

**The Race for Beauty: Examining the Social Drivers of Personal
Care Product Use and the Impacts of Exposure on Black Women**

Marissa Chan

**Occidental College
Department of Urban and Environmental Policy
Mijin Cha**

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EXECUTIVE SUMMARY

Personal care products are a part of the daily routine. Currently women use an average of nine products a day, which is equal to around 126 unique ingredients (Environmental Working Group 2016). These products are not regulated or tested for safety prior to being placed on the market, and can contain chemicals known as endocrine disruptors. These chemicals are believed to impact the endocrine system and lead to altered reproductive health outcomes such as earlier puberty or menarche. Additionally, there are clear patterns of inequity in exposure and women of color are found to be unjustly burdened. This research project aimed to analyze the impacts of endocrine disrupting chemicals (EDCs) on the reproductive health of Black women as well as identify contextual drivers behind product use. Through a mixed methods study using surveys and semi-structured interviews, this research intended to answer the question of, is there a relationship between the starting age of product use, frequency of use, and the number of personal care products that women of African descent used before puberty, and the start of puberty and menarche? The survey analysis had few statistically significant results due to limitations in sample size. In comparison, through the interviews the main product use influences of family, social pressure and judgment, YouTube, and company branding were discovered. Resolving this multifaceted issue will require a combination of efforts encompassing redesigning the Federal Food and Drug Administration's cosmetic regulatory system, expanding local and national campaigns, establishing funding sources for alternative chemistry research, and the general inclusion of product exposure in racial justice discussions.

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1. INTRODUCTION

Product use is an individualized and personal routine. Factors including the age, sex, culture, and physical attributes of an individual play a significant role in the products used. These different product routines result in disproportionate exposure of certain populations to the combination of chemicals found in personal care products. Product exposure as a racial justice issue is an understudied field that has not yet explored the complexities surrounding disparities in exposure and health outcomes. Difficulties developing methods encompassing a specific source of exposure while taken into consideration the social drivers of exposure have resulted in the absence of evidence surrounding product use and health outcomes. This lack of research begs the question of, is there a relationship between the starting age of product use, frequency of use, and the number of personal care products that women of African descent used before puberty, and the start of puberty and menarche?

2. BACKGROUND

2.1 History of Personal Care Product Safety

The modern consumer market place is flooded with an inconceivable number of options. What is not usually considered when buying personal care products is ingredient safety. Product use comes with the assumption that consumer products are thoroughly tested and regulated for safety by the government. However, public faith in consumer product safety is misplaced (Schettler et al. 2000) (Urbina 2013). There are no toxicity studies or pre-market testing required for personal care products (Environmental Working Group 2016). In fact, according to the Office of Cosmetics and Colors at the Federal Food and Drug Administration (FDA), “a cosmetic manufacturer may use almost any raw material as a cosmetic ingredient and market the product without an approval from the FDA.” (US FDA 2016b) This lack of approval and product

regulation is reflected in the fact that only nine chemicals and classes of chemicals are banned for use in cosmetics (US FDA 2016b).

Federal Food and Drug Administration's lax authority over personal care products has allowed cosmetic companies to take control of what chemicals are used in products. The personal care product industry earns over \$41 billion a year. Its wealth and power in combination with the lack of FDA authority has resulted in products containing classes of endocrine disrupting chemicals (EDCs), carcinogens, and other body system toxins, some of which have been linked to concerning health outcomes (Environmental Working Group 2016) (Kessler 2015). Regardless, cosmetic companies universally defend that their ingredients are safe. The only evaluation or testing of products is run by the Cosmetic Ingredient Review (CIR), a panel funded by the Personal Care Products Council Trade Association. In 50 years the CIR has only found 11 chemicals unsafe for consumer use (Kessler 2015).

This blind trust in product safety is not reflected in other parts of our consumer market such as pharmaceuticals. People generally know that pharmaceuticals must go through a series of safety tests before they are placed on the market. Cosmetic safety is assumed, and it is compounded by the fact that conversations surrounding chemicals in products are rare and they are often in scientific language that excludes the public.

2.2 “Regulated” but not Tested or Approved

The existing regulatory system focuses on the packing and sales of products instead of safety testing. The burden of safety is placed on companies and manufacturers, who are legally responsible for substantiating the safety of their products (Kessler 2015). However, there are no legal requirements to demonstrate product safety. In addition, there is no accepted definition of

safety used by both companies and the FDA. Therefore, the definition of safety is up for interpretation by both parties.

The acts in place for the regulation of personal care products are extremely outdated and lack the focus on modern problems. The main regulatory act for cosmetics and personal care products is the Federal Food, Drug, and Cosmetic Act. Passed in 1938, it officially defines the term cosmetic and explains the regulation of poisonous, deleterious, and misbranded cosmetics (US FDA 2016a). The Fair Packing and Labeling Act (1967) was implemented to prevent deception of consumers and it discusses trade secrets. These acts illustrate the flaws in the current regulatory system. It relies on weak, misdirected regulation rather than pre-market approval and testing for safety. The resulting system is ineffective and it does not give FDA the regulatory authority and oversight needed to ensure product safety.

2.3 Introduction to Endocrine Disrupting Chemicals (EDCs)

The weak regulatory system has resulted in a host of chemicals in our personal care products that may impact certain body systems (Kessler 2015). Endocrine disruptors are defined as a substance or a mixture of substances from outside the body that alters the function(s) of the endocrine system and consequently cause adverse health effects in an organism or its progeny (WHO 2016b). Humans can be exposed to EDCs through ingestion, inhalation, or dermal exposure. These chemicals can also be transferred to a fetus through the placenta (WHO 2016a) (Schettler 2006) (Wolff et al. 2010).

This group of chemicals impact the endocrine system, a collection of glands that produce hormones that regulate metabolism, growth, development, tissue function, sexual function, reproduction, sleep, and mood. This system includes the thyroid gland, parathyroid glands, adrenal glands, pituitary glands, pancreas, and ovaries/testicles (Zimmermann 2016). EDCs have

chemical structures that are similar to naturally occurring hormones, and they impact the endocrine system by inducing a biological response or blocking a hormone from expressing its effects (Roy, Chakraborty, and Chakraborty 2009). Evidence of these activities has resulted in alternative names for EDCs: xenoestrogens, oestrogens, anti-oestrogens, and anti-androgens (Den Hond and Schoeters 2006). For these reasons, EDCs are a large concern for prenatal and pre-pubertal exposure during critical developmental periods (Roy, Chakraborty, and Chakraborty 2009) (Colón et al. 2000) (Bergman et al. 2013).

2.4 Prevalence of EDCs

Endocrine disruptors are ubiquitous in our environment and pervasive in the human body (Silins and Hogberg 2016). There are close to 800 chemicals that are known or suspected of being capable of interfering with hormone receptors and hormone synthesis (Bergman et al. 2013). DDT is one of the most well-known endocrine disruptors. It was popularized in Rachel Carson's book *Silent Spring*, which went in-depth into the environmental consequences of DDT and other chemicals. Currently, pesticides such as chlorpyrifos are suspected of being low-level endocrine disruptors (TEDx 2016). Environmental or occupational exposure is just one source of exposure and individuals may be exposed every day from household products.

In terms of consumer products, people may associate endocrine disruptors with the chemical Bisphenol A (BPA), which was brought into the public spotlight when plastic water bottles were found to contain the chemical. Since the public outcry, BPA has been phased out of most bottles which now are labeled "BPA free". Its replacements (BPS among others) have been found to mimic estrogen and promote growth in breast cancer cells (Bienkowski 2017). Additionally, these chemicals can be found in foods, containers, dust, toys, receipts, pharmaceuticals, medical supplies, and personal care products (Kessler 2015b).

2.5 Temporal Trends in EDCs

The levels of EDCs in the environment are constantly changing and reflect the chemicals used in consumer products and released into the environment. One example is phthalates, where there have been notable changes in the levels of phthalate metabolites (the product formed after it is metabolized) in almost every population in the past decade (Zota, Calafat, and Woodruff 2014). These changes have all been positive and indicate decreases in certain exposures. However, it is believed that most of these decreases reflect substitutions in chemicals rather than eliminations. As described above, BPA was replaced with BPS (Calafat, Valentin-Blasini, and Ye 2015). Even with these changes, 97% of the population still has measurable concentrations of phthalates in their bodies (Silva et al. 2003). In addition, with limited information on the original chemicals and the corresponding replacements, it is difficult to connect which original and replacement chemicals were in what products. (Calafat, Valentin-Blasini, and Ye 2015). Ultimately, trends in chemical exposure indicate that endocrine disruptor exposure is ubiquitous, but the specific chemicals are constantly changing.

2.6 Endocrine Disruptors in Personal Care Products

Endocrine disruptors are used to preserve or enhance a feature commonly associated with a brand or a product. For example, Johnson & Johnson claim that their baby shampoo needs a certain composition of chemicals to retain its familiar smell and color, and without them a complete reformulation would be required (Kessler 2015). Phthalates, triclosan, and parabens are common chemicals used in a variety of personal care products.

1. **Phthalates.** This class of chemicals is the most wide-spread in our environment and can be found in everything from medical supplies to makeup. In cosmetics, they are known to reduce brittleness, increase malleability, and as a solvent/fixative (FDA 2016). These attributes are useful in fragrances, perfumes, nail polish, lotion, shampoos, and conditioners (US FDA 2016b)

2. **Triclosan.** This chemical is used for antibacterial purposes and is found in most hand and body soaps. Research has shown that this antibacterial agent is no more effective than regular soap and it may actually cause harm (Cherednichenko et al. 2012). The antibacterial product industry earns \$1 billion annually and triclosan can be measured in 75% of the U.S. population (National Resource Defense Council 2016). On top of its endocrine disrupting properties, triclosan may contribute to antibiotic resistance in bacteria (National Resource Defense Council 2016).
3. **Parabens.** These chemicals are used as preservatives to prevent growth of microbes. They are commonly found in personal care products and can be located in shampoos, conditioners, lotion, facial and shower cleaners, and scrubs (Campaign for Safe Cosmetics 2016a).

These chemicals can be found in a variety of personal care products. Certain products, such as Black hair care products, are found to be more toxic than products used by the general population (Black Women For Wellness 2016). Studies have found that African-American women were more likely than other ethnicities to use hair care products that contain hormones or hormone-like chemicals (Kessler 2015) (T. M. James-Todd, Chiu, and Zota 2016). Additionally, certain products such as hair relaxers can contain sodium hydrochloride or calcium chloride which can burn the scalp or result in easier entry of EDCs into the skin (Kessler 2015). Products catered to Black women are more likely to contain certain endocrine disruptors, and this disparity may explain why women of color are bearing the burden of exposure and reproductive health effects (T. James-Todd, Senie, and Terry 2012).

2.7 Beauty Product Purchasing among Black Consumers

Black consumers are found to be the largest purchasing base for beauty and hair products. They spend nine times more in the ethnic hair category than other product purchasing categories. Households spend between \$89-\$132 at beauty supply stores annually based on income (Nielsen 2013). Including expenditure at salons and other personal care purchases, the average annual

expenditure of all households on personal care is \$318.71, making up 3.8% of total expenditure of Black households (Noël 2017).

2.8 Inequities in Exposure

There are clear patterns of inequity surrounding endocrine disruptor exposure and the demographics of the population. One noticeable pattern is the difference in phthalates between men and women. Biomonitoring (measuring metabolites in blood, urine, or other body fluids) has found that women have higher concentrations of short chain phthalates (most commonly found in personal care products) than men (Wittassek et al. 2011) (Kay, Chambers, and Foster 2013) (Silva et al. 2003). This disparity between sexes has been hypothesized to be due to the increased use of personal care products among women (Wittassek et al. 2011).

Younger populations are also exposed to higher concentrations of certain endocrine disruptors. Children and adolescents ages 6 to 12 have higher exposure to phthalate metabolites than other age groups. These high levels are believed to be due to the use of phthalates in toys to ensure malleability (Zota, Calafat, and Woodruff 2014) (Silva et al. 2003) (Wittassek et al. 2011).

One notable inequity is the level of EDCs in women of color (Black and Latino women), who are found to have higher exposure to certain endocrine disruptors than White women (Harley et al. 2016) (Kessler 2015b) (Wolff et al. 2010) (T. James-Todd, Senie, and Terry 2012). For example, products used by Black women are more likely to contain parabens than products used by White women (T. James-Todd, Senie, and Terry 2012). Concurrently, black women are also found to have a higher burden from certain hormone related diseases than other populations as well as increased risks of neurodegenerative diseases, cancer, and respiratory problems (Kessler 2015) (Women's Voices for the Earth 2017). The causes of this disparity are unknown,

but it is hypothesized that Black hair products may be a notable source of EDC exposure (Kessler 2015) (T. James-Todd et al. 2011).

2.9 Impact on Reproductive and Developmental Health

There is growing evidence that EDCs can cause reproductive and developmental health effects as well as a host of other health issues in exposed populations. Particularly exposure during critical developmental periods can result in damage to the body systems (Roy, Chakraborty, and Chakraborty 2009). In terms of specific health outcomes, there have been increased incidence of cryptorchidism (testicles fail to move into the scrotum), hypospadias (urethra is located on the underside of the penis in boys), other genital malformations, adverse birth outcomes, and neurobehavioral disorders (Den Hond and Schoeters 2006) (Bergman et al. 2013). Prenatal exposure from cumulative EDCs may be connected to the rise in physical malformations and disorders in children. However, we do not yet know the role of specific exposures, concentrations, or chemicals on the resulting disorders.

2.9a Precocious Puberty and Premature Menarche

Pre-pubertal exposure may also lead to altered reproductive body systems or health effects in adolescents. It has been suggested, “that at the onset of puberty the neuro-endocrine processes becomes highly vulnerable to environmental factors that can permanently affect the development and functions of reproductive organs, growth spurt, and even the maturation of the brain” (Roy, Chakraborty, and Chakraborty 2009). Secondary sexual development such as thelarche (premature breast development), precocious puberty, and premature menarche are a few of the reproductive health effects that may be attributed to chemical exposure.

These reproductive outcomes are concerning due to the additional burdens they may place on adolescent girls. Socially, premature menarche has been linked to a higher risk of

pregnancies, increased substance abuse, antisocial behavior, eating disorders, and emotional stress (Schoeters et al. 2008). These social burdens may be amplified by socioeconomic status or other social or physical burdens that individuals may face. Additionally, relationships have been found between precocious puberty and breast cancer, other reproductive tract cancers, adult obesity, adult onset asthma, shorter adult stature, hyperinsulinemia and metabolic syndrome, and type 2 diabetes (Roy, Chakraborty, and Chakraborty 2009) (Buttke, Sircar, and Martin 2012) (Kay, Chambers, and Foster 2013).

The inequity in exposure is reflected in health outcomes. Black adolescents are found to have on average an earlier start of menarche than other race/ethnicities (Schoeters et al. 2008) (Buttke, Sircar, and Martin 2012) (Reagan et al. 2012) (Teilmann et al. 2002). A portion of the earlier menarche time has been found to be associated with social factors. However, the major causes are unknown (Reagan et al. 2012). Women of color not only endure the majority of exposure, they also bear social and reproductive burdens.

2.10 Federal Regulatory Progress

There have been significant efforts to change chemical policies. However, due to the current political climate and the drastic shift in funding and support for scientific research, progress may be halted or reversed. President Trump's view of chemical regulations is not fully known, but it is believed that the new administration may attempt to shape laws instead of eliminate them (Rizzuto 2016). From past comments and actions by Trump, chemical policies will be shaped to benefit companies and industries. Since personal care products are not regulated to begin with, it is assumed that this lack of regulation will remain the same. Even with these significant setbacks, champions in this field will continue to fight for changes to protect public health over corporate profit.

At the federal level, there was a focus on amending the outdated Food, Drug, and Cosmetic Act through the Personal Care Products Safety Act sponsored by Senator Diane Feinstein. The act required that the FDA must test at least five compounds per year to determine if they are safe and at what concentrations. In addition, manufacturers had to register with the FDA and provide information on their product ingredients (Kessler 2015). This act would give the FDA authority to test products and respond appropriately to ensure that products are safe before they reach the consumer market. Hearings were held in 2016 by the Committee on Health, Education, Labor, and Pensions. The legislation was not enacted by the end of the 114th Congress, so it was dropped (GovTrack 2017).

Recently the Frank R. Lautenberg Chemical Safety for the 21st Century Act that revises the Toxic Substance Control Act (TSCA) was passed in efforts to improve chemical safety in consumer products. This act aims to provide the Environmental Protection Agency with the tools necessary to ensure safety, set deadlines, and increase transparency to the public (The Energy and Commerce Committee 2016). Since this act is a revision of the Toxic Substance Control Act it has a limited effect on personal care products. Even though this act is still flawed in protecting consumer safety, its passage shows the potential for the revival of the Food, Drug, and Cosmetic Act to give the FDA authority and accountability to protect consumer health.

3. LITERATURE REVIEW

Endocrine disrupting chemicals have not been at the forefront of scientific or public considerations. Before the early 2000's, research and discussions surrounding endocrine disrupting chemicals were rare. Since the emergence of this field, researchers have just begun to scratch the surface into the health effects of EDCs and the result of interactive and cumulative chemical exposures. There is literature on EDCs in personal care products, the impacts of EDCs

on puberty and menarche, and the difference in puberty and menarche between Black and White adolescents. However, literature connecting these three themes is lacking. For this reason, the literature review will examine the individual themes that have been studied, as well as the literature connecting endocrine disrupting chemicals in personal care products to altered puberty and menarche in Black women.

3.1 Endocrine Disrupting Chemicals in Products

Regardless of the uncertainties surrounding exposure and health impacts, one fact has been agreed upon through numerous research projects. Personal care products can contain detectable concentrations of endocrine disrupting chemicals. Phthalates, parabens, bisphenols, and dioxins are some EDCs commonly found in consumer and personal care products (Kessler 2015).

Kessler 2015 examined the state of literature surrounding chemicals in personal care products, the role of regulation and industry, and inequity in reproductive health outcomes. The author first went into an in-depth explanation of the lack of FDA regulations surrounding personal care products and how safety testing conducted by companies is minimal and focuses on the potential for skin irritation instead of other health outcomes. After going into the failures of the regulatory system, Kessler pivoted to discuss the successes of campaigns and legislations surrounding this work, most notably the Campaign for Safe Cosmetics, Environmental Working Group's Skin Deep data base, and the Personal Care Product Safety Act. The review article ended with discussions surrounding studies that connected the use of personal care products to earlier puberty and menarche, as well as how Black hair products are found to contain more harmful chemicals than other products.

Harvey et al. 2016 discussed their HERMOSA study (Health and Environmental Research on Makeup of Salinas Adolescents) which was a youth empowerment intervention to determine ways to reduce adolescent girls' chemical exposure from makeup. Their methodology included giving 100 Latina girls safe alternative products for three days and biomonitoring to compare the levels of phthalates, parabens, triclosan, and BP-3 metabolites before and after the switch. They found that concentrations of MEP (phthalate metabolite) decreased by 27% and methyl and propyl parabens decreased by 43.9%. Surprisingly, concentrations of ethyl and butyl parabens increased. While this study is important to connect personal care products to the measurable chemical metabolites, the short study period and lack of product analysis were major limitations.

Lastly, Romero-Franco et al 2011 discussed their study which examined the relationship between personal care product use and levels of phthalate metabolites. The methodology included interviewing and biomonitoring women to determine their product use and the levels of metabolites in their systems. The results found that users of body lotion and deodorant had significantly higher concentrations of DEHP, and perfume users had increased concentrations of MiBP (DEHP/MiBP are both phthalate metabolites). Through this study, it was determined that personal care products contribute to an individual's phthalate body burden, an emerging health issue that needs to be further examined.

3.2 The Link between EDCs and Puberty

Uncertainties surround the impacts of endocrine disruptors on all body systems. However, scientists and researchers who work in this field believe that endocrine disrupting chemicals can cause abnormalities in pubertal development (Bergman et al. 2013). Through epidemiologic studies, evidence has found that EDCs can, "interfere with the production,

transport, metabolism, or excretion of naturally occurring hormones” (Den Hond and Schoeters 2006).

A review of the literature linking EDCs and puberty by Den Hond and Schoeters 2006 examined the known effects of endocrine disruptors on puberty. Den Hond and Schoeters discussed the trend in adverse reproductive effects on animals and humans caused by low-level chemicals in the environment. The main point from this discussion was that low-level exposure is found to cause more of an effect than previously expected, emphasizing the concern for chemicals in products. Next, the researchers described the following studies, exposure to PBB in a food cohort, accidental exposure to dioxin in Seveso, exposure to PCBs and DDT in Michigan, and the North Carolina Infant Feeding Study. Disasters sites are usually the main location for epidemiologic studies aimed to determine the relationship between a chemical and a health outcome, due to the unique environment that lack confounding variables. With the emphasis on both low-level chemical exposure as well as disasters, the authors managed to evaluate both extremes of exposure and connect them to precocious puberty and premature menarche.

Another review article by Roy et al. 2009 examined the impacts of endocrine disruptors in the human body. Multiple types of EDCs such as DDT, dioxin, BPA, and PBB are believed to be linked to early menarche or thelarche. During puberty, the endocrine system is vulnerable to external factors that can affect the development and function of body systems. This review article was a detailed analysis of the current literature on the signs of precocious puberty, the potential sources and system pathways, and the health effects in pubertal girls.

Colón et al. 2000 conducted a study in Puerto Rico in response to the high rates of thelarche in young Puerto Rican girls. The annual incidence rate in girls 6-24 months was eight cases per 1,000 live female births. Through this study, the researchers aimed to examine the

specific mechanisms and sources of chemicals. The researchers analyzed 41 serum samples from girls who experienced thelarche and 35 control samples to determine potential chemical sources. No pesticides or their metabolites were found in the thelarche serum. However, very high levels of phthalates and their metabolites were found. Through this study, the researchers discovered a possible link between phthalates and thelarche.

Another study investigating the relationship between EDCs and pubertal stages in adolescent girls was Wolff et al. 2010. Their methodology focused on measuring three chemical classes of urinary biomarkers (phenols, phthalates, and phytoestrogens) in adolescent girls and examined the association with breast and pubic hair development. The results found that 30% of girls had breast development and 22% had pubic hair. High molecular-weight phthalates were weakly associated with pubic hair development and a positive trend was observed between low molecular-weight (MWP) phthalates and breast/pubic hair development. Low MWP were higher in African Americans and Latinos than in Caucasians and Asians.

Lastly, Kay et al. 2013 conducted a review of the literature examining the link between phthalates and reproductive health outcomes in epidemiologic and animal models. The section on puberty was selected for content. Young women were found to have greater exposure to phthalates than men of the same age. Additionally, seven studies on the reproductive impacts of phthalates were examined. From the seven studies, one found no effect, two connected increasing concentrations with premature thelarche, and the remaining four found a weak to no association between exposure and breast development. Overall, the studies discussed follow the trend in EDC literature, results are extremely conflicting and it is difficult to parse out what sources lead to health outcomes.

3.3 Menarche Differences between Races/Ethnicities

The difference in age of menarche between races/ethnicities has been well established. Through numerous studies, Black women have been found to have earlier menarche than White women (Reagan et al. 2012) (Teilmann et al. 2002). The drivers behind the difference in age of menarche have not been fully determined, and a combination of social, economic, and environmental variables may be the cause.

One seminal study by Reagan et al. 2012 tried to account for the difference in menarche between adolescents by examining the causal effect of social and physical factors (BMI, birthweight, maternal age of menarche). The methodology surrounded collecting data on age of menarche and contextual variables. Their analysis determined that the difference in age of menarche accounted for only 39% of the factors examined (or 2.52 months in the 6.5-month difference) and 61% remained unexplained. The researchers did not account for the influence of environmental or product-based toxicants, which could potentially contribute to premature menarche or precocious puberty.

A review article by Teilmann et al. 2002 examined the literature on the effects of endocrine disruptors on pubertal development. The researchers discussed studies examining the difference in thelarche and menarche between Black and White adolescents. It was determined that the mean age for breast stage 2 (using the Tanner stages of a well-known scale that defines physical sex characteristics for males and females) was 8.87 years for Black teens and 9.96 years for White teens. In addition, the average age of menarche for White adolescents was 12.88 years, while Black adolescents had an average age of menarche of 12.16. These differences were hypothesized to be caused by improvements in health, socioeconomic status, nutrition, and contaminants.

Lastly, an article by Schoeters et al. 2008 discussed burdens from abnormal pubertal development and the impacts on vulnerable populations. The authors described the social burdens on adolescent populations from earlier puberty due to higher risk of pregnancies, emotional stress, and compounding socioeconomic factors. Additionally, discussions surrounded the difference in reproductive health outcomes between races/ethnicities. Black and Latina girls are more likely than White girls to have their menarche before the age of 11. Taken together, women of color are experiencing earlier puberty from a combination of factors, and as a result they are burdened by negative social and health outcomes.

3.4 Linking Personal Care Product Use to Health Outcomes in Black Adolescents

Few studies have connected exposure from EDCs in personal care products to earlier menarche and puberty due to limitations in methodology and the scope of research. Data from these studies have conflicting results in terms of reproductive health outcomes.

A study by Buttke et al. 2012 used NHANES (National Health and Nutrition Examination Survey) data from 2003-2008 to determine the impacts from individual EDCs in consumer products on the age of menarche in Black and White adolescents. Using statistical tests to examine if there is a relationship, they determined that 2,5-DCP and environmental phenols were inversely associated with age of menarche. Comparatively, total parabens, BPA, triclosan, benzophene-3, total phthalates, and 2,4-DCP were not significantly associated with age of menarche. Overall, other than 2,5-DCP, the chemicals they examined did not have the impact on age of menarche that has been found in other studies. One large limitation of this research was the lack of focus on the interactive nature of chemicals.

Another study by James-Todd et al. 2011 focused specifically on exposures from hair care products and the impacts on the age of menarche for Black girls. Data were collected on the

use of hair oil, lotion, conditioner, perms, and age of menarche as adolescents. The results found that Black women who used hair products were more likely to reach menarche earlier than other racial/ethnic groups. Women who reported using hair oil or hair perms had an adjusted risk ratio of 1.4. This study managed to link product use, exposure, and reproductive health outcomes which is extremely difficult and absent from current endocrine disruptor research.

3.5 Data Gaps

Personal care products are one source of exposure that has not been historically included in racial justice discussions. Only a few studies have attempted to examine the impacts from low-level chemical product exposure on Black women. Research needs to be conducted to fully examine all sources of exposure, the interactive nature of chemicals, and the resulting health effects. Learning more about the connection between product use and health impacts is important to build a base of scientific evidence as well as inform potential interventions. In addition, the social, economic, and psychological contextual drivers behind product use is an understudied field and not much is known about the influences on Black beauty purchasing habits and product use.

4. METHODOLOGY

The current state of research surrounding product exposure is complex, incomplete, and contradicting. This mixed methods project had two distinct avenues: 1) use measurable indicators of product use to see if there is a relationship between chemicals in products and reproductive health outcomes and 2) examine the social drivers behind product use.

The data were collected from participants self-reporting on their reproductive health outcomes and product use. The only requirements for this study were that the women had to be of African descent, between the ages of 12 and 25, and they must have had at least one menstrual

cycle. An incentive was developed for the participants that if they completed the survey they would be entered into a raffle to potentially win a gift basket of healthy personal care products.

4.1 Recruitment of Participants: Black Women for Wellness

To recruit participants, Black Women for Wellness (BWW), a non-profit organization that works to promote the health and well-being of Black women and girls through health education, advocacy, and empowerment was contacted (BWW 2016). BWW has experience in this field through their Perfectly Natural program, community based research studying the impacts of chemicals in products on the health of hair salon workers.

Lashea Brown (Youth Organizer) and Jannette Flint (Director) assisted in recruiting youth from the BWW youth group as well as surrounding organizations that support and service youth in Los Angeles. The main recruitment strategy was going door to door to explain the project and the importance of this work. BWW was also recruiting for their reproductive justice program Get Smart B4 U Get Sexy. Recruiting together allowed us to both gain participants and further support for their reproductive justice work.

4.2 Additional Recruiting Avenues

In addition to recruiting with BWW, alternative avenues were taken. Recruiting took place through Peer Health Exchange, past Occidental College students who have completed their senior comprehensive project on topics relating to Black women, emails and social media posts to the entire student body, contacting cultural clubs, recruiting in front of Crenshaw High School in South Los Angeles, and word of mouth to friends and family. Overall, these efforts resulted in 25 surveys and 8 interviews.

4.3 Materials

On-line informed consent forms were primarily used to educate the participants of the procedures, potential risks and benefits of participation, the purpose of this study, and contact information for the researcher. The participants were notified that participation in this study was voluntary and that benefits or rights given to them would not be taken away if they did not complete the study. Additional materials consisted of a survey and an interview protocol.

4.4 Design and Procedures

Surveys were distributed to gain information about product use and reproductive health outcomes. The variables for product use were age at decision to start using personal care products, how many products were used each day before their menarche, and how often did they use products before their menarche. For reproductive health outcomes, menarche and puberty were examined (Figure 1).

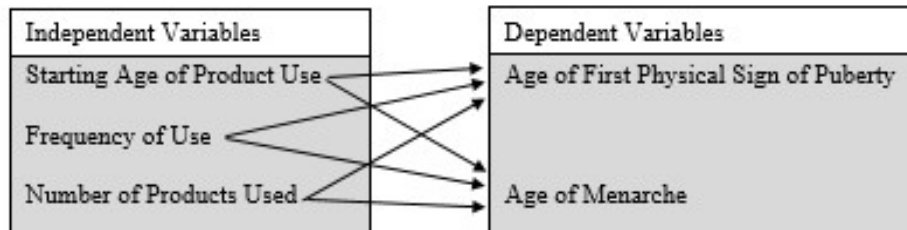


Figure 1: Diagram of Dependent and Independent Variables

Interviews were conducted with eight survey participants to learn more about their personal care product routine and the reasons for product use. Specifically, pressures and influences that may drive product use for participants were evaluated.

5. FINDINGS

5.1 Demographics

The target population for this study was women of African descent ages 12-25 years old. The vast majority (84%) of participants self-identified as African, African American, or African American mixed (biracial), and the remaining participants (16%) identified as Caribbean (Figure 2) (Appendix A). Additionally, even though the target population age range spanned almost 15 years, most participants were between the ages of 20 and 23. The computed range was between 17 and 25 and the average age was 20.4 years old. Participants were located across the country, but the majority lived in Los Angeles (17). The remaining participants lived in Washington, Pennsylvania, and New York.

5.2 Surveys: Connecting Product Use to Health Outcomes

A series of statistical tests were conducted to examine potential relationships between the independent and dependent variables and to compare averages between data sets. Linear regressions, simple ANOVAs, general linear models', and Kruskal-Wallis' were used for this study.

5.2a Relationship between Independent and Dependent Variables

The majority of tests examined if there was a relationship between a dependent and an independent variable using linear regressions. Linear regressions are used to give a numerical explanation of how variables relate, and allow for the prediction of dependent variables given independent ones (Marshall 2017). Specifically, regressions produce best fit lines which show the trend in data and R^2 values used to quantify the strength of the relationship.

5.2b Starting Age of Product Use

To examine if there was a relationship between the starting age of product use and the reproductive health outcomes a few questions were posed. The hypothesis tested was, if participants chose to start using products early, then their reproductive health outcomes (puberty and menarche) would be early. The linear regression for age of first physical signs of puberty had an R^2 value of 0.1841 and a slope of 0.3156 (Figure 3) (Appendix A). Comparatively, the age of menarche relationship had a smaller slope (0.0929) and a lower R^2 value (0.0447) (Figure 4) (Appendix A).

5.2c Number of Products Used

The number of products the participants used per day before menarche was another independent variable analyzed in relation to puberty and menarche. The hypothesis for this variable was, if participants used more products per day, then their puberty and menarche would be earlier. For the age of first physical signs of puberty analysis, the slope of the trend line was -0.1667 and the R^2 value was 0.0108 (Figure 5) (Appendix A). On the other hand, the slope of the best fit line for the age of menarche analysis was 0.2857 and the R^2 value was 0.0875 (Figure 6) (Appendix A). One interesting finding was the negative slope for the starting age of puberty trendline, while the menarche trend line was positive. In addition, the R^2 value for age of menarche was larger than age of first physical signs of puberty. This independent variable was the only one analyzed with different directional trends between reproductive outcomes.

5.2d Frequency of Product Use

Frequency of product use required a one-way ANOVA test because it was discrete and categorical variable. One-way ANOVA tests detect the difference in means of three or more independent groups (Marshall 2017). The hypothesis for this test was that if participants

used products more frequently, then their puberty and menarche would be earlier. The multiple-choice options (the categories) for the frequency question in the survey protocol were, 2-3 times a week (column 1), 4-6 times a week (column 2), Daily (column 3), Every Few Weeks (column 4), and Rarely. Figures 7 and 8 refer to frequency of product use and age of puberty (Appendix A). Figure 9 and 10 refer to frequency of product use and age of menarche (Appendix A).

From the ANOVA, the differences between the means (age of puberty or menarche) of the four categories were analyzed. Column 4 or “Every Few Weeks” had the lowest average age of puberty and menarche out of the four categories. However, there was only one individual (count) in this category. Excluding column 4, as the frequency of use increased, the age of first physical signs of puberty and menarche decreased (from 2-3 times a week to daily). The p-value for the age of physical signs of puberty analysis was 0.905225. Comparatively, the p-value for the age of menarche analysis was 0.510898.

5.2e Product Analysis

In addition to analyzing the independent variables related to product use, it was important to look specifically at the products the participants used around the time of their menarche and puberty. GoodGuide and the Environmental Working Group’s Skin Deep Database were used to gain information about the potential health concerns of ingredients in products. The majority of products that the participants used were located on these websites. However, in some cases where the participants did not specify the exact product name, the product was excluded from the analysis. After identifying the products that contained endocrine disruptors, the total number of products were totaled per participant (Table 2) (Appendix A).

As done in the previous relationship analyses, a linear regression was analyzed. Scatter plots were created to show the number of products with EDCs versus the starting age of puberty

and age of menarche (Figure 11 and 12) (Appendix A). The hypothesis for this relationship was if participants used more products with endocrine disrupting chemicals when they were younger, then their reproductive health outcomes would be earlier. The slope of the best fit line for the first physical signs of puberty analysis was 0.1 and the R^2 value was 0.0173. On the other hand, for the age of menarche analysis the slope of the best fit line (0.0153) and the R^2 value (0.0021) were lower than the values of the previous relationship.

5.2f Relationship between Independent Variables

The last variable analysis conducted was to determine if there was a relationship between the predictors and the health outcomes. A general linear model (GLM) was used for this purpose. GLM's look at a series of independent variables and examine how they interact and if they affect the dependent variable (Marshall 2017). Two separate GLM's were run: the first included age of menarche as an independent variable and looked at the impact on the start of puberty (Figure 13) (Appendix A), and the second included age of puberty as an independent variable and menarche as the dependent variable (Figure 14) (Appendix A). Including the age of menarche and age of first physical signs of puberty in each test were the controls. Theoretically, those relationships should have low p-values (indicating a strong relationship) because they are related. Excluding the control variables, the independent variables examined were: number of products with endocrine disrupting chemicals, frequency of product use, total number of products used, age at decision to start using products, and stages of breast development. From the GLM output the most important results were column (1), which is an indicator of the trend in the data and column (2), which is the p-value.

There was only one significant p-value (indicated by the * which illustrates that was below 0.05) in the first physical signs of puberty analysis. This p-value (0.0159) was for the age

of menarche variable. The only other variable with a relatively low p-value was the Tanner stages of breast development stage 5. Within column 1 there were three positive trends, age of menarche, frequency of product use-every few weeks, and frequency of product use -2-3 times a week.

Column 2 in Figure 14 had a similar pattern, the only significant p-value was for the age of first physical signs of puberty (0.0185). However, as opposed to the first GLM, the second smallest p-value was frequency of product use-4-6 times a week (0.2536). In addition, in column 1 most of the trends were positive, except frequency of use-every few weeks and 2-3 times a week.

5.3 Age of Menarche: NHANES vs Study Participants

On top of examining the relationships between independent and dependent variables, the average age of menarche in this study was compared to the average age of menarche for participants in the NHANES data set (National Health and Nutrition Examination Survey). NHANES is a series of studies conducted each year designed to assess the health and nutrition of adults and children in the United States (“NHANES - National Health and Nutrition Examination Survey” 2017). For this analysis, the most recent available data from the survey section under the topic reproductive health was used (2013-2014).

A Kruskal Wallis test, which compares the means of two samples was used for this analysis (Marshall 2017). This test allowed for the difference between the data sets to be analyzed. The mean age of menarche for the NHANES data was 12.5, while the mean age for the participant data was 11.76. From the Kruskal Wallis test the p-value was 0.005189134 (Figure 15) (Appendix A).

5.4 Interviews: External Drivers of Product Use

Women of color are more likely to use products containing endocrine disruptors than other races (T. M. James-Todd, Chiu, and Zota 2016) (Black Women For Wellness 2016). Treatments such as perms can result in hair loss or burns to the scalp (Etemesi 2007). These wounds can also potentially lead to the entry of endocrine disruptors, which can be in the treatments themselves or in additional products (Kessler 2015). From this knowledge, the hypothesis was created that increased exposure to Black women is due to increased product use. It was also hypothesized that the higher rates of product use are the result of American standards and ideals of beauty that do not include African features, skin tones, or hair texture. These hypotheses guided the interviews and analysis.

To analyze the interviews Dedoose, a web application for mixed method and qualitative research was used. With this program, each transcribed interview was coded based on code words generated to reflect the main themes of the interviews (Figure 16). The codes were organized into “parent codes” and “child codes”. The parent codes were used as organizing codes and they reflect large overarching themes prevalent throughout the interviews. The child codes were subsets of the parent codes and they went into more detail about the parent code topic. The parent codes were: Hair, Influences, Product Use, Transformation, and Self-perception.

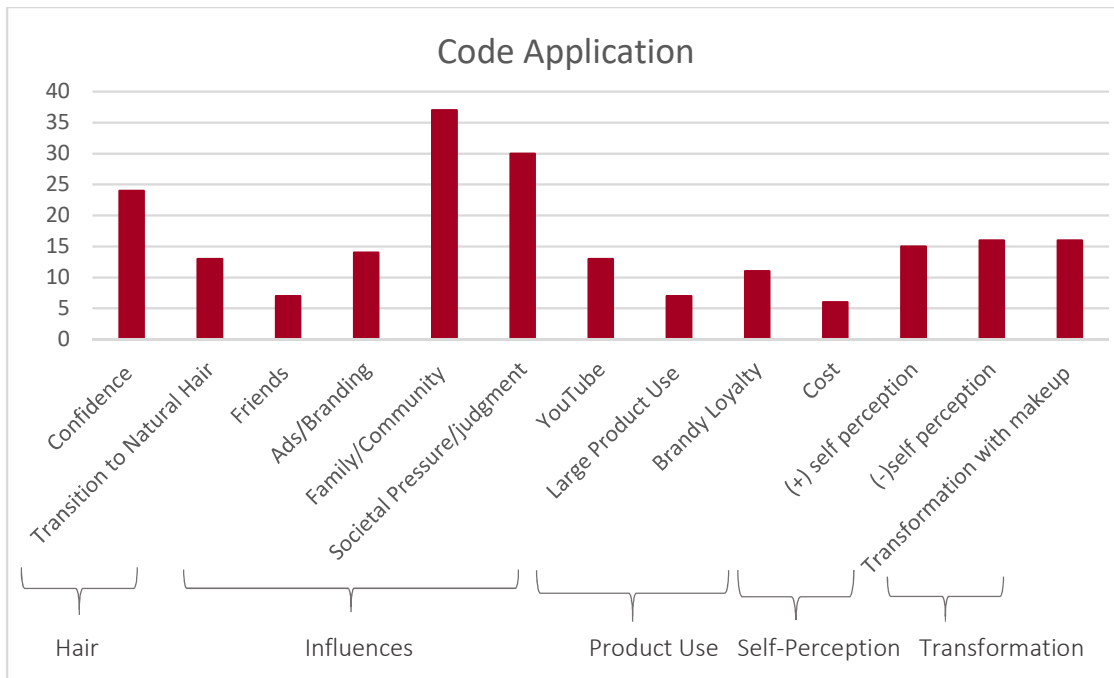


Figure 16: Code Application Chart

5.4a Hair

Hair was one of the central themes in all eight interviews. Regardless of the question the conversation always made its way back to not only hair products, but also how hair was central to the participants' identity. These discussions surrounding what their hair means to them broadened not only the understanding of hair as a main defining physical feature, but also how it relates to their personality and views of self. Seven out of the eight interview participants currently have their hair natural (styled in braids, locs, or natural curls without chemical treatments). In addition, six out of the eight participants relaxed their hair when they were younger and have transitioned to natural hair. Within the parent code of hair, there were three child codes: Confidence, Identity, and Transition to Natural Hair.

Confidence

The theme of confidence was present 20 times total throughout seven interviews. Even though this theme was central to the interviews, many participants did not themselves use the

word confidence. In fact, only one participant chose to use the word confidence to describe her definition of personal care products. Participant 1 went into how, “Hair is definitely confidence. It is pretty common among Black women, they do stuff to their hair. Whether it be natural, straightened, in a weave or wig, Black women do a lot of stuff to their hair, it has been a big political and cultural issue within the Black community.” The six participants that transitioned exuded a positive confidence and had positive views towards their current hair. From interviewing these women, it was clear that hair was not just a physical attribute, it was deeply engrained and intertwined with their views of themselves.

On the other hand, it was quite clear that many of the participants did not always have these feelings towards their hair. Seven out of the eight participants had at least one story regarding negative statements or feelings about their hair, mostly about wash day (many Black women do not wash their hair every day, many often only wash it once a week or once every two weeks). The impact of these views on their self-confidence was apparent as Participant 6 explained,

All my friends were Japanese when I was younger, so they did not really get my skin or my hair...so I feel like I internalized a lot of things, so I tried to be so much like them, I wanted straight hair. They washed their hair every day or every other day, so I feel like that might have influenced that too. They didn't really have to say anything, I knew I was different.

Self-confidence was clearly linked to the participants' hair and their positive and negative experiences with their hair.

Transition to Natural Hair

One unique discussion surrounded the participants' transition to natural hair and their natural hair care journey. The theme of transition to natural hair was mentioned 14 times throughout six interviews. Eighty-three percent of the participants viewed transitioning as a positive experience that has resulted in healthier hair. This view was supported by Participant 4's

statement that, “I just realized if I wanted to straighten it, it would be healthier to have a weave or extensions.” However, Participant 5 was not completely comfortable with her hair and she explained, “Hair is hard, I cannot find anyone with my exact hair, so I don’t do natural hair I just straighten it all the time.”

Hair was one of the most prevalent themes throughout all of the interviews. Not only did the participants discuss their hair routine and how they take care of their hair now versus when they were younger, the interviews always evolved past the physical transition and began to go deeper into how hair relates to their confidence and identity.

5.4b Product Use

Often the hair discussions naturally transitioned into product use and the role of products in their routine. Through these interviews, the participants’ preferences regarding what they look for in products, if they have a favorite product or brand, and cost were discussed. In general, Black hair requires the use of hair oil (also known as pomade and grease) to stay moisturized, and all the participants mentioned using at least one oil product for their hair type. Within the parent code of Product Use there were three child codes: Large Product Use, Brand Loyalty, and Cost.

Large Product Use

The theme of large product use was mentioned seven times in four interviews. All four of the participants stated that most of their products were for their hair. Specifically, eighty-seven percent of the conversations on product use surrounded experimenting to find products that work for their hair or using a lot of products for the LOC (liquid, oil, cream) hair method. Participant 5 explained how, “I probably have spent thousands of dollars on hair products, and I still don’t

know.” From these conversations, it became clear that the participants’ large product usage was the result of hair care products.

Brand Loyalty

Another common theme throughout the discussion surrounding product use was the participants’ favorite brands and their brand loyalty. The most common favorite brand was SheaMoisture, a previously Black-owned company that grew out of a family’s experience selling shea nuts at a village market in Sierra Leone. The theme of brand loyalty came up 11 times in all eight interviews. The participants stated that their support for SheaMoisture came from the variety of products they have for women with different hair types. Another common sentiment was that they were supportive of brands that were Black-owned or operated. As Participant 8 explained, “I thought it was really cool that when I started using them they were Black-owned.” A couple of the women stated that they would spend more for products or try new products from a brand that they had previously used or supported. This support in a brand and in their products stemmed from past experiences. As Participant 2 commented, “it’s my favorite brand because it works.”

Cost of Products

Products catered to women of color are found to cost more than other hair products. SheaMoisture products cost around \$6.00-\$15.00 and the brand’s product volume is smaller than other brands that cost less. For example, the SheaMoisture Raw Shea Butter Moisture Retention Shampoo costs almost \$9 for 13 fl oz. at Target, while the Pantene Daily Moisture Renewal Shampoo costs \$7 for 29.2 fl oz. This price trend can be found among many natural products catered to women of color.

Cost was mentioned six times in five interviews. The participants that mentioned cost stated that they would be willing to spend more and they have spent more on products that work particularly well or cater to their hair type. Some products mentioned were: Redken Diamond oil (\$32), CHI Silk Infusion (\$18.99), and a variety of SheaMoisture products. All five women expressed that even though these products are expensive, it is worth it to spend money if it works. Participant 7 expressed this sentiment in her statement, “I think as I got older I became more interested in finding products that worked specifically for my hair texture, and I have found these products to be more expensive.”

Product selection and use were very important considerations for all the participants. The conversations surrounded what they purchase products based on and the importance of the certain factors in their decision to buy products. What became evident throughout these conversations was that these women were willing to try out and spend money on products to find what works for them.

5.4c Influences Driving Product Use

The theme of influences and what has prompted product use among participants was another central theme. As mentioned in the hypothesis, these interviews were conducted under the assumption that product use is propelled by ideals of beauty, but through these conversations it was discovered that there was much more nuance behind the contextual drivers. The child codes within Influences were: Family/community, Friends, YouTube, Ads/branding, and Societal Pressure and Judgment.

Family/Community

The participants’ choices of products, brands, and hair styles were influenced by their family and their close community. This theme was brought up 37 times in all eight interviews. It

was one of the few codes mentioned in all interviews, and it was mentioned the most number of times.

When asked about their first memory of buying or using personal care products, six of the women told stories about either using their mother's, sister's, or grandmother's products or going shopping with them. Participant 3 explained how her product choices were guided by her mother, "my mom uses this coconut St. Ives Shea Butter Lotion and I've been always using it." This response was also expressed by Participant 5, "I would have to say my favorite brand in Nivea, my mom got me on it." Additionally, five women discussed their desire to perm or straighten their hair to look like their mothers.

Family and community were also mentioned in the context of puberty. Sixty-two percent of the time when puberty was mentioned it was concurrent with comments about their family or their families influence. Five of the women explained how when they began puberty, their families were usually the driving force to start shaving or using deodorant. Participant 6 expressed this sentiment, and explained how she didn't start using deodorant until a comment from her father, "I started using deodorant in 6th grade... my dad told me I needed it."

Friends

Growing up friends play such an influential role on decisions and interests. For this reason, it was believed that they would be a considerable influence in terms of product choice or decisions for the participants. However, the theme of friends was mentioned the least number of times compared to the other main influencers, it discussed seven times in five interviews. Two participants commented on feeling separated from their friend group growing up due to differences in physical features.

The Role of YouTube

An unforeseen influence was the role of YouTube in the participants' product choices and actions. A question about the role of naturalistas on YouTube was not included in the survey protocol until the third interview after it was brought up multiple times in previous conversations. Overall, the theme of YouTube was brought up 13 times in six interviews.

Five of the six participants who transitioned connect their decision to naturalistas and YouTube videos. These videos showed participants how to style and wash their hair and how to create their own hair regime. Participant 8 explained how she began her transition and the role of YouTube, "I started my natural hair care journey when I came to Oxy. I saw on social media and YouTube girls with really cute afros and I thought maybe I could do that, and from there I started watching YouTube videos." This view was also affirmed by Participant 6 who stated that she began watching videos featuring mixed/African girls with straight hair and when they went through their natural hair care journey, it felt like she was going through it with them.

The other role of YouTubers as an influencing force was in product choices. Six of the participants stated that they would pay attention to a recommendation from a naturalista that they follow on YouTube. However, all of them did say that they would need more than one recommendation to actually consider the product. Participant 3 explained this concept further, "now there are a lot of people who do marketing for specific products for companies and I try to stay away from those because I think they are being honest, but I don't know if they are being honest or they are getting a benefit from a company."

Ads/Branding

In this era of social media, people are constantly bombarded with ads and recommended posts from companies that may appear to be actual recommendations. Even though many of the

women were willing to listen to recommendations from naturalistas, they were wary of discrete advertising or promotions from companies. These conversations brought up the role of advertising or branding in product decisions (branding: how the company brand their products and themselves). This theme was mentioned 13 times throughout seven interviews. Only a couple participants seemed influenced by ads, when asked why Glossier was her favorite brand, Participant 1 replied, “it’s sheer marketing I swear.” She proceeded to discuss how she first saw their ads on social media and was prompted to go to their blogs to read more. Participant 6 stated that ads in Seventeen Magazine influenced her purchasing habits when she was younger. On the other hand, branding appeared to play more of a role in decisions and the participants discussed their favorite brands and why they supported certain companies.

Societal Pressure/Judgment

The theme of societal pressure and judgement was prevalent throughout the interviews. Specifically, participants experienced a large amount of pressure or judgement regarding their personal care product choices or how they should look. Societal pressure and judgment was mentioned 27 times in all eight interviews.

Two participants mentioned that when they were younger they felt pressured to wear makeup or products that made them more attractive. Participant 3 explained that she felt cosmetics were related to self-esteem more when she was younger and that she tried to do stuff for attention. She went on to elaborate that, “I felt like when I was younger I was more self-conscious about what I wore, what I put on my skin, and if I did my eyeliner a certain way would I get more attention.” Participant 5 also felt a need to wear cosmetics for attention when she was younger and explained that the initial reasons for wearing makeup were for boys in 6th grade.

Family was not the only pressure that these women experienced regarding personal care product use during the start of puberty. Another large driver was societal views and “standards” of what women should look like and what they should do to their bodies when they enter puberty. Participant 3 further explained the pressure felt when she entered puberty,

At this age, you become more self-aware about your body, and also when you are younger you become more aware of what puberty means and think that oh I should wear makeup and deodorant and stuff like that. You’re kind of trained in a way to think that when you hit puberty you need to shave your legs, but you don’t need to, you do it cause you want to.

Participant 5 also expressed this feeling by stating that she was a tom boy when she was going up until 6th grade when she felt she needed to look a certain way.

The last common experience surrounding judgment was negative comments or attitudes towards wash day or hair products. Weekly/bimonthly wash days are different from many Americans current routines, and conversations arose between the participants and individuals who found this routine weird or gross. Seven out of the eight participants had at least one story of experiencing negative comments towards their hair. Participant 4 explained how she used to tell people that she put oil in her hair and they would comment, “why would you do that, that makes it oily, and why do you not wash your hair every day?” She went on to talk about how now in college she only talks about wash day to people who she thinks can relate, and if someone asks about it she avoids giving details. Participant 1 had similar experiences and went on further to explain why she felt that way, “we were taught that the standard for society is thin, straight hair—so it has to be treated differently. Things were honestly invented for White people, so when things don’t apply to us we’re considered the weird ones, even though we weren’t considered.” It was clear from these conversations that all participants felt judged for their decisions that were best for them.

From these conversations, the magnitude of judgement and pressure these participants have faced were brought to light. These conversations were particularly important to learn more about the role of society on the participants' views of themselves and their product selection.

5.4d Transformation: Makeup

Other than puberty, another prominent transformation that was present in the interviews was the transformation that comes with makeup. Conversations surrounded if the participants liked using cosmetics and if they felt like their self-esteem was connected to makeup (both now and when they were younger). Out of the eight interviews conducted, all eight participants discussed their relationship with cosmetics.

Participant 7 was the only women who did not wear or own any makeup. She stated that she has no interest in beauty products and she actually dislikes the transformation that comes with makeup.

The majority of conversations fell into the category of wearing makeup only for certain occasions. Six participants stated that they wear makeup now for a night out, dinner with friends, concerts, clubs, interviews, and other special events. Supporting this, they all spoke to the fact that they have never worn makeup every day to work or school. When asked if they feel like makeup is related to their self-esteem, they all responded that they do not think so, but makeup does make them feel fancy or special. Participant 1 explained why she has these views, "when I dress up to go out and I wear makeup I feel fancy and I want to take pictures. I wouldn't say its self-esteem, but it feels special when I wear it. It is kinda how my mom always wore it."

Participant 6 had similar opinions and stated that she wears makeup to enhance her features.

Participant 5 was the only women that said she wore makeup more frequently than special occasions. However, wearing makeup multiple times a week was not connected to her

self-esteem and she explained that makeup enhances her features. She went on to explain that she had a positive self-esteem before she started wearing makeup, but as she grew up she became more confident wearing makeup. These conversations dove deeper into the participants' relationship with makeup and if they believed it was connected to their confidence.

5.4e Positive and Negative Self-Perceptions

The culmination of influences the participants experienced growing up resulted in differing self-perceptions at different points in their lives. To separate these experiences, they were grouped between positive and negative self-perceptions. Positive self-perception referred to moments when participants were confident in who they were (physically) and with their actions regardless of other individual's judgements or beliefs. On the other hand, negative self-perception referred to when participants questioned either something about themselves (physically) or their actions, either because they were not confident or they have faced ridicule that has impacted their views. Both these terms and definitions were created to explain a concept and a trend in the data. By no means does this label indicate that the women have a negative self-perception or self-confidence in themselves, the aim was to merely identify certain instances that may reflect moments of negative or positive self-perception.

Stories, comments, or statements related to positive self-perception occurred 15 times throughout all eight interviews. Ninety-three percent of the time positive self-perception was mentioned was concurrent to conversations surrounding their perceptions of themselves without makeup. The remaining times the code Positive Self-Perception was used was in relation to their current experiences with their natural hair.

In comparison, negative self-perception was brought up 16 times in seven interviews. Eight-one percent of the time this code was used was in relation to experiences the participants

have faced regarding their hair and negative social judgement. More specifically, discussions surrounding negative self-perception revolved around stories about the participants' hair when they were younger.

It was very interesting to explore the different experiences related to positive and negative self-perception for the participants. Through the conversations, it appeared that both these codes were connected to specific actions or experiences throughout the participants' lives.

6. ANALYSIS

Through the findings, data from numerous statistical tests and interviews were described. The purpose of data collection was to delve into a relatively new and controversial field that hasn't fully explored the idea of product exposure as a racial justice issue. The analysis aimed to explore the data further to examine the potential reproductive justice burdens that Black women face and the potential contextual drivers behind product use from Black women. Due to limitations, the statistical tests did not result in many significant relationships, and the bulk of the innovative findings were through the interviews.

6.1 Connecting Product Use to Health Outcomes

There is little to no data on the impacts of chemical exposure on reproductive health outcomes through a similar survey protocol using variables to examine product use. Therefore, no available data was found to compare the findings of this study to. However, there is evidence that grant funders are interested in examining this issue in-depth ("Community-Drive Pilot Studies To Explore Racial/Ethnic Disparities in Consumer Product Availability and Use" 2017). As a result, a brief analysis of the notable relationships, a description of the limitations, and the potential improvements for future studies were produced. An in-depth analysis of the results from the statistical tests can be found in Appendix B.

6.1a Relationship between Product Use Variables and Reproductive Health Outcomes

The relationships between the product use indicators and reproductive health outcomes were relatively weak and insignificant (Figures 3-12) (Appendix A). Out of the eight relationships examined, the strongest was between starting age of product use and age of first physical signs of puberty. The remaining relationships did not have notable statistical values. However, in seven of the eight linear regression relationships the trend in the data supported the hypothesized trends. Overall, most of the data supported the predicted trend that increased product use would result in decreased age of reproductive health outcomes.

Examining the relationships between all the independent variables and the health outcomes resulted in two significant relationships (Figure 13 and 14) (Appendix A). These associations were both the controls, which were included to demonstrate there was a relationship between two variables that are known to be connected, age of puberty and menarche. The remaining variables did not have significant effects on the health outcomes.

Comparing NHANES Menarche to Study Participants

Age of menarche is not a static figure between races/ethnicities, it is well established that Black women have earlier menarches than other races. For instance, Black adolescents are found to have their menarche on average 6.54 months before White adolescents (12.2 years compared to 12.9) (Reagan et al. 2012). In addition, women of color are more likely to have their menarche before age 11 than White women (Schoeters et al. 2008). These figures indicate that women of color are more likely to have premature menarche and precocious puberty than other races.

The statistical analysis between the average age of menarche for the NHANES data set and study data set resulted in a significant relationship (Figure 15) (Appendix A). This relationship indicated that there was no similarity between the data sets, which was supported by

the fact that NHANES participants had their menarche on average 0.9 years after study participants (12.5 versus 11.76). This finding indicated that Black women in this study had earlier age of menarche than other races/ethnicities. However, due to limitations, this difference could either indicate that the data is skewed or it follows the knowledge that Black women have earlier menarche.

6.1b Limitations and Future Studies

The largest limitation on the statistical analyses was the sample size. This limitation made it impossible to determine if any of the relationships examined were significant or strong. Additionally, the impact of low-level endocrine disruptors on reproductive health outcomes may be minor, thus a larger sample size would allow for trends and relationships to be discovered that were hidden by the small sample size.

The lack of a cumulative analytical frame was another large limitation. Issues surrounding exposure from a chemical or group of chemicals are difficult to research due to multiple sources of exposure. Cumulative exposure was unable to be taken into consideration in this project due to time and the lack of an appropriate method to consider environmental, occupational, and product exposure.

Future studies should aim to resolve these issues and further analyze the potential relationship between chemicals in personal care products and reproductive health outcomes. The best method would be a longitudinal study that follows Black girls from the age of six to 16 and tracks product use and reproductive health outcomes. This study should also include biomonitoring and a product analysis to determine the exact chemicals in the products and the quantity of the chemical and their metabolites within the body. A cumulative study design should also be incorporated.

The limitations for the statistical portion of this project were significant. Even with these limitations, this study design was unique in its attempt to try to connect a specific chemical exposure to health outcomes through a survey protocol. Regardless of the limitations, this project managed to scratch the surface into alternative study designs that aim to address the connection between product exposure and health outcomes for Black women.

6.2 Impact of Influential Drivers

The origins of the large Black beauty market have been unexplored, and product purchasing may be the result of certain contextual drivers (social and psychological). Analyzing the interviews explored potential pressures and influences that may have impacted the participants' product choices and spending habits.

6.2a Top Contextual Drivers

Family as Influences and Role Models

Family was inexplicably linked to the participants' perceptions and choices. The influence of family is a well-researched concept and has been widely debated over in discussions regarding the role of nature versus nurture (McLeod 2007). This influence is clearly shown through a widely-circulated diagram in public health that illustrates health influences throughout the course of a life time (Figure 17). The beginning of this diagram can also be loosely applied to perception and views. By examining the findings, it was very apparent that family had influenced the participants' product choices and actions.

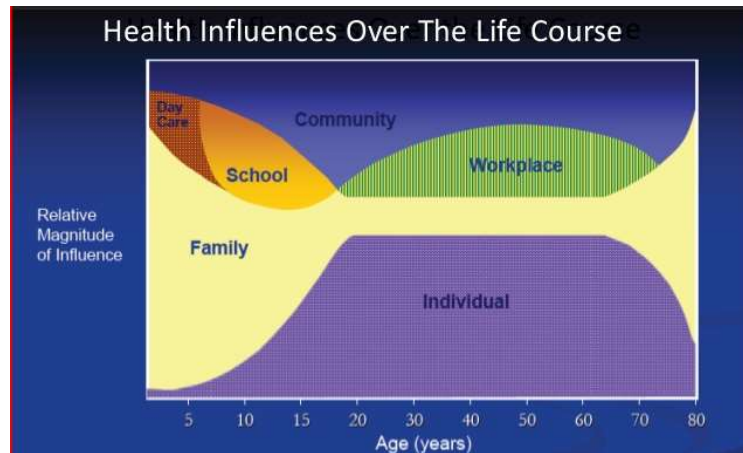


Figure 17: Diagram of Health Influences over Life (U.S. Department of Health and Human Services 2017)

All eight women cited their families as the reason they use certain products and it was clear that personal care product use was a family affair. This influence extended beyond products and it was noted that the participants' mothers were their primary role model and they mimicked beauty routines performed in their household. Five of the participants stated that they began to relax their hair because they saw their mothers with straight hair and they wanted to look like them. The participants' desire for society's standard of beautiful hair stemmed from non-verbal familial influences that the participants perceived when they were younger.

On the other hand, verbal familial influences did play a role in some of the participants' actions and perceptions. In the case of makeup and starting to use personal care products, family comments were the driving force in their actions. The conversations surrounded how their families told them that natural is beautiful and that they do not need to wear makeup. Verbal affirmations from their families have influenced their perception of themselves as well as their choice to not wear makeup every day. Comparatively, comments from their families about product use were the main reason they started using deodorant and other hygiene products. Examining both verbal influences side by side resulted in an interesting contrast, their families' influence led the women not to wear makeup, while at the same time led them to use certain

hygiene products. It was apparent that familial influence resulted in higher or lower product use depending on the product type.

Societal Pressure and Judgment

The contextual driver of societal pressure and judgment was also a clear influence on participant actions. The three main themes within societal pressure and judgment were: pressure to wear makeup, pressure to wear personal care product during puberty, judgement and pressure regarding hair.

Women of color have been found to “mask”, or hide physical features to present an improved appearance to society (Davis 2013). The motivations behind masking are to use it as a 1) mask, to enhance and bring attention to an individual’s appearance at a certain standard, 2) disguise, to hide, or impersonate a position that is more desirable, or 3) masquerade, to pretend to be someone or a part of some group that they are not (Davis 2013) (Tseñlon, Burton, and Crane 2014). As found in Davis 2013, it was believed that participants would participate in the disguise or masquerade portion of masking through makeup to portray more European features.

Surprisingly, the pressure to wear makeup was not a common sentiment expressed by the participants. This finding rejected the hypothesis that external pressure would result in participants feeling required to wear makeup. It appears that the influence from their families prevented the women from ever feeling required to wear makeup to fit in. The couple that did feel pressured to wear makeup to feel more attractive eventually altered their perceptions. Familial influence had a long-lasting impact on the participants’ views and choices that overshadowed some societal pressure.

A more commonly expressed feeling was pressure to wear personal care products during the start of puberty. This fits into the idea of using a “mask” to portray certain acceptable

attributes. For example, wearing deodorant and perfume to smell better to others. As a result of modern day media, women are frequently bombarded with manipulated images and expectations of the “ideal women” that have unrealistic physical attributes (Davis 2013). Even though the women now realize that they have the right to choose what they want to do with their bodies, as adolescents they felt required to conform to standards and wear certain personal care products for hygiene. If society did not focus so much on appearance and what women should look like after puberty, then hygiene related product use may not be amplified by social pressure.

One of the most prominent influences of societal judgment was regarding hair products, hair texture, or wash day. Eighty-seven percent of the participants had at least one story of individuals expressing negative comments towards their use of hair oil or wash day. Many of the participants thought it was incredible that people of color make up over half of the population and certain hair habits still thought of as gross. A couple participants also expressed annoyance and anger towards people touching their natural hair without asking. These negative views and experiences throughout their adolescent years have influenced their self-perceptions and it is believed to be one of the reasons that the participants began to perm their hair.

The last impact of societal judgment was the decision for participants to perm their hair when they were younger. This concept was not expressed explicitly by many of the participants, but it became evident as the conversations developed. In terms of the concept of masking this directly played into the idea of “masquerade”, where the participants perm their hair to fit into society’s ideals of beauty. Participants spoke about perming their hair to fit in with their friends. The combination of familial and societal influence resulted in many of the participants’ decisions to straighten and chemically treat their hair.

The Era of Social Media: YouTube

The most surprising influence was the role of YouTube and naturalistas in the participants' decisions and actions. Currently, social media and digital media platforms are used incessantly by younger generations. Social media may influence a number of decisions and actions, including anything from fashion to healthy eating. Through these conversations, two distinct avenues of influence were discussed: transitioning to natural hair and product selection.

Transitioning to natural hair is a major decision for any person of color who has been perming or relaxing their hair for an extended period of time. The reasons for transitioning are usually health related, either from chemical burns, hair loss, or frustration over weak and brittle hair (Etemesi 2007). Recently, with the explosion of the natural hair movement, more women of color are transitioning to natural hair. This process requires time, money for natural hair products, and trial and error to figure out a hair care regime. This combination of factors requires a large commitment from individuals who have been using chemical treatments on their hair from an extended period of time.

Discussions surrounding the participants' transition to natural hair exemplified the power and influence that social media has on decisions. It was astonishing to learn that over 80% of participants that transitioned to natural hair cited YouTube as one of the main reasons. Specifically, it was watching naturalistas go through their own personal hair care journey that inspired the participants to make the switch. Watching women with similar hair go through their personal transition was like watching someone they knew well. YouTubers and most celebrities on social media platforms connect with their audience as if they are a friend or peer. This phenomenon is known as para-social interaction (PSI), which has been used to describe feelings of friendship and closeness that people feel with celebrities that they have never met ("Parasocial

Interaction - Oxford Reference” 2017). This perceived interaction is found to be similar to many attributes of social interactions. It is specifically believed to arise from human instincts to form attachments with others (Giles 2002). This apparent closeness gained through watching videos made the participants confident and comfortable enough to make the transition.

Additionally, YouTubers were found to influence product choices. Participants were willing to consider recommendations for products from naturalistas they follow on social media. This trust again played into the idea of para-social interactions. The perceived connection between the YouTuber and the participants allowed them to trust their recommendations.

Social media was clearly an influence on decisions and product choices. It became evident that the participants were willing to make large decisions (transitioning to natural hair) as well as smaller choices (products) off the basis of a YouTuber’s actions or recommendations. It is believed to be the result of perceived interactions that viewers experienced when watching social media personnel for an extended period. The impact of social media on decision making is unique to younger generations, and its continued impact on product decisions will be interesting to follow.

Branding as the New Advertising

Companies are well aware of the importance of advertising to their success, and beauty and cosmetic companies spent 3.59 billion dollars in 2013 on advertising (Statista 2017). In terms of Black consumers, Procter & Gamble and L’Oréal, two large personal care products companies, spent the most money among companies on media towards Black audiences in 2011 and 2012 (Nielsen 2013). Together in 2012, the two companies spent around \$127 million on advertising to the Black consumers (Nielsen 2013). With the increase in social media use over

the past decade, companies have begun to use other platforms to distribute their ads to younger populations.

Through discussing the role of ads on purchasing decisions, it was apparent that many participants were not persuaded by ads and they were wary of discrete advertising or sponsored ads on social media. The fact that the participants were not persuaded by ads and even skeptical of YouTubers that they trust may explain why cosmetic brands are the largest spenders in advertising towards Black consumers.

Alternatively, the participants were more likely to be persuaded by branding. The participants support for a company originated from the companies values as well as prior experiences with products. It was found that if the participants were a fan of a brand they were more willing to purchase more expensive products than from other companies. Participants were aware of the values and priorities companies hold (if they oppose animal testing, Black-owned and operated, or focus on different hair types) and their purchasing was based off this branding rather than advertising. This concept of branding as the new advertising was notable throughout the findings. From these discussions, it was clear that the company values and branding were more influential than advertising in participant purchasing behaviors.

6.3 Self-Perception and Product Use

Participant self-perceptions were connected to various influencers or actions that they have experienced. Examining the coding scheme between the various interactions allowed for an in-depth examination of self-perception and what actions have positively and negatively impacted their views of their physical appearance. The strength of the overlap between codes were unequal, indicating that certain influences may be more connected to self-perception than others.

Merge Strength	Code 1 (Self-perception)	Code 2 (Action/influence)	Merge	Hypothesis
Low	Portrayed Confidence	Transition to Natural Hair	Both	Contradict
	24	13	7	
Medium/High	Positive Self-Perception	Makeup	Both	Contradict
	15	16	10	
High	Negative Self-Perception	Societal Pressure/Judgment	Both	Support
	15	23	11	

Table 3: Summary of coding overlap analysis between prominent themes. (Merge indicates the number of time both codes were used and merge strength compares the three merges.)

6.3a Transition to Natural Hair and Confidence

Use of chemical treatments was common for participants and 75% stated that they permed their hair for an extended period of time when they were younger. However, the influence from YouTube shifted their perception of their hair and all six of the participants that permed their hair transitioned. Out of the 15 times the transition to natural hair was discussed almost 50% of the time it was connected to confidence. In comparison, out of the 24 times confidence was mentioned, only 29% of the time was in combination with transition to natural hair. The coding analysis indicated that transition to natural hair had a stronger connection to confidence than confidence had to transition to natural hair. Overall, the coding overlap was not as strong as the other relationships examined, potentially due to the focus of the interviews on how they see themselves versus how their self-perception was portrayed as confidence.

6.3b Positive Self-Perception and the Role of Makeup

Through examining the contextual drivers behind product use, it was evident that many participants never have felt pressured to wear makeup. By analyzing the overlap, evidence for this finding deepened. One indicator that makeup was not used as a tool of confidence was discovered through analyzing the overlap between the code positive self-perception and makeup.

Out of the 15 times positive self-perception was mentioned, ten of the times it was concurrent to discussions surrounding how the women do not feel a need to wear makeup. This strong overlap was also present in the makeup code, out of the 16 times that the code makeup was used, over 62% of the time it was in combination with positive self-perception. The analyzed coding overlap was medium/high compared to the other relationships examined. From this, it was gathered that the women interviewed have a high self-confidence and self-perception of themselves without makeup.

It has been found that populations of Black adolescents are more accepting of their physical body than White adolescents who are strict in their perception of beauty and often are dissatisfied with their bodies (Parker et al. 1995) (Jefferson and Stake 2009). These self-perceptions are believed to be the result of being raised by strong supportive families and communities that embrace diversity. The strong support and positive affirmations the participants in this study received when they were younger resulted in a positive self-confidence towards their appearance that has endured even to this day. Supporting this, a few of the women went on to talk about Black girl magic and how proud they are of their melanin.

6.3c Negative Self-Perception and Societal Pressure/Judgment

The impacts of social drivers on product use were determined through examining the interaction between negative self-perception and social pressure. Out of the 15 times negative self-perception was brought up, 73% of the time it was in combination with societal pressure/judgment. However, out of the 30 times societal pressure and judgment were discussed, only 11 times were in combination with negative self-perception. This finding results in mixed conclusions, it can be claimed that negative self-perception was almost directly related to societal pressure/judgment, but the opposite may not be true. However, this coding overlap was the

strongest out of the three relationships, indicating the role of socially constructed ideals of beauty on the women's decisions.

The fact that there was a relationship between negative self-perceptions and societal pressure/judgment did not explain what factors or influences have resulted in negative self-confidence. The 11 times both codes were used was in relation to critiques that the participants experienced when they were younger about their product use, wash day, or perming/relaxing their hair. This finding indicates that negative comments about product use and their hair influenced their perception of themselves and in turn their actions.

This coding analysis resulted in an interesting conclusion. From the discussion on negative self-perception it can be claimed that when the participants were younger they used hair and hair products as a tool for confidence to emulate American beauty standards seen in the media. Now, as adults these women view their transition in a positive light and connected to their confidence. This alteration in their self-perception does not change the fact that hair was still connected to confidence. The change in their opinion of their hair was a unique finding from this study that reflected the participants changing views as well as the role of social influences on their perspectives.

Through analyzing the findings a few important conclusions were drawn (Figure 18).

- ✓ The largest influences on participant actions and choices were: family, societal pressure/judgment, YouTube/social media, and the branding of beauty companies.
- ✓ Positive self-perception was connected to natural beauty and their appearance without makeup
- ✓ Negative self-perception was connected to societal judgment and pressure, specifically from external judgments towards their hair or hair products

- ✓ Transitioning to natural hair was connected to confidence—this was a drastic shift from when the participants were younger and negative self-views were connected to their hair.

The analysis resulted in the conclusion that the culmination of pressures may account for increased product use among Black women by influencing their self-perceptions. Specifically, hair and hair products were the largest source of both judgment and exposure. Delving deeper into these conclusions in the future will be important to expand literature and research examining social drivers of product use on Black women.

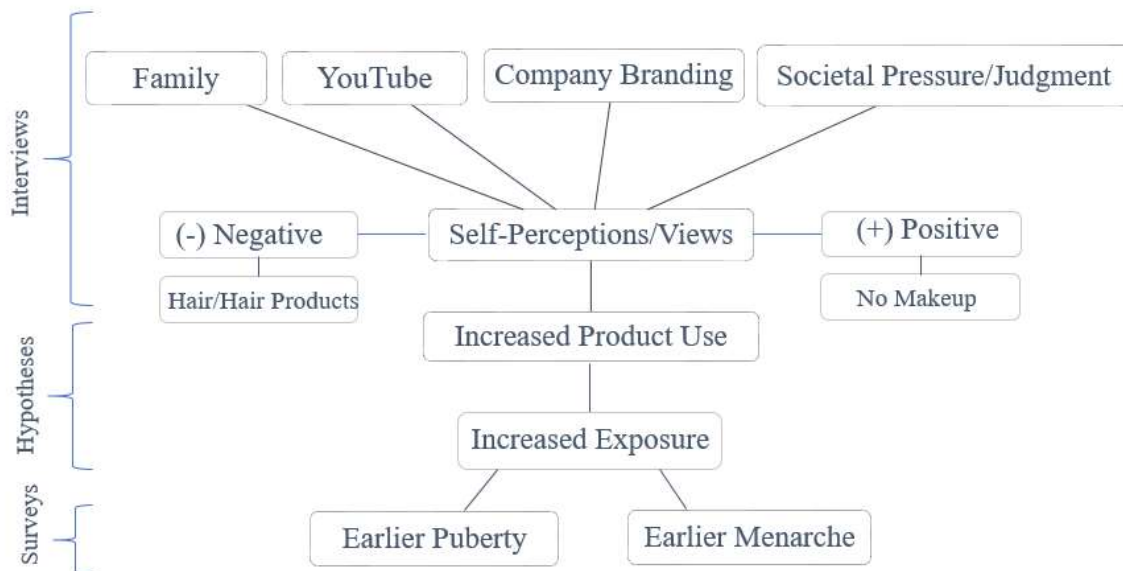


Figure 18: Exposure Diagram of Conclusions and Hypotheses

7. RECOMMENDATIONS

The issue of chemicals in personal care products and the reproductive health impacts is multifaceted. The culmination of weak regulations, a controlling chemical industry, and a large Black beauty market has resulted in a broken system where products with harmful chemicals are released into our consumer market. The addition of societal pressures and other large influences have resulted in increased product use in populations of color. Ultimately, addressing this issue will require a completely new regulatory system for testing and approving chemicals, the expansion of local, state, and national campaigns/programs, the creation of a social media campaign celebrating diversity, the establishment of a green chemistry fund, and the inclusion of product use in racial justice research and discussions.

The creation of an FDA regulatory and testing system modeled off Canada and the European Union

Canada and the European Union have developed systems built on the foundation of consumer safety that include ingredient disclosure, safety testing, and regulatory enforcement. Canada's system requires companies to disclose ingredients in products to ensure they are not found on a Cosmetic Ingredient Hotlist. In addition, Health Canada scientists monitor national and international studies for evidence of risks or harm from chemicals (Health Canada 2007). The European Union (EU) has created two regulatory systems for cosmetics and consumer products that work to locate a responsible party, research chemicals and products for evidence of harm, and increase transparency between companies and the public through reporting (European Commission 2017b).

A combination of components from the EU Cosmetic Directive, the EU REACH program, and Canada's cosmetic regulation would be ideal to develop a more effective and

protective system. Specifically, the following recommendations should be implemented by the FDA (A full explanation of the regulation recommendations in Appendix C).

1. Required product safety testing both from companies and an external FDA scientific review board
2. Creation of a cosmetic ingredient database
3. Creation of a cosmetic products notification portal
4. Implementation of a products market surveillance system
5. Structuring the system on the foundation of REACH (registration, evaluation, authorization, and restriction of chemicals).

Establishing this system that emphasizes consumer safety will require a large shift in both public perception as well as political focus.

Expansion of existing local, state, and national campaigns/programs to build a movement against toxic chemicals in personal care products

Local, state, and national campaigns are important to educate the public and change the narrative surrounding this issue. An expansion of the current campaigns and the creation of new ones (through funding and public support) is important to build a nationwide movement against chemicals in products by pressuring companies to eliminate ingredients as well as build support for a regulatory shift.

One of the most successful and notable national campaigns for safer products is the Campaign for Safe Cosmetics. Through their efforts, the Campaign has managed to change both the public narrative to demand alternatives to personal care products as well as hold companies accountable for the chemicals they use (Campaign for Safe Cosmetics 2016b). Thus far, the campaign has been successful and continuous biomonitoring has shown decreases in certain EDC metabolites throughout the US population which have been attributed to the campaign

(Calafat, Valentin-Blasini, and Ye 2015). Expanding and upholding this campaign through increased funding and public support will be vital to the success of the movement.

California has made important strides towards requiring ingredient disclosure from companies. The California Safe Cosmetics Program collects information about hazardous ingredients in cosmetics and disseminates it to the public through an on-line database. Programs such as this should be reproduced in other states and supported by increased state funding.

In addition, local campaigns have made huge strides towards protecting occupational health from chemical exposure. Through Black Women for Wellness' Sisters in Control Environmental Justice Program, the organization has empowered and educated local salon workers on the risks of exposure and ways to protect themselves (Black Women For Wellness 2017) . Their campaign is an example of a local non-profit that is organizing and educating their community about the serious potential impacts from exposure. Additionally, the Healthy Nail Salon Campaign fights to protect worker safety from exposure to toxics found in nail polish (California Healthy Nail Salons 2017). Through their efforts, the campaign has successfully created a series of Healthy Nail Salon Programs which reward salons that place worker and consumer health first.

Campaigns and programs have played a huge role in education and framing conversations surrounding chemicals in consumer products. Their continued efforts are imperative for the shift needed to transform how consumers see products and the regulatory system.

Nationwide social media campaign to incorporate diverse features and hair in beauty discussions

In addition to the introduction of a new regulatory system and the expansion of campaigns, there needs to be a general shift in society's perception of beauty. The creation of a nationwide social media campaign highlighting diverse features and how diversity is beautiful

would be an effective way to begin changing perceptions of beauty. Following the Humans of New York (a popular social media page telling the stories of New Yorkers) social media format would be an ideal structure to tell stories of the subjects and the experiences they have faced. There have been huge strides in this field with the growth of the natural hair movement on social media which has allowed many women to transition and embrace their features. Transforming discussions of beauty to include people of color will not only reduce exposure from personal care products, but also help increase the self-confidence of young Black women.

Creation of a national green chemistry fund

Regulating and limiting the chemicals permitted in personal care products is a part term solution. There also needs to be increased research and development into green chemistry, which focuses on designing chemicals to reduce or eliminate the use of dangerous chemicals (US EPA 2017). Creating a national fund run by an organization dedicated to expanding green chemistry for consumer products would allow for scientists and researchers to have a consistent source of funding regardless of the political atmosphere.

Inclusion of product exposure in racial justice analyses

Historically, racial justice has focused primarily on economic injustices and systematic inequity experienced by people of color (Equal Justice Initiative 2017). Consumer products are not usually included in cumulative racial justice analyses, which has allowed for this disproportionate burden to be excluded from race discussions. The integration of personal care product exposure into racial justice conversations would allow for a more holistic view of women of color's burden and experiences.

8. Conclusion.

Inequity in exposure from personal care products has been demonstrated, and evidence is building on the social and physical impacts on women of color. On an individual level, not much would be attributed to a woman of color having her menarche a few months earlier than a White woman. However, when examined in the context of an entire race this shift in earlier puberty and menarche is concerning. There needs to be recognition among researchers and activists that this is a racial justice issue that has distinct burdened populations. Resolving this issue will require an approach that combines policy, regulation, and efforts from local, state, and national community groups. Once there is an acceptance of the need for a cumulative and collaborative approach to this issue, new and innovative ways of examining exposure, evaluating the interactive nature of chemicals, determining contextual drivers, and most importantly protecting the health of Black women will develop.

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10. APPENDICES

APPENDIX A: Tables

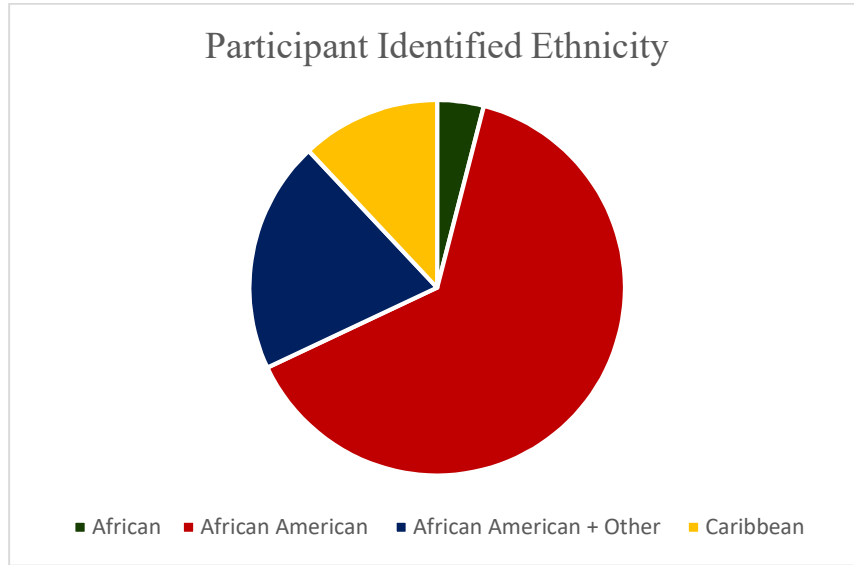


Figure 2: Participant Identified Ethnicity

Age at Decision to Start using Personal Care Products

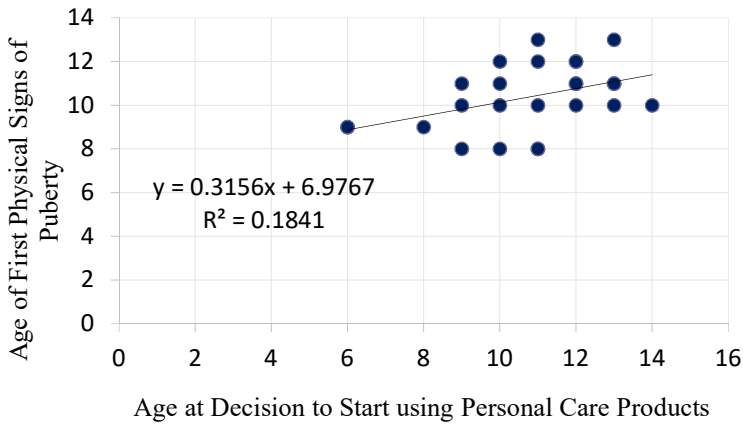


Figure 3: Scatter plot showing Age at Decision to Start Using Products vs Age of First Physical Signs of Puberty

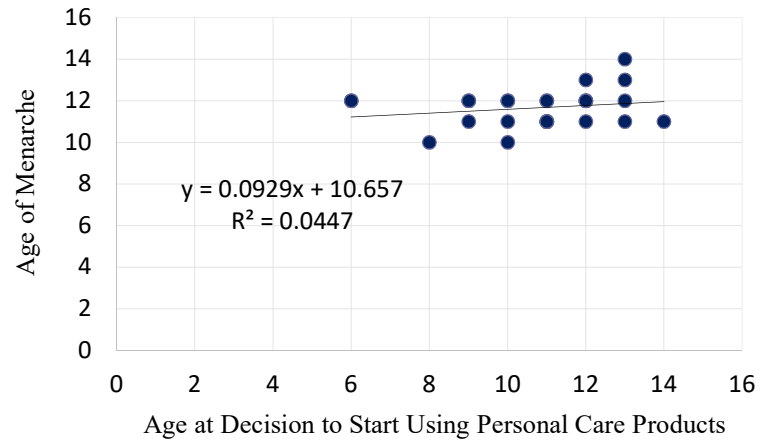


Figure 4: Scatter Plot showing age at Decision to Start Using Products vs Age of Menarche

Number of Products Used Per Day

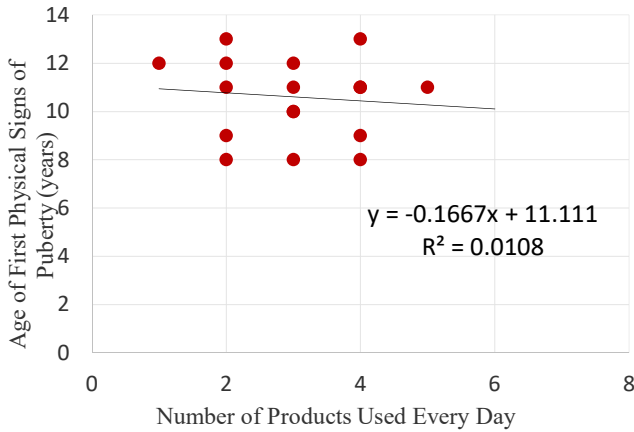


Figure 5: Scatter Plot of Number of Products Used Each Day vs Age of first physical Signs of Puberty

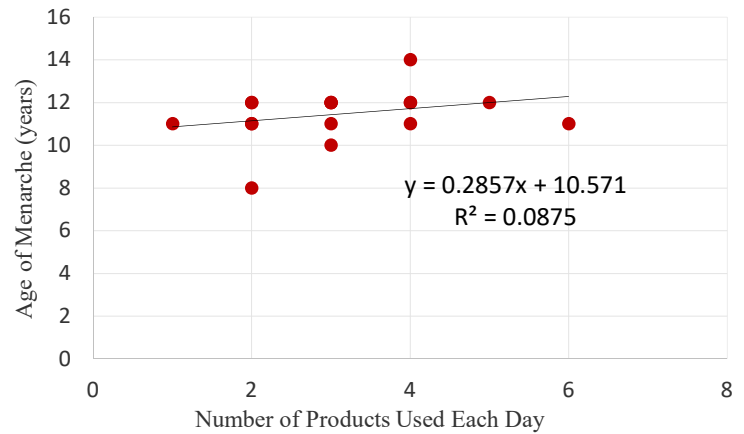


Figure 6: Scatter Plot of Number of Products Used Each Day vs Age of Menarche

Frequency of Product Use and Age of First Physical Signs of Puberty

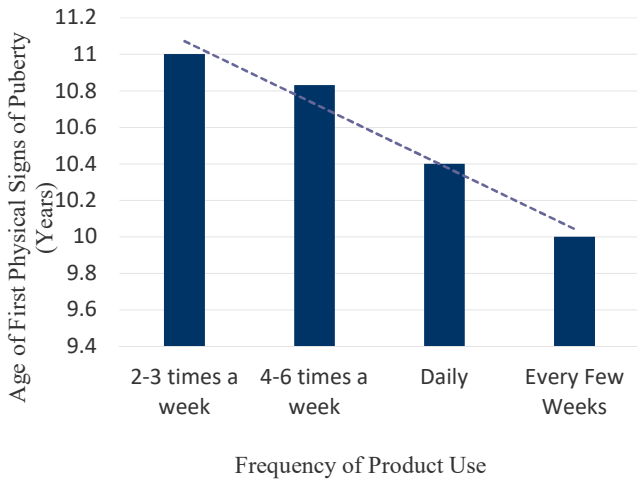


Figure 7: Averages of the First Physical Signs of Puberty for Categorical Frequencies

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	3	33	11	1
Column 2	6	65	10.83333	2.966667
Column 3	10	104	10.4	3.155556
Column 4	1	10	10	#DIV/0!

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1.566667	3	0.522222	0.184721	0.905225	3.238872
Within Groups	45.23333	16	2.827083			
Total	46.8	19				

Figure 8: The ANOVA analysis output for age of puberty

Frequency of Product Use and Age of Menarche

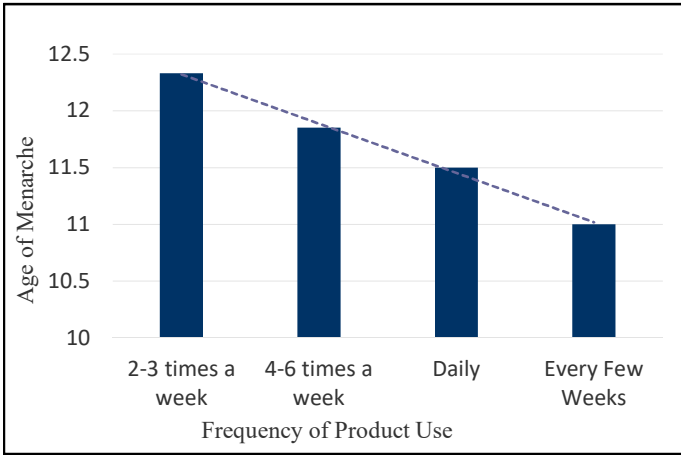


Figure 9: Averages of the Age of Menarche for the Categorical Frequencies

Anova: Single Factor

SUMMARY

Groups	Count	Sum	Average	Variance
Column 1	3	37	12.33333	0.333333
Column 2	7	83	11.85714	1.809524
Column 3	10	115	11.5	0.5
Column 4	1	11	11	#DIV/0!

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	2.261905	3	0.753968	0.799901	0.510898	3.196777
Within Groups	16.02381	17	0.942577			
Total	18.28571	20				

Figure 10: ANOVA analysis print out for age of menarche

Participant Products Containing Endocrine Disrupting Chemicals

	Participant Code																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Chemical Name	X							X												
Butylated hydroxyanisole	X																			
Cyclopentasiloxane																				
Benzophenone-2		X																		
Methylparaben		X			X	X						X	X					X		
Propyl paraben		X			X	X	X					X	X							
Ethyl paraben						X						X								
Tea tree oil						X														
Isobutylparaben												X								
Butyl paraben												X	X							
Acrylamide												X								
SD Alcohol 1												X								
Total EDCs	2	3	0	0	2	4	1	1	0	0	0	7	3	0	0	0	0	1	0	0
Total Number of Products with EDCs	2	4	0	0	1	4	1	1	0	0	0	8	1	0	0	0	0	1	0	0

Table 2: Number of Products with EDCs and the chemical name

Number of Products with Endocrine Disruptors

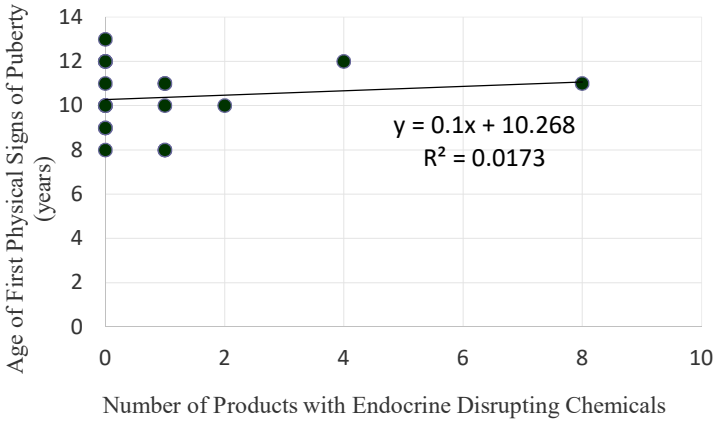


Figure 11: Scatter Plot of Number of Products with EDCs vs Age of first Physical Signs of Puberty

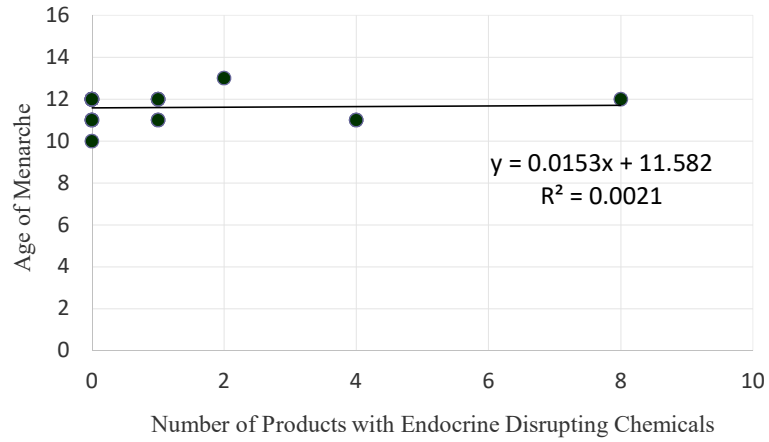


Figure 12: Scatter Plot of the Number of Products with EDCs and the Age of Menarche

Impacts of Multiple Independent Variables

Coefficients:	1	2	3	4
	Estimate	Std. Error	t value	Pr(> t)
Age of Menarche	2.7462	4.5597	0.602	0.5660
# of EDCs in products	1.1366	0.3594	3.162	0.0159 *
Starting age of product use	-0.2412	0.2796	-0.863	0.4168
# Products per day	-0.2218	0.2057	-1.078	0.3166
Breast Development: Stage 3	-0.4968	0.3383	-1.469	0.1854
Breast Development: Stage 4	-0.5301	1.3092	-0.405	0.6976
Breast Development: Stage 5	-1.9161	1.5958	-1.201	0.2689
Frequency of use: few times a week	-2.8950	1.6550	-1.749	0.1237
Frequency of use: 2-3x a week	0.5703	1.5373	0.371	0.7216
Frequency of use: 4-6x a week	0.4819	1.0532	0.458	0.6611
	-0.8999	0.7762	-1.159	0.2843

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Figure 13: GLM output examining relationship between independent variables and first physical signs of puberty

Coefficients:	1	2	3	4
	Estimate	Std. Error	t value	Pr(> t)
Age of Menarche	3.4515	2.9631	1.165	0.2776
# of EDCs in products	0.1335	0.1564	0.853	0.4182
Starting age of product use	0.2810	0.2323	1.209	0.2610
# Products per day	-0.9066	1.0246	-0.885	0.4020
Breast Development: Stage 3	-0.3727	0.7305	-0.510	0.6237
Breast Development: Stage 4	0.6775	0.5508	1.230	0.2536
Breast Development: Stage 5	0.3301	0.9358	0.353	0.7334
Frequency of use: few times a week	1.1909	1.1746	1.014	0.3403
Frequency of use: 2-3x a week	0.8949	1.2765	0.701	0.5031
Frequency of use: 4-6x a week	0.5086	0.1726	2.947	0.0185 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Figure 14: GLM output examining relationship between independent variables and age of menarche

Column 1: Trend in data
Column 2: P-value

Kruskal-Wallis		
Chi-squared	DF	P-value
7.812316	1	0.005189134

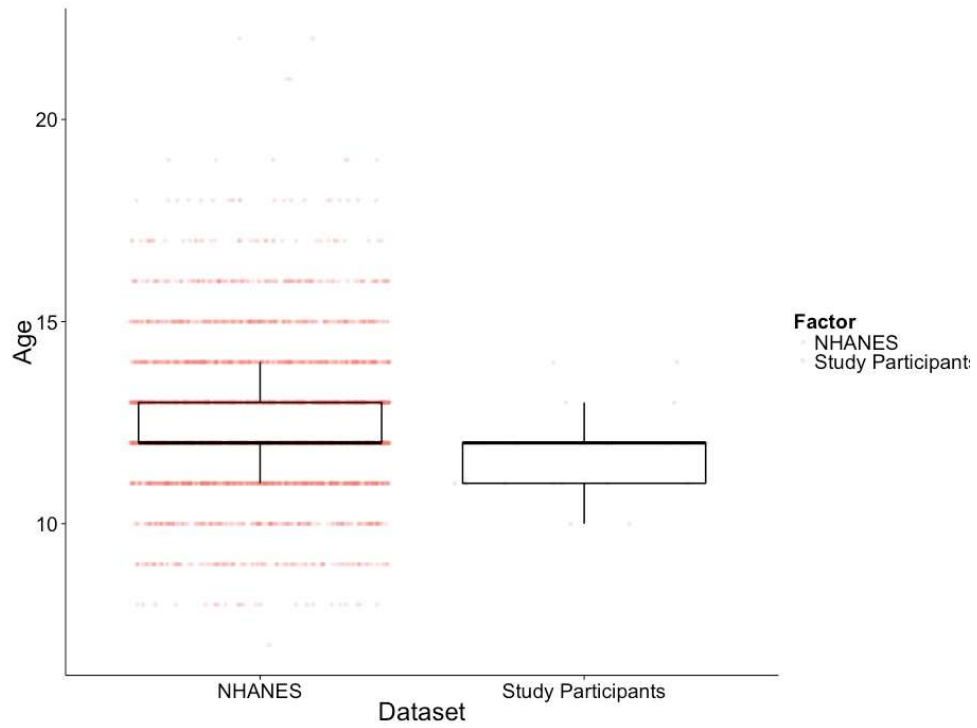


Figure 15: Box plot and chart for NHANES data vs survey participants

APPENDIX B: Comprehensive Statistical Analysis

Independent Variable	Dependent Variable	Statistical Test		Results: P and R ² values
Starting age of product use	Age of first physical signs of puberty	Linear Regression	Slope = 0.3156 R ² = 0.1841	Low
	Age of menarche	Linear Regression	Slope = 0.0929 R ² = 0.0447	Low
Frequency of product use (categorical)	Age of first physical signs of puberty	ANOVA	P-value = 0.905225	Insignificant
	Age of menarche	ANOVA	P-value = 0.510898	Insignificant
Number of products used per day	Age of first physical signs of puberty	Linear Regression	Slope = -0.1667 R ² = 0.0108	Low
	Age of menarche	Linear Regression	Slope = 0.2857 R ² = 0.0875	Low
Number of products containing EDCs	Age of first physical signs of puberty	Linear Regression	Slope = 0.1 R ² = 0.0173	Low
	Age of menarche	Linear Regression	Slope = 0.0153 R ² = 0.0021	Low

Summary of Linear Regression relationships and outcomes

Starting Age of Product Use

The best fit line for the analysis on starting age of product use and first physical signs of puberty had a positive slope (0.3156) which agreed with the hypothesis predicted for the relationship. The R² value of 0.1841 was somewhat low (1 indicates that the model explains all variability in response data). Additionally, this relationship had the largest R² of all the relationships examined. Overall, examining the linear regression for the relationship between starting age of product use and age of first physical signs of puberty indicated that there is a low, but positive relationship between the variables.

This independent variable was also examined in relation to age of menarche. The best fit line had a positive trend which was predicted in the hypothesis. Additionally, it had a smaller slope (0.9229) and R^2 value (0.0447) than the puberty analysis. These values indicated that the relationship between age of menarche and the age of decision to start using personal care products was weaker than the previous relationship.

Quantity of Products Used

The number of products participants used each day compared to the age of first physical signs of puberty had a negative trend in the data (-0.1667). This trend followed the hypothesis that the more products used each day the earlier the first physical signs of puberty. The R^2 value was low (0.0108), which indicated that there was not a strong relationship. Overall, even though the trend in the data supported the original hypothesis, the low R^2 value indicated a less than expected relationship between the variables.

The number of products used and the age of menarche had a different relationship. The trend line indicated that there was a positive relationship (slope= 0.2857). This trend which signified that lower product use would result in earlier menarche rejected the predicted hypothesis. The R^2 value of 0.0875 was higher than the previous relationship, which may indicate a stronger relationship than the previous variable. Overall, both the trend in the data and R^2 value reject the original hypothesis.

Frequency of Use

For the analysis between the frequency of product use and the age of first physical signs of puberty, a negative trend was observed. The majority of the categories supported the hypothesis that increased product use will result in earlier puberty. The only category that rejected the hypothesis was “Every Few Weeks” which had the lowest age of first physical signs

of puberty. This category only had one participant, so this finding was not significant or reliable. From the ANOVA output the main result was the p-value of 0.905225 which indicated that there was no significant difference in the age of first physical signs of puberty between categories. In other words, the high p-value suggested that the data did not provide enough evidence to reject the null hypothesis that increased frequency of product use was not related to earlier age of puberty.

The analysis between the frequency of product use and the age of menarche discovered the same pattern described in the previous relationship. The negative trend was present throughout the majority of the categories. Again, the “Every Few Weeks” category had the lowest dependent variable. This trend supported the hypothesis that increased frequency of product use resulted in an earlier menarche. The p-value of 0.510898 indicated that there was no significant difference between the age of menarche between categories. Comparing the p-value between relationships, there was clearly a stronger relationship between age of menarche than age of first physical signs of puberty.

Endocrine Disruptors in Products

A more specific way to examine if personal care products contained endocrine disruptors was to look at the ingredients. The best fit line between number of endocrine disruptors in products and first physical signs of puberty was positive (slope 0.1). This value supported the hypothesis that the more products participants used with endocrine disruptors, the earlier the first physical signs of puberty would be. The R^2 value (0.0173) was small which indicated that the independent variable was not the best predictor of the dependent. Overall, the direction of the data supported the hypothesis. However, the smaller R^2 value may indicate less of a relationship than predicted.

The number of products with endocrine disruptors was also examined in relation to the age of menarche. The trend in the data was positive (slope= 0.0153) which supported the hypothesis. Additionally, the R^2 value was very low (0.0021). Again, as seen in the previous analysis the positive trend fits the hypothesis, but the relationship was not as strong as predicted.

Comparing Independent Variables

The GLM compared several independent variables to the age of first physical signs of puberty. It was determined that the only explanatory variable that had a significant p-value was age of menarche (0.0159). This control was confirmed by the significance of the relationship. The second smallest p-value was for Tanner stages of breast development 5, indicating that participants with highly developed breasts were likely to have earlier physical signs of puberty. No other variable had a small significant p-value, signifying that the relationships between the independent variables and age of first physical signs of puberty were weak/not occurring. The majority of trends in column 1 were negative. However, not much can be concluded from the individual trends due to limitations.

The independent variables were also examined in relation to age of menarche. The only significant relationship was the control, age of first physical signs of puberty (p-value =0.0185). Frequency of product use (4-6 times a week) had the second smallest p-value (0.2536). The other independent variables measured did not have significant p-values, signifying weak relationships. Compared to the first GLM, the majority of the trends were positive except frequency (every few weeks and 2-3 times a week). These trends were completely opposite of the first GLM.

Age of Menarche: NHANES vs Study Participants

Through the Kruskal-Wallis analysis the p-value (which indicates how similar or close the data sets are) of 0.005189134 was determined. Since this value was below 0.01, a common

indicator of statistical validity, a claim can be made that there is no similarity between the data sets.

APPENDIX C: Transformed FDA Regulatory System

1. Required product safety testing from both companies and an external scientific review board

One of the most important things that the current regulatory system in the U.S. does not have is an effective and thorough system for testing cosmetics. The EU system requires companies to test and evaluate safety through a standardized safety assessment. Authorities have to review the assessments, including products that are already on the market (European Commission 2017b). Creating a system where both companies and an external FDA agency review the ingredients and products would be an effective way to ensure some product safety. In addition, there would need to be laws requiring companies to conduct product safety tests before the product is released into the market. The only issue with product testing is that it usually does not consider chemicals that may cause long-term harm at low levels, such as endocrine disruptors. Additional tests may be required that consider chemical structure, health impacts from similar chemicals, and studies that have assessed the risks associated with the chemical.

2. Creation of a cosmetic ingredient database

The EU also has a cosmetic ingredient database (CosIng) which contains information about ingredients in cosmetics from a series of regulations or directives (European Commission 2017b). Creating a database of the ingredients in all cosmetics produced and marketed would be a useful way for consumers, researchers, or officials to look up ingredients and determine what is in certain products. It would be even more effective if it was created like GoodGuide or the Environmental Working Group's Skin Deep Database. Both these include information about the

potential health outcomes of ingredients in products. Creating a national system of all products and brands sold in the United States would allow for transparency between companies and consumers. However, this would be difficult to implement, so potentially products with certain ingredients should be required first.

3. Creation of a cosmetic products notification portal

In addition to an ingredient database, the EU has a Cosmetic Products Notification Portal which requires that “responsible persons” and distributors to submit information about the products they place on the market. This database is accessible to authorities, poison centers, “responsible individuals”, and distributors (European Commission 2017a). In terms of the U.S. regulatory system, it would be efficient to require information for both the notification portal and the cosmetic ingredient database to be submitted after testing before the products are placed on the market. The creation of this notification database would allow for quick access to all products that are available on the market.

4. Implementation of a products market surveillance system

The implementation of a Market Surveillance system would be an important way to foster communication and collaboration for research and management (European Commission 2017a) . For the EU, this system was created to foster cooperation between EU member countries, because each country is responsible for their own surveillance. If implemented in the U.S., it would create a system that focuses on international cooperation and allows for improvements in terms of testing procedures, product safety, and best practices for market surveillance.

5. Structuring the system on the foundation of REACH (registration, evaluation, authorization, and restriction of chemicals).

The European Union has also implemented a program to protect human health and the environment from chemicals through, “the identification of the intrinsic properties of chemical substances”(European Commission 2017). This program known as REACH (registration, evaluation, authorization, and restriction of chemicals), places direct responsibility on industry to provide and collect safety information and register it in the European Chemicals Agency database (European Commission 2017). Creating a program structured off REACH’s four main principles would allow for chemicals to be evaluated and tested prior to the market.

APPENDIX D: Survey Protocol and Interview Questions

Survey

Chemicals in Personal Care Products - Final

Q1 Chemicals in Personal Care Products Survey Requirements: - You need to be at least 12 years old.- You need to have had at least one menstruation cycle.- You must have signed (and kept a copy) of the informed consent or teen assent form. Do you meet the requirements listed above?

- Yes (1)
- No (2)

If Yes Is Selected, Then Skip To End of Block If No Is Selected, Then Skip To End of Survey

Q2 What is your name?

Q3 Where do you go to school or work?

Q4 How old are you?

Q5 What do you identify as?

- African (1)
- African American (2)
- Caribbean (3)
- Hispanic or Latina (4)
- Other (5) _____

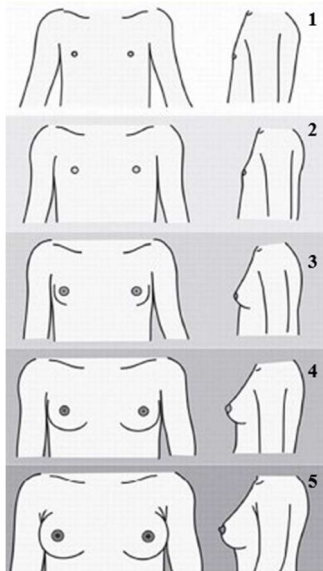
Q6 What were your first physical signs of puberty? (puberty is the period in which adolescents reach sexual maturity and become capable of reproduction.)

- Breast development (1)
- Pubic/underarm hair growth (2)
- Changing body shape (3)
- Other (4) _____

Q7 How old were you when you had your first physical signs of puberty?

Q8 Please choose the image that looks the most like your body when you had your first period.

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)



Q9 What age did you have your first period? (please enter your age and if possible the month of the year)

Q10 What age did you personally decide to start using personal care products? (example: makeup, deodorant, hair products)

Q11 What was your first memory of buying or using personal care products?

Q12 Why did you start using personal care products/cosmetics?

Q13 What types of products do you use?

- Underarm deodorant (1)
- Vaginal douches (2)
- Baby powder (3)
- Fragrances (perfumes, oils) (4)
- Makeup (lipstick, foundation, eyeliner) (5)
- Skin lotions (6)
- Hair products (oil, pomade, gel) (7)

Q14 Do you currently use the same personal care products that you used when you started your period?

- Yes (1)
- No (2)
- I don't know (3)

Condition: Yes Is Selected. Skip To: Can you name the most common personal....Condition: I don't know Is Selected. Skip To: Can you name the most common personal....Condition: No Is Selected. Skip To: Can you name the most common personal....

Q15 Can you name the most common personal care products that you used when you started menstruation?(Please list all makeup, skin care products, hygiene products, and hair products Ex: Covergirl Lashblast Mascara and Shea Moisture Raw Shea Butter Moisture Retention Shampoo)
If Can you name the products y... Is Displayed, Then Skip To Around the time of your first period ...

Q16 Can you name the most common personal care products that you currently use? (Please list all makeup, skin care products, hygiene products, and hair productsEx: Covergirl Lashblast Mascara and Shea Moisture Raw Shea Butter Moisture Retention Shampoo)

Q17 Around the time of your first period how often did you use personal care products?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week or less (4)
- Every few weeks (5)
- Rarely (6)

Q18 Around the time of your first period how many products did you use each day?

Q19 How often do you currently use makeup?

- Daily (1)
- 4-6 times a week (2)
- 2-3 times a week (3)
- Once a week or less (4)
- Rarely (5)

Q20 How many products do you use now?

Q21 Please write down your email if you would like to be entered into a raffle to win a gift basket of healthy personal care products!

Q22 Are you willing to participate in an interview to explain your story in depth?

- Yes (1)
- No (2)

If Yes Is Selected, Then Skip To What is the best way to contact you? If No Is Selected, Then Skip To End of Survey

Q23 What is the best way to contact you? (email or phone number)

If What is the best way to con... Is Empty, Then Skip To End of Survey

Interview Questions

1. Personal care products mean different things to different people, what do they mean to you?
2. Are you interested in beauty products/fashion?
 - a. What part interests you?
3. Do you watch any beauty gurus on YouTube?
 - a. If yes, why?
 - b. What type of videos do you watch?
 - c. When did you start watching them?
4. Do you have a favorite brand of cosmetics or personal care products?
 - a. Why are they your favorite?
5. Can you tell me about your current daily beauty routine?
6. Do you feel that cosmetics are related to your views of yourself?
7. Can you discuss your reasons for wearing cosmetics?
8. Do you purchase products based on?

9. What was your first memory of using/wearing/buying cosmetics?
10. Can you tell me what prompted you to start using these products?
11. Do you use the same products now that you did when you started your period?
 - a. If no, what has changed/why do you use different products
12. Can you discuss the time when you started your menstruation?