Review Article

Harmful effects of beauty care products on human health

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ABSTRACT

The review evaluates the current scenario of cosmetic use and their damaging tendencies in different organs of human body. The continuous and homogenous exposure to chemicals present in cosmetic products is health deteriorating at an alarming rate. Various cosmetic products are full with number of raw ingredients such as surfactants, foam agents, fragrances, thickeners, minerals, metals, and preservatives have synthetic origin, and hence, pose a disturbance to normal physiology and are harmful for health ,percutaneous absorption of irritants, and allergens of dermal skin. Various reviews and reports showed chemical composition of commonly used cosmetics have been evaluated to examine their ill effects and mechanism of action while passing in different routes of body. The focus of the work was also given on some main and commonly used ingredients of different cosmetic products, their rate of dermal absorption, and impact on general metabolism in humans.

KEY WORDS: Carcinogenic; Cosmetics; Endocrine; Phthalates; Paraben

INTRODUCTION

Cosmetics as personal care products are not as good as we think. The United State researchers identified 10,500 industrial chemicals used as cosmetic ingredients, including carcinogens, pesticides, reproductive toxics, endocrine disruptors, plasticizers, degreasers, and surfactants. A substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips, and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively for cleaning, perfuming, changing appearance, protecting, keeping them in good condition, or correcting body odors had declared a cosmetics by European Union (EU).[1] Chemicals used in cosmetics as preservatives or solubilizes as fragrances, colorants, and UV-protection are mostly non-persistent, but traces persist such as toxic metal lead (Pb), butyl phthalic acid (BPA), musk xylene, siloxane D5, triclosan, UV-filter isotiazoliner 4-methylbenzylidene camphor, and methylbenzene, which were reported to be the main causes of some cancers including the melanoma. It is one of the most serious skin cancers, caused by neural crest-derived melanocytes-pigmented cells normally presented norma of epidermis.[2] Using makeup frequently, people are being exposed to deadly diseases through the everyday use of common cosmetics bought over the counter. The increasingly numerous synthetic ingredients manufacturers add to their products turn the usual products into cocktails of toxins that could cause cancer over years of sustained use. These ingredients are inexpensive, stable and have good benefit for the manufacturers. The adverse effects of toxins are accumulating over decades, confusing hormone receptors, and slowly altering cell structure. Chemicals are transmitted into the bloodstream in a number of ways: Powders have the least absorption, while oily solutions or those designed to increase moisture allow more of the chemical to be absorbed. Scientists admit that virtually all

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substances spread on the skin have a very real chance of being absorbed into the bloodstream, causing some serious damage in the health. Coal tar colors, phenylenediamine, benzene, and even formaldehyde are just a few of the synthetic chemicals commonly included in shampoos, skin creams, and blushes-toxins which are absorbed into the skin with every use. Eye makeup can be absorbed by the highly sensitive mucous membranes. Hair sprays, perfumes, and dusting powders can be inhaled, irritating the lungs. Lipstick is often chewed off and swallowed. The United Nations Environmental Program estimates that approximately 70,000 chemicals are in common use across the world with 1000 new chemicals being introduced every year.[3] Constant exposures do most likely occur from the use of cosmetics, which is in conformity with evidence showing higher cosmetic use among women than men. Elevated paraben exposures among women can also cause exposures to the most vulnerable groups such as the fetus and breastfeeding infants. Based on available evidence, it can be concluded that strong evidence exists on widely occurring paraben exposures. The incidence of cosmetic linked melanoma and endocrine disorders and birth defects is increasing at an alarming rate. While in the US, the lifetime risk of melanoma in 1935 was one in 1500 persons, in 1960, it was one in 600 persons, and in 2000, it was one in 75 persons.[4] The progression of the melanocyte to a malignant melanoma involves various sequential steps such as development of benign naevocellular, naevus preneoplastic, dysplastic nevus, primary melanoma, and metastatic melanoma.[5] There are four main types of malignant melanoma: (a) Superficial spreading malignant melanoma which is the most common among Caucasians and accounts for 70% of all melanomas occurs in adults and may develop anywhere on the body but appears with increased frequency on the upper back of both men and women and on the legs of women, (b) nodular melanoma (15–30% of all melanomas) tends to rapidly invade the dermis from the onset with no apparent horizontal growth phase, (c) lentigo maligna melanoma (4–10% of all melanomas) originates from lentigo maligna,[6] and (d) acral lentiginous melanoma (2–8% of all melanomas) occurs on the palmar and plantar surfaces, the digits, and the sublingual areas.[7] Cosmetic-based melanoma in women folk often develops in legs while in men it strictly arises on the trunk, on the areas between the shoulders and hips. It usually appears on the palms, soles, and under fingernails or toenails without the discrimination of sex.[8]

Most of the ingredient chemicals of cosmetics have direct effects on hormonal system of body that causes disruption of endocrine system and leads to a number of endocrine disorders. Over the past 50 years, the increase in cosmetic use has a direct link with increase of endocrine disorders such as breast, prostate and testicular cancers, diabetes, obesity, and reproductive problems.[2]

MATERIALS AND METHODS

Sufficient literature survey has been done to review the updated information on the chemical ingredients of cosmetics including epidemiological studies addressing risk factors of different diseases and infections from the past 15 years (2000–2015). Human studies were preferred over animal and *in vitro* experiments. This preference was caused by the thesis objective of dermal exposures in humans, and as it is debated to what extent, we can generalize evidence from animal and *in vitro* studies to humans. Where human studies were lacking, animal and *in vitro* studies were used to indicate evidence. Scientific studies were obtained from Scopus, Science Direct, Web databases, Scholar Google, and PubMed, respectively. Background theory, laws, and directives were obtained from reports (the national, EU, and WHO), web pages, and textbooks. EU reports were used because they have been much debated and there have been frequent meetings about cosmetics in scientific committees in the EU-system.

The current review evaluates the overall scenario of cosmetic use and their damaging tendencies in different organs of human body. The continuous and homogenous exposure to chemicals present in cosmetic products is health deteriorating at an alarming rate.

The various cosmetic products made of a number of raw ingredients such as surfactants, foam agents, fragrances, thickeners, minerals, metals, and preservatives have synthetic origin, and hence, pose a disturbance to normal body physiology and dangers the percutaneous absorption of irritants and allergens of dermal skin.

The various reviews and reports showed chemical composition of commonly used cosmetics have been evaluated to examine their ill effects and mechanism of action while passing in different routes of body. The focus of the work was also given on some main and commonly used ingredients of different cosmetic products, their rate of dermal absorption, and impact on general metabolism in humans.

RESULTS AND DISCUSSION

Cosmetics and Endocrine Abnormality

Cosmetic ingredients disrupt the normal functioning of hormones and cause abnormal metabolism and physiology of the body.[9]

The various endocrine disrupting chemicals are Parabens[10] UV-filters such as benzophenone-1, benzophenone-3 and octinoxate,[11-13] synthetic musks and other fragrance compounds, antimicrobials such as triclosan, cyclosiloxanes octamethylcyclotetrasiloxane

(D4), decamethylcyclopentasiloxane (D5), and dodecamethylcyclohexasiloxane (D6), bisphenol-A (BPA), alkylphenols such as nonylphenols and octylphenol, and glycol ethers.[14]

Mechanism of Action on Endocrine Disruption

The different cosmetic chemical ingredients have different mechanisms of action on different hormones of the human body. They initially target hormone receptors or binding on specific proteins that regulate hormone delivery to the receptors and also target the protein involved in hormone production (aromatase), the protein may be act as transporter (sodium/iodide symporter) or a carrier protein (cortisol binding protein). They even block the hormone-synthesis, which results in imbalances normal level of a particular hormone.[15] The main endocrine systems that can be altered by cosmetic chemicals are the estrogen, androgen, and thyroid.[16] The protruding mechanism of action occurs through the binding of elements to nuclear receptors.[17] This binding of cosmetic chemicals to these receptors causes the synthesis of new proteins due to binding at some regions of DNA that regulates the development of gene transcription. However, the binding mechanism of chemicals to steroid hormones (estrogens and progestin) occurs by both membrane receptors and nuclear receptors.[13] Most of the lipophilic chemicals (xenobiotics) too bind to nuclear receptors and disturb the downstream gene expression. Some cosmetic chemicals have also been reported to alter the normal functioning of endoplasmic reticulum which in turn changes normal action of estrogens and androgens ligands, and most of the reproductive developmental changes are caused by this mechanism. Some cosmetic chemicals also act through non-steroid receptors like neurotransmitter receptors (serotonin, dopamine, and norepinephrine); however, orphan receptors such as aryl hydrocarbon receptors and enzymatic routes affecting steroid biosynthesis metabolism also been reported.

The various cosmetic chemicals mostly PCBs which are mostly called as thyroid-disrupting chemicals cause adverse health effects in humans because of the fact these hormones are important in brain maturation, cognitive growth behavior, and development. Women during early pregnancy are highly vulnerable to permanent effects on neurodevelopment of infants. Cosmetic chemicals cause changes in endocrine receptors are associated with breast and reproductive system cancers,[18] while cosmetic chemicals having estrogenic and anti-androgenic effects cause[19] clear changes in masculinization process of male fetus, low sperm count, testis cancer, hypospadias, and cryptorchidism.[20] The breast cancer is triggered by cosmetic chemicals through changes in endocrine receptors as estrogens can stimulate growth, progression, and metastasis of breast cancer.[21] However, some reports also support the cosmetic chemicals that have a direct effect on normal metabolism which causes abnormal fat depositions in human (obesity). The obesity is a rather a metabolic syndrome which is the basic cause of diabetes type 2, liver, and cardiovascular diseases.[17]

Parabens

Most of cosmetic products have a prominent ingredient chemical called paraben. It has both estrogenic and antiandrogenic effects,[22,23] acting as endocrine receptor agonists and antagonists.[23] Parabens, the alkyl esters of p-hydroxybenzoic acids (PHBA),[24] are non-persistent chemicals[25] and have antimicrobial and preservative effects. They are effective against molds and yeasts, widely used because of their relatively non-irritating and non-sensitizing properties[26] with low acute toxicity, with pH-stable.[27] Short-chained parabens are more hydrophilic, and the long chained are more lipophilic. When the chain length of the paraben increases, the resistance to hydrolysis and antimicrobial activity also increases,[28] but water solubility decreases. As a consequence, methylparaben (MP) and propylparaben (PP) have shorter chains, and hence, mostly used in cosmetics. MP and PP, butylparaben (BP), ethylparaben, heptyl and benzylparaben, isopropyl, and isobutylparaben are homologous.[29] Parabens may affect health at lower concentrations and more precise than non-receptor-mediated mechanisms, due to their capability binding to enodocrine receptors.[25] Several studies, both *in vitro* and *in vivo*, have demonstrated parabens disruptive effects in physiologically important mechanisms. The disruptive effect most described in research is the parabens ability to bind to human enodocrine receptors and thereafter regulates gene expression and cell growth in estrogen-responsive cells through enodocrine receptor-mediated mechanisms. A higher estrogenic effect is also associated with branching in the alkyl chain, from n-PP to iso-PP,[30] and n-BP to isobutylparaben.[31] However, the estrogenic effects have been detected to be 10,000–100,000-fold weaker than natural 17β-estradiol, after subcutaneous administration to rats.[32] Reproductive diseases and endocrine cancers have been of special concern as parabens have been detected in larger concentrations in the axilla area compared to the lateral, mid, and medial side of the breast, and a link between parabens in underarm cosmetics and breast cancer has been suggested.[33] A recent study by Charles and Darbre,[34] on the other hand, showed that combinations of parabens in human breast tissues are large enough to stimulate proliferation of MCF-7 breast cancer cells.

Paraben and Reproductive Syndrome

The parabens are involved in reproductive abnormalities such as reduced sperm production and opposing effects on testosterone concentrations after oral exposures to male rats,[23] due to estrogenic activity. The effects were also caused by anti-androgenic mechanisms, as several parabens are shown to bind to human androgenic receptors and antagonize the effects of testosterone on reporter gene expression. Recent studies have also suggested parabens to

be genotoxic, i.e., parabens may influence the development of malignant melanoma through both genotoxic and estrogenic activities.[23]

Phthalates

Phthalates are salts or esters of phthalic acid, frequently used chemicals of the most cosmetics as a clinging agent to skin, hair, and nails, and enhance their staying capacity. The Environmental Working Group (EWG) in the USA released the first-ever consumer alert on beauty products that contain dibutyl phthalate (DBP), a chemical coming under growing scientific scrutiny because of its high levels found in reproductive age women and possible risks of birth defects.[35] The phtalates disrupt hormonal functions, which control normal cell development and reproduction. More than two decades ago, scientists began building a body of work indicating that phthalates such as diethylhexyl phthalates and DBP can be a powerful reproductive and developmental toxicant in laboratory animals, particularly for males. Early studies focused on phthalates' ability to cause testicular atrophy,[36] but phthalates are now known to cause a broad range of birth defects and lifelong reproductive impairment in laboratory animals. The main birth defect hazards of Phthalates are as follows:

Fall of Sperm Count

According to the studies of Dr. Shanna Swan (1934-1996), University of Missouri, shows that sperm counts is badly effected fromcosmetic products containing phthalates. The earlier report has confirmed by the results of 101 studies that average sperm counts in industrialized countries are declining at a rate of about 1% each year.[37]

Hypospadias

Continuous use of cosmetic products containing phthalates causes hypospadias. It is a physical birth deformity of penis in which the urethra opens on undersurface. As per studies from centers for disease control (CDC) investigated therate of hypospadias in USA, increases during the years 1970 and it keeps increasing through 1980s. Currently, the occurrence of hypospadias appears to be stable likely 30–40 cases per 10,000 births.[38]

Failure of descended testicles

Phthalates cause this birth defect, where testicles fail to completely descend into the scrotum during pregnancy, occur in 2–5% of full-term boys in Western countries. Rates of the defect increased in the the U. S. In the 1970s and 1980s, men born with this defect are at higher risk for testicular cancer and breast cancer.[38]

Testicular cancer

This is the most common cancer of young men in many countries, including the U. S. Its incidence continues to increase at a rate of about 2–4% each year in industrialized countries, although rates appear to have stabilized in the U. S. After a 20-year increase, men with hypospadias, infertility, and undescended testicles - the same constellation of conditions seen in laboratory animals exposed to certain phthalates - are at greater risk for developing testicular cancer.[39]

Scientific concerns about DBP's risks increased, when in 2005, the federal and prevention CDC reported that they had found breakdown chemicals from two of the most common cosmetic phthalates in almost every member of a group of 2782 people examined, with the highest levels in reproductive-age women, a highest risk group. According to laboratory animal studies, DBP can harm nearly every physical structure in the developing male reproductive system.

A report published (2005) in environmental health perspectives showed that men who used the most personal care products such as after-shave and cologne had the highest urinary levels of diethyl phthalate. After 1 year (2006), one more report published which showed low testosterone levels in male newborns exposed to higher levels of phthalates in breast milk. DBP is used to help nail polish form an even film as it dries, as a consistency enhancer to keep products blended, and as an ingredient to help cosmetics penetrate the skin. It can be absorbed through the skin or inhaled as the product is applied. The CDC has postulated that one of the routes of DPB exposure in young women would be cosmetics and personal care items.

In 2003, EU directive bans phthalates in cosmetics in Europe, but the United States and other countries like Canada have not been so proactive, despite having evidence of potential harms.[40]

Aluminum Compound

With aluminum as the active ingredient, antiperspirants work by clogging, closing, or blocking the pores so that they cannot release sweat. A review of the common sources of aluminum for humans found that antiperspirant use can significantly increase the amount of aluminum absorbed by the body. Agreeing to the evaluation, after a single underarm application of antiperspirant, about 0.012% of the aluminum may be absorbed.[41] Other concerning sources of aluminum to humans are food, drinking water, contaminated air, and industrial and medicinal, such as vaccines, exposure.[42] The apprehension with antiperspirant is that the aluminum, it is absorbed by the body and wreaks havoc in the head, where it is likely to support to the growing numbers of people coming down with Alzheimer's disease and also breast cancer. Research conducted in Chicago 2004 by a allergologist who investigates to have found a connection between antiperspirants, underarm shaving, and cancer shows that the toxins in aluminum salts (such as aluminium

chlorohydrate) do not normally penetrate the skin enough to cause a problem unless the skin is shaven; in that case, the substance enters the lymphatic system, which is connected to the breast. This study found that women who perform underarm shaving and used antiperspirants had a diagnosis of breast cancer much earlier than the non-users. Besides, British researchers have found traces of chemicals called parabens in tissue taken from women with breast cancer, suggesting that underarm cosmetics might be a cause of breast cancer.[43] At the very least, if consumers cannot totally avoid these products, if they are using a deodorant, to avoid the aluminum in antiperspirant, they must also be certain that the deodorant does not contain parabens.

Triclosan

Triclosan, an antibacterial facilitator is an important constituent for most of the beauty care products ,as per research these chemicals are harmful for health triclosan not only kills bacteria but also damages the skin cells.[44] Antibacterial ingredients have become prevalent in most products such as soaps, laundry detergents, shampoos, toothpastes, body washes, dish soaps, and many household cleaning products. However, many scientists fear that the widespread use could lead to a strain of resistant bacteria and cause the ingredients to lose effectiveness for the times when they really are needed. People who used antibacterial soaps and cleansers developed cough, runny nose, sore throat, fever, vomiting, diarrhea, and other symptoms just as often as people who used products that did not contain antibacterial ingredients because antibacterial soaps do not protect against viruses [Figures 1-3].[45]

Sodium Lauryl Sulfate (SLS)

SLS is a detergent ingredient of cosmetic products mostly used in toothpastes, shampoos, and lotions. Its use has shown to be very dangerous for brain cells, heart muscles, and liver cells. It disrupts the immune system and eye muscle and causes skin allergic reactions. It is highly reactive when used with other chemicals and gives rise to cancerous compounds.

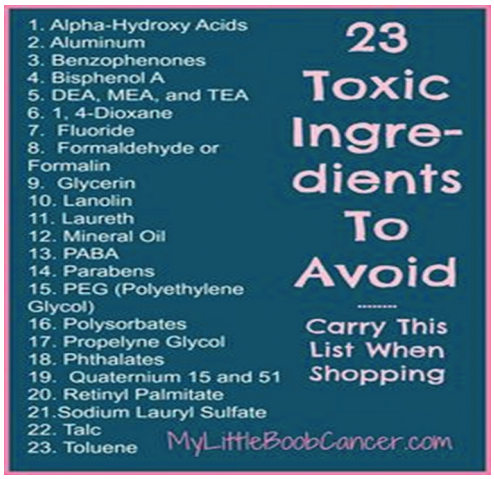

Figure 1: 23 toxic ingredients to avoid harmful for human health

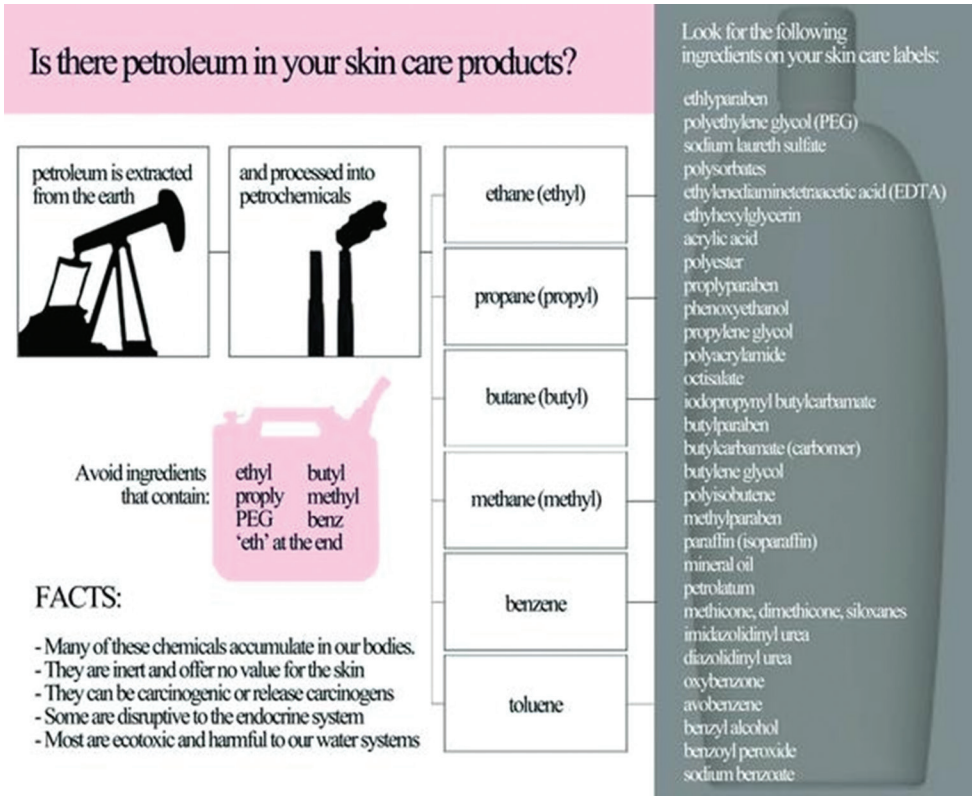

Figure 2: Harmful chemical in beauty care products to avoid

Figure 3: Toxic top ten most skin care ingredients to avoid

Food and drug administration reported (1978) that shampoo contaminated with nitrosamine leads its absorption into the body much higher than eating nitrate-contaminated foods, and nitrate absorption from one shampoo is equal to eating a pound of bacon. A particular bottle of shampoo is full with SLS as per researches, hence acts as powerful carcinogenic compounds can only be determined through laboratory testing.[46] SLS presents that toxicity being used also in toothpaste and is associated with premature hair loss. To minimize the risks, consumers should check for SLS in their shampoos, toothpaste, liquid soaps, body gels, and other skin products. Scientists recommend avoidance of any further skin contact with products containing this ingredient. Sunblock products may also contain it, and they are dangerous, especially if they contain aluminum, this being a potentially dangerous combination for brain cell deterioration. Given this, children must under no circumstances use shampoos and toothpaste containing SLS. Children under 6 are, especially, vulnerable to improper eye development.[46] Consumers should replace products containing SLS with safer alternatives (formulas without SLS).

Propylene Glycol (PG)

PG is used as an antifreeze, deicer, and brake oil in airplanes, and it is an important cosmetic ingredient used as a vector and solvent in a number of beauty care products such as creams, cleansers, makeup, body lotions, and lipsticks. Latest research reports from clinical human and animal studies have proved PG a severe agent for kidney failure, liver damage, dermatitis, and ototoxicity compound.[46]

PG has shown measurable toxicity to human cells in culture and inhibits skin cell growth and cell respiration in animal tests. It directly alters cell membranes and causes skin thickening, dehydration, and chronic surface damage. New findings suggest that propylene glycol (PG) causes early aging of skin cells resulted in development of wrinkles at younger stages. It is estimated that the skin prematures before 3 years from the actual skin age of PG users, and hence, it decreases the age of skin at the rate of 3 times than the real age.

Alpha-hydroxy Acids

Alpha-hydroxy acids are frequently used to buy cosmetic industries in most of their products such as moisturizers, toners, cleansers, masks, and age-spot removers. Its usage in cosmetics aims to speed up the exfoliation of dead skin cells. As per the results of some reports, these acids make the dermal cells much sensitive toward the radiations of sun which leads to the production of oxidants by the skin cells that ultimately lead to skin cancer.

Formaldehyde

Formaldehyde is mostly found in skin creams, soaps, nail polishes, and shampoos as a preservative agent. However, its absorption in skin cells causes severe allergic reactions which leads to chronic lung disorder such as asthama and bronchospasm that results to hyperactivity of allergens and rapid changes in air temperature of the body.[47] Due to its ill health effects, it has been now banned in some countries like Japan and Sweden.

Talc

Talc is a soft mineral, a basic silicate of magnesium used in some cosmetic products like makeup and body powders. According to some reports, talc causes ovarian cancer.[43]

CONCLUSION

Compared to the toxins found in the air, soil, and water, cosmetics may seem a trivial pursuit to many environmental health and consumer advocacy groups. However, many of the same poisons that pollute our environment, from dioxins to petrochemicals, can be found in the cosmetic products people use every day. As testing is voluntary and controlled by the manufacturers, many ingredients in cosmetics products are not safety tested at all. In fact, 89% of 10,500 ingredients used in personal care products have not been evaluated for safety by the CIR or anyone else. in the skin deep investigation by the Environmental Working Group, 99.6% of the 7,500 products examined contain one or more ingredients never assessed for potential health impacts by the CIR. The absence of government oversight for this industry leads to companies routinely marketing products with ingredients that are poorly studied, not studied at all, or worse, known to pose potentially serious health risks of cancer, birth defects, and reproductive abnormalities. Cosmetic ingredients in humans have been studied, and number of evidence found dermal absorption, metabolism, and excretion. The results show high detection rates of native and total ingredients in blood and urine and provide strong evidence of regular or constant

exposures to such compounds. Evidence from the literature show a higher cosmetic use and higher among women than men. Chemicals that are used for beauty care products can damage the development and future fertility of mothers, and infants do not belong in products designed to make women feel more attractive. In particular, for manufactures that have safe preparations in place, a move toward complete health friendly product lines should be possible. Global cosmetics manufacturers will have to differentiate their products to adjust them to the safest expectations of their users, respectively.

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