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