Research Article

Assessing the Impact of Endocrine-Disrupting Chemicals in Makeup Products on Female Reproductive Health: Exposure Levels and Regulatory Improvements

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ABSTRACT

This report discusses the common endocrine disrupting chemicals present in makeup products and their effects on female reproductive health. It also reviews original data collected to understand the prevalence of these identified chemicals in the products of popular makeup brands. The chemicals surveyed were lead, butylated compounds, phthalates, parabens, formaldehyde and formaldehyde-releasing preservatives, titanium dioxide, and per and polyfluoroalkyl substances. Three types of makeup products (lip gloss, concealer, and mascara) from both affordable (L'Oreal Paris, Pacifica Beauty, and Revlon) and luxury (Anastasia Beverly Hills, Dior Beauty, and Benefit Cosmetics) brands were surveyed for the identified endocrine disrupting chemicals using the Environmental Working Group database. 133 products were surveyed in total with every identified chemical except per or polyfluoroalkyl substances being present in at least 1 product. Since the United States does not regulate ingredients in cosmetic products as strictly as the European Union, more stringent regulations should be put in place. Public education and outreach should also be conducted to spread awareness to makeup consumers, especially young girls, on the importance of avoiding the use of endocrine-disrupting chemicals.

Keywords: Endocrine-disrupting chemicals; female reproductive health; cosmetics; infertility; makeup; endocrine-disruptors; fertility

INTRODUCTION

1 in 7 women, ages 15-49, have trouble getting pregnant or sustaining a pregnancy (1), Infertility remains a prevalent reproductive health issue for women in the United States. According to the World Health Organization (2) infertility can be defined as "a disease of the male or female reproductive system defined by the failure to achieve a pregnancy after 12 months or more of regular unprotected sexual intercourse."

The greatest chemical threat to female reproductive health is endocrine-disrupting chemicals (3). Endocrine-disrupting chemicals are defined as toxins that can negatively affect the endocrine system and its ability to function properly. These chemicals may enter the body

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through ingestion, inhalation, or absorption through the pores. Numerous disruptors are commonly found in everyday products including cosmetics, pharmaceuticals, and food packaging (4). According to available literature, makeup products are defined as "articles intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body...for cleansing, beautifying, promoting attractiveness, or altering appearance" (5). Additionally, it was found that in the U.S., up to 74% of women and girls reported wearing makeup (6), revealing its prevalence within the daily lives of numerous individuals. Available research has confirmed the presence of the endocrine-disrupting chemicals lead, parabens, phthalates, butylated compounds, titanium dioxide, per and polyfluoroalkyl substances, and formaldehyde and formaldehyde releasers in several makeup product formulations.

Considering the prevalence and impact of infertility in women, it is important to better understand and address the large number of products that contain endocrine-disrupting toxins within society. The current study seeks to examine the presence of toxic endocrine-disrupting chemicals in makeup products commonly used by women and girls by reviewing existing literature and analyzing secondary data from the EWG's Skin Deep database. It also explores how regulatory measures can be improved to reduce exposure to these toxic chemicals and protect consumer health.

METHODS AND MATERIALS

Sample Selection

Two phases of the sample selection process were completed to determine the specific types and brands of makeup products to be assessed in this study. In phase one, the makeup products lip gloss - for the lips, mascara - for the eyes, and concealer - for various blemishes and imperfections on the skin were selected. The diversity of these items allows for a comprehensive exploration of various makeup products in this study.

In phase two, the brands of makeup products to be assessed were selected from a total of six brands. Three brands were selected from a list of affordable/drug-store makeup brands (prices ranging between $10 and $30 per item) (7) and three brands were selected from a list of luxury/high-end makeup brands prices (ranging between $31 and $60 per item) (8). The affordable brands selected were L'Oréal Paris, Pacifica, and Revlon. The luxury brands selected were Anastasia Beverly Hills, Dior Beauty, and Benefit Cosmetics.

Ingredient Analysis Process

Secondary data collection and ingredient analysis were carried out using EWG's Skin Deep Database. For each type of makeup product, all selected brands were surveyed individually. An initial database search was run to display all products available in the database for the selected type and brand of makeup products. Once the database displayed all of the products available under that category for the certain brand, the ingredient lists on every single product's packaging were reviewed. This step-by-step process was done to identify if one of the endocrine-disrupting chemicals of concern is present in the product formulation. For makeup products with multiple skin tone shades available in the database (e.g., lip gloss and concealer), each shade of the makeup product was analyzed in case a certain pigment for a specific skin tone contained more endocrine-disrupting chemicals than a different color.

Environmental Working Group (EWG) Skin Deep Database

The EWG's Skin Deep Database was used to survey the ingredients within each product for all of the brands. Every product on its website gets a two-part score, the first part being from 1-10 based on an item's level of hazardous ingredients and the second part ranging from none to robust, referring to the information available on the components of that item. Then, to find the product's overall score, the individual ingredient hazards are compared to all the other items within the database and given a final score. The safest products are those that score low on the hazard scale and have a decent amount of information available about the ingredients in their formula. For every product, the database lists every identified component. It also marks whether the overall item is a low, moderate, or severe threat to reproductive health and whether certain chemicals are endocrine disrupting (9).

RESULTS

133 make-up products across the six brands were examined for final analysis. These included 47 products across three affordable brands and 86 products across three high-end brands. The numerical breakdown of products examined per brand is as follows: 41 for Revlon, 29 for Benefit Cosmetics, 23 for L'Oreal Paris, 22 for Pacifica Beauty, 14 for Anastasia Beverly Hills, and 4 for Dior Beauty. A total of 32 lip glosses, 34 concealers and 67 mascaras were examined (Table 1).

Table 1. Identified Endocrine-Disruptor Prevalence and Environmental Working Group Safety Ratings of Mascaras, Lip Glosses, and Concealers from Affordable (L'Oreal Paris, Pacifica Beauty, Revlon) and Luxury (Anastasia Beverly Hills, Dior Beauty, Benefit Cosmetics) Brands. A comprehensive list of products analyzed in the current study is available upon request.

Total Number of Products	Brand	Product Type	Phthalates	Parabens	Formaldehyde-Releasing Preservatives	Lead	Butylated Compounds	Titanium Dioxide	EWG Safety Rating
133	N/A	N/A	2	14	20	2	78	79	3.53
47	High-end	Mascara, Lip gloss, Concealer	0	4	7	0	39	36	3.62
86	Affordable	Mascara, Lip gloss, Concealer	2	10	13	2	39	43	3.48
67	N/A	Mascara	0	10	6	2	46	20	3.16
34	N/A	Concealer	0	1	4	0	22	30	3.59
32	N/A	Lip Gloss	2	3	10	0	10	29	4.49
23	L'Oreal Paris	Mascara, Lip gloss, Concealer	2	1	13	0	11	20	5.00
22	Pacifica Beauty	Mascara, Lip gloss, Concealer	0	0	0	2	3	10	2.50
41	Revlon	Mascara, Lip gloss, Concealer	0	9	0	0	25	13	3.15
14	Anastasia Beverly Hills	Mascara, Lip gloss, Concealer	0	3	1	0	5	9	3.50
4	Dior Beauty	Mascara, Lip gloss, Concealer	0	0	2	0	0	2	2.75
29	Benefit Cosmetics	Mascara, Lip gloss, Concealer	0	1	4	0	34	25	3.79

Overview based on EWG Safety Rating

The average EWG safety rating across all 133 makeup products was 3.53 indicating that, on average, the products were considered moderately hazardous. This score suggests a moderate level of concern regarding the health risks associated with the ingredients and a modest volume of available research and information on the products' ingredients and formulations.

The average EWG safety rating for the 47 high-end products was 3.62, while the average rating for the 86 affordable products was 3.48, despite both categories containing similar levels of butylated compounds and titanium dioxide. Furthermore, high-end products had no phthalates or lead, when compared to affordable products, which included two products with phthalates and 2 with lead. The EWG safety ratings were also analyzed by product type, revealing that lip glosses had the highest (worst) average rating at 4.49, indicating that lip glosses posed the greatest potential toxicity concern among the three product types.

The EWG safety ratings were also analyzed by brand, revealing that Pacifica Beauty had the lowest (best) EWG rating of 2.50, indicating the cleanest product formulation profile. Pacifica Beauty products had no parabens, phthalates, or formaldehyde-releasing preservatives, aligning with its marketed image as a "clean beauty" brand (Pacifica Beauty, LLC). In contrast, L'Oreal Paris had the highest (worst) EWG rating of 5.00, with the highest levels of phthalates and formaldehyde-releasing preservatives when compared to other make-up brands. Benefit Cosmetics, Anastasia Beverly Hills, and Revlon showed moderate ingredient risk, with EWG safety ratings of 3.79, 3.50, and 3.15, respectively. Dior Beauty, while being a high-end brand, had a relatively low product count of 4, making its broader safety conclusions limited.

DISCUSSION

One of the most prevalent chemical groups found were butylated compounds. The only two types encountered in the surveyed products were butylene glycol and butylated hydroxytoluene. More products contain butylene glycol than BHT, which is a positive. BHT is of greater reproductive concern than butylene glycol, as it has been stated to have a strong correlation with endocrine disruption by the European Commission (13). These high quantities of BHT are concerning because several brands incorporate the chemical into their products, meaning that it is being absorbed by a range of buyers. Increased exposure to BHT can lead to a higher risk of diminished quantity of healthy, immature eggs within a woman's ovaries (14, 15).

The presence of titanium dioxide was split almost evenly between affordable and high-end brands, as well as amongst the three types of makeup. This indicates that consumers of all socio-economic demographics and identities are at risk of decreasing the function of their reproductive organs and fertility (16, 17).

Phthalates, parabens, formaldehyde releasers, and ingredients traced to lead were all only found in more cost-friendly brands. This indicates that consumers who most likely have a lower income have an increased exposure to such toxins, all of which have been identified as endocrine-disrupting chemicals by the European Union (18; 19; 20). High exposure to these chemicals also may lead to disruption of hormone levels within the body, impacting proper reproductive function (12, 18, 21, 22).

It is important to note that the average safety ratings of affordable and higher-end cosmetic brands were similar, although the luxury brands had a slightly higher average rating. Despite the comparable safety ratings, the overall average rating across all products evaluated in this study indicates a moderate level of hazard. This suggests that many cosmetic products still pose potential health risks. Further research is needed to assess the extent of these risks based on the types and concentrations of endocrine-disrupting chemicals present.

Recommendations for regulatory changes and improvements

Currently, the US Food and Drug Administration (FDA) primarily relies on post-market monitoring to ensure consumer safety and does not require approval for cosmetics before they are introduced to the market, except for certain color additives (23). In contrast, the European Commission (EU) Cosmetics Regulation has requirements for comprehensive safety assessments, ingredient bans and restrictions, and requirements for labeling and ingredient disclosures (24). Furthermore, the EU currently has bans and restrictions in place for more than 1,300 substances in cosmetic products while the FDA has a significantly shorter list of less than 30 prohibited items (25).

Considering the identified gaps in comprehensive safety assessments, the FDA should support research activities to identify the endocrine-disrupting chemicals used in cosmetics that can pose harm on the female reproductive system. Identified chemicals and toxins

should be subsequently banned from inclusion as ingredients in cosmetic products. The list of restricted and banned ingredients identified by the EU Cosmetics Regulation can be adopted as a guide to inform the process of developing a more comprehensive list for the US.

Additionally, the FDA should strengthen the safety requirements and processes for cosmetic products to be FDA approved. This may include requiring brands to submit relevant evidence and testimony that no endocrine-disrupting chemicals are present in the formula of the product as part of the approval process. These requirements should ensure that the ingredients in the products themselves are endocrine and reproductive friendly but also do not contain contamination or trace concerns. The FDA should also mandate manufacturers to clearly disclose any potential reproductive health risks of product ingredients on the label or ingredient list.

Finally, the FDA should partner with the European Union and take serious note on which ingredients the EU bans.

Recommendations for Cosmetic Product Manufacturers and Retailers

Manufacturers should prioritize reproductive health safety by developing and testing cosmetic products to ensure they are safe for the reproductive system. This should include paying special attention to identifying and eliminating endocrine-disrupting chemicals, particularly those identified in the current study from cosmetic product formulations.

Cosmetic retailers (such as Sephora and Ulta Beauty) should only stock products that have been independently tested and verified as safe for the reproductive system. If the adoption of this recommendation is not immediately feasible, retailers should at a minimum clearly label which products meet these safety criteria. The implementation of this recommendation empowers consumers to make informed decisions on makeup purchases and reinforces manufacturer and retailer accountability across the supply chain.

Finally, manufacturers and retailers should collaborate with brands, health experts, or advocacy groups to educate shoppers about endocrine-disrupting chemicals and other reproductive health concerns. This education is especially critical for informing younger consumers who may not yet consider the long-term impacts on reproductive health.

Limitations

One limitation to the study is that the EWG Skin Deep Database does not provide information on the concentration levels of each chemical or bioavailability. Thus, the data is limited to the overall toxicity and exposure risk of a product, without taking into account the level of each individual harmful chemical in that product. Additionally, only six makeup brands were surveyed and only three types of products were surveyed with only seven identified endocrine-disrupting chemicals being examined for. The only database utilized for data collection was the EWG Skin Deep Database. Thus, the sample size was relatively small and may not be a completely accurate representation of the prevalence of endocrine disruptors amongst all makeup brands and types of products.

CONCLUSION

This study examined the links between toxic chemicals found in makeup products and fertility issues in women and girls while investigating the improvement of regulatory measures to mitigate these risks. Data was collected through the implementation of the Environmental Working Group database, focusing on lip gloss, mascara, and concealer from three affordable brands (L'Oreal Paris, Pacifica Beauty, and Revlon) and three luxury brands (Anastasia Beverly Hills, Dior Beauty, and Benefit Cosmetics). 6 out of the 7 chemicals that the products were surveyed for were present within the data. Titanium dioxide and butylated compounds occurred most frequently, revealing risks such as lower immature egg count and endocrine disruption for women. In order to minimize these effects, more stringent consumer protections should be put in place by regulatory bodies such as the FDA. Specifically, cosmetic production companies should be banned from utilizing known endocrine disrupting chemicals within their formulations, and cosmetic sellers should not allow for such products to be sold without alerting consumers of the risks that those products pose to their reproductive health. Lastly, outreach should be conducted to ensure that makeup consumers, especially young girls, are aware of the threats that commonly used toxins pose on their health.

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CONFLICTS OF INTEREST

The author declares that there are no conflicts of interest regarding the publication of this article.

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