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A Study of Consumer Perceptions of the Possible Effects of Endocrine Disrupting Chemicals on Prepubescent Development

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Running head: PERCEPTIONS OF ENDOCRINE DISRUPTING CHEMICALS

A Study of Consumer Perceptions of the Possible Effects of Endocrine Disrupting
Chemicals on Prepubescent Development

A Thesis Submitted to

the Faculty of the University of North Georgia

In Partial Fulfillment

Of the Requirements for the Degree

Bachelor of Science in Kinesiology with a Concentration in Health and Fitness

With Honors

Madison Medina

Fall 2020

Acknowledgements

Thank you to my thesis committee for all the contributions you have made towards my thesis project and academic career. Thank you, Dr. Jakiel, for choosing to be my thesis chair. You have helped me with every step along the way, and your guidance has allowed the whole project to come together. Over the last year and a half, you have challenged me, sacrificed your time, and worked with me to overcome every obstacle I faced during the project. Thank you for helping me grow as a student throughout this process.

Thank you, Dr. Podsen, for being part of my thesis committee. I am grateful for all the skills you've taught me in your classes, and you have helped me learn the importance of functional human movement. In my future career, I will always refer back to the wisdom you shared during your classes.

I would like to thank Dr. Dansby-Sparks for being part of my thesis committee and for encouraging me throughout my undergraduate courses. You have helped me learn important leadership skills and have been a great mentor. You've made a great impact on my life, and Andrew and I are both grateful for your guidance during our time at UNG.

Each of my committee members has made a large impact on my life and undergraduate experience, and I hope to use what I've learned from each of you in my graduate courses and future career.

Introduction

Over the past few decades, adverse changes in the health of upcoming generations have become a greater public concern. The rising rates of autism spectrum disorders (ASDs), childhood obesity, attention-deficit/hyperactivity disorder (ADHD), and changes in pubertal timing in both boys and girls are causing researchers to explore factors that are potentially contributing to the increasing number of these cases in children.

According to the latest reports from the Centers for Disease Control and Prevention, 18.5% of children and adolescents ages 2-19 are obese, 1 in 59 children have been diagnosed with ASDs, and 5% of children have ADHD (Centers for Disease Control and Prevention, 2019a, 2019b, 2019c). There has also been a gradual shift in the average age of puberty; Farello et al. (2019) explained that during the last twenty years, the average onset of puberty occurs 12 to 18 months sooner than in previous generations. A direct cause has yet to be discovered, but there are numerous theories exploring possible factors that may be contributing to the increasing number of health problems in children. Wong and Duranni (2017) examined the relationship between several endocrine disrupting chemicals (EDCs) found in common consumer products and the rising prevalence of some childhood health issues and found that EDCs may be a contributing factor.

Although researchers have focused on the effects of endocrine disrupting chemicals on specific health problems that children are encountering, limited research has analyzed the holistic effects of EDCs on the various aspects of child development.

EDCs may be contributing to the changes in trends of childhood health issues, and they may ultimately disrupt multiple parts of a child's development. Although previous research has linked EDCs to potential adverse effects in children, limited studies have

looked at the public's awareness of these effects. Since EDCs may cause a variety of problems and parents and/or guardians decide what ingredients they expose their children to, the primary researcher has designed a study to examine parents' awareness and perceptions of these chemicals and explore the motivation behind parents' decisions when purchasing consumer products for their children. A survey created by the researcher examined parents' awareness of EDCs and determined which factors were important to them when buying cosmetic/hygiene products for their children, and it tested the hypothesis that there is a significant relationship between awareness of EDCs and likelihood of purchase.

Background

The endocrine system consists of the glands throughout the body that produce and secrete chemical messengers, known as hormones, that control and regulate all biological processes (United States Environmental Protection Agency, n.d.). Numerous endocrine disrupting chemicals are found in many consumer and personal care products, and these compounds can disrupt the functioning of the endocrine system because they can bind to hormones' receptors (Greenspan & Lee, 2018). Since the endocrine system is powerful and controls the body's development and functioning, consistent exposure to EDCs over time can be harmful and cause many negative effects.

In order to protect consumers, the government formed the Food and Drug Administration (FDA) in 1906 to monitor food and consumer products (Food and Drug Administration, 2018). In 1938, the FDA passed the Food, Drug, and Cosmetic Act, and part of the action of this act required regulations on cosmetics for the first time (Meadows, 2006). The FDA includes a variety of products under the title of *cosmetics*

including personal care products such as lotions, beauty products, and personal hygiene products (The Food and Drug Administration, 2016). Other common personal care products are included under the title of *drugs*, like antiperspirants or treatments for dandruff or acne, whereas some products meet the criteria for *cosmetics* and *drugs* such as antidandruff shampoo or antiperspirant deodorants (Food and Drug Administration, 2016). Although drugs must receive premarket approval by FDA, cosmetic products have less regulations, other than for color additives, and their ingredients don't have to be approved before being released to the market (Food and Drug Administration, 2016). The lack of regulations on cosmetics allows companies to have more flexibility when choosing ingredients for their products (Food and Drug Administration, 2016). Since the FDA doesn't approve cosmetics before they go on the market, endocrine disrupting chemicals may be present in common products which can result in daily exposure to EDCs.

The frequent use of products with hidden EDCs may have long-term effects especially on pre-pubescent development. Endocrine disrupting chemicals have been previously proven harmful to adults, but Wong and Durrani (2017) suggested that additional care and insight should be given to the negative effects potentially seen during the growth and development of infants and children. During these periods, their organs are developing which makes them more susceptible to disturbances including EDCs (Wong & Durrani, 2017). Since these age groups have less developed metabolic systems, they cannot process and excrete toxins efficiently, and the skin of infants and children is thinner than adults so chemicals are absorbed easier through the skin, and these physiological characteristics cause their bodies to be more vulnerable to effects of EDCs

(Wong & Durrani, 2017). While people are not yet fully aware of the effects of endocrine disrupting chemicals, Wong and Durrani (2017) argued that EDCs can be especially harmful to those who have not yet reached puberty, and the damage to children can affect all parts of their development. Since endocrine disrupting chemicals interfere with the functioning of the endocrine system, several factors including the age of exposure, the type of chemical(s) exposed to, and the frequency of exposure may contribute to a variety of physical changes that can occur to children's bodies (Russ & Howard, 2016).

Beszterda and Frański (2018) explained that exposure to low doses of EDCs over long periods is common today, and these frequent exposures may be linked to several of the increasing health problems in the younger generations.

Metabolic Diseases

Metabolic diseases are issues for both children and adults, but they have become more of a focal point for youth due to their negative and long-term consequences.

Obesity and diabetes mellitus are examples of metabolic diseases that have become more prevalent over the last few decades (Russ & Howard, 2016). Obesity is defined as a person who has a body mass index (BMI) of at least 30 kg/m², and type 2 diabetes is a disease caused by increased insulin resistance and insulin deficiency (Russ & Howard, 2016). However, for children and teens, the CDC (2018) defines overweight as a BMI between the 85th and 95th percentile and obese as a BMI at or above the 95th percentile for children and teens of the same age and gender. Russ and Howard (2016) reported that during the early 2000s, the prevalence of type 2 diabetes in children increased by roughly 30%. During this same time frame, over a third of people under 20 years old were deemed either overweight or obese. Children's diet and activity levels affect their health,

yet Russ and Howard (2016) suggested that other factors, such as environmental factors including endocrine disrupting chemicals, are contributing to the substantial increase in childhood obesity and diabetes because of their potential impact on changes in natural metabolic processes. Russ and Howard (2016) cautioned that there seems to be a greater environmental effect on the current population's metabolisms than in previous generations.

Even before birth, children can be affected by endocrine disrupting chemicals if pregnant mothers are frequently exposed to these chemicals. EDCs can “cross the placenta and enter the fetus” and cause changes to the developing fetus that may increase the risk of diseases later in childhood or adulthood (Howard, 2018, p.2). Russ and Howard (2016) acknowledged that when a fetus, infant, or child is exposed to low doses of EDCs, weight gain can occur because the chemicals damage “the body’s natural weight control mechanisms” and because these developmental periods are the most “sensitive window of susceptibility for metabolic disruption” (p.257-258). Although only a few exposures to EDCs for some children may immediately manifest health issues, repeated exposure during childhood for others may not cause health problems to appear until later when they are adults. In 2014, a hypothesis known as the Parma Consensus Statement proposed the following:

Environmental chemicals can act during development and/or other sensitive time periods across the lifespan to control adipose tissue development by increasing the number and/or size of fat cells and/or by altering food intake and metabolism via specific effects on the brain, pancreas, adipose tissue, liver, GI tract, and muscle individually or in combination (Russ & Howard, 2016, p. 258).

Russ and Howard (2016) explained that when a fetus or child is exposed to EDCs during critical developmental periods, the chemicals may interfere with the hormones that control development which can then disrupt proper growth. Therefore, frequent prepubescent contact with EDCs, such as bisphenol A (BPA) and phthalates, can cause metabolic changes that can last into adulthood by increasing the risk of obesity, type 1 diabetes, type 2 diabetes, and insulin resistance (Howard, 2018). Howard (2018) summarized how exposure to EDCs during critical developmental periods can promote autoimmunity and affect the development of the beta cells and pancreas which could ultimately alter metabolism, affect insulin secretion, and cause type 1 diabetes. Experimental and epidemiological studies revealed that when endocrine disrupting chemicals interrupt hormones during development, they can cause metabolic changes that are linked to diabetes mellitus and obesity and can persist through adulthood and be passed down to subsequent generations (Howard, 2018).

The physiological changes that cause alterations in metabolism can also have negative effects on other aspects of development. Of the metabolic changes that EDCs potentially contribute to, childhood obesity can greatly influence a child's social and emotional development. Obese children are more at risk for depression, low self-esteem, social withdrawal, and isolation, and they have been viewed as "one of the most stigmatizing and least socially acceptable conditions in childhood" (Kornilaki & Cheng, 2019, p. 1639). Kornilaki and Cheng (2019) have warned that obese children are the least liked as friends, and other children associate obese children with negative attributes which causes the obese children to be more isolated than their peers. Since relationships with peers are critical for a child's social development and emotional well-being, obesity

can negatively affect more than just a child's physical health which makes it more critical to try to reduce the prevalence of childhood obesity and consequently reduce children's exposure to EDCs (Kornilaki & Cheng, 2019).

Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder is a neurobehavioral disorder, and it can negatively affect a child's academic skills since the disorder presents with symptoms of "hyperactivity, poor sustained attention, and diminished impulse control" (Thomaidis et al., 2017, p. 29). The cognitive development of children with ADHD can be adversely affected, and these children may have impaired cognitive functioning and more school-related problems (Thomaidis et al., 2017). Likewise, children with ADHD may experience social and interpersonal problems because ADHD can disrupt a child's social cognition (Uekermann et al., 2010). ADHD during childhood can impact every area of a child's life, and the increasing prevalence of this disorder is unsettling because more children will live with development deficits.

The rise of children with attention-deficit/hyperactivity disorder has caused many to investigate the possible contribution of early environmental factors. Rochester, Bolden, and Kwiatkowski (2018) stated that previous research has focused on the impact of environmental factors like "fetal exposures to alcohol, cigarette smoke, and lead" on the development of ADHD, but lately, new studies on the relationship between BPA and ADHD have been performed (p. 344). BPA is a chemical found in linings of canned foods and beverages, thermal papers, polycarbonate beverage containers and bottles, epoxy resins, plastics, and recycled paper products (Beszterda & Frański, 2018; Wong & Durrani, 2017). Wong and Durrani (2017) reported that urinalysis revealed BPA was

identified in almost every child and adult, and it's been found in breast milk, placenta, and fetal livers. There are limited FDA regulations on BPA except for its ban in the linings of baby bottles, sippy cups, and infant formula packaging (Wong & Durrani, 2017). Rochester et al. (2018) argued that exposure to BPA during development may contribute to the disruption of neurobehavioral functioning and may cause symptoms of ADHD like hyperactivity. Rochester et al. (2018) found that animal and human studies revealed BPA is a presumed link to hyperactivity behaviors because it alters the serotonergic system and the catecholaminergic system which include dopamine, norepinephrine, serotonin, and their transporters. Though more research needs to be done to support the current findings, parents should still be cautious and try to avoid exposing their children to BPA since this is a possible contributor to ADHD and it may negatively impact various parts of development.

Autism Spectrum Disorders

As previously stated, recent studies are also examining the potential association of environmental toxins and autism spectrum disorders in children. Autism spectrum disorders can cause emotional, behavioral, and social problems due to these children's communication difficulties, odd and repetitive behaviors, mood instability, and disruptive behaviors (Nicholas et al., 2008). The rising prevalence of ASDs is occurring globally, and the heightened concern has caused more research to be undertaken in attempts to determine the source of the increased prevalence (Ye, Leung, & Wong, 2017). Ye et al. (2017) suggested that complex interactions between hereditary, biological, and environmental factors can occur prior to birth or during childhood and contribute to ASDs. Some of the environmental toxicants that Ye et al. (2017) analyzed were mercury,

lead, bisphenol A, and phthalates, and they discovered that there may be an association between these chemicals and an increased risk of ASDs. Of the examined EDCs, Ye et al. (2017) indicated that phthalates (PAEs) and BPA are two of the most concerning chemicals that may be contributing to autism spectrum disorders.

Phthalates are a group of chemicals that increase the flexibility of plastics, and they are found in many foods, toys, personal hygiene products, beauty products, and even baby care products (Wong & Durrani, 2017). Since PAEs and BPA are found in common everyday products, people can be exposed to them frequently and from a young age. Ye et al. (2017) argued that childhood exposure to phthalates may cause autism-like behaviors and alter neurodevelopment, and prenatal exposure to BPA can affect neurobehavioral functioning in children. Exposure to some endocrine disrupting chemicals during sensitive developmental stages can contribute to permanent damage to children's brains which can cause changes that are similar to characteristics of ASDs, yet there is still limited understanding and a lack of direct evidence to link EDCs to ASDs (Ye et al., 2017).

Pubertal Timing

Puberty is an important period of development because this process creates physical changes in a child's body that lead to sexual maturity. There is more data available regarding the average age of puberty for females than data for males because it is easier to clinically assess changes in females, such as the development of breasts and onset of menarche, which has resulted in inconsistent information about the average age that puberty begins in males (Fudvoye, Lopez-Rodriguez, Franssen, & Parent, 2019).

Farello et al. (2019) acknowledged a general shift in pubertal timing for females over the last few centuries as the age of menarche has decreased from age 17 in the early nineteenth century to age 13 in the mid-twentieth century. In recent decades, the average age of the onset of breast development has declined from about 11 years old to 10 years old (Farello et al., 2019; Greenspan & Lee, 2018). Although the average onset of breast development, an early stage of puberty, has started sooner, Farello et al. (2019) and Greenspan and Lee (2018) have noted little changes in the average age of menarche, an advanced pubertal milestone. Fudvoye et al. (2019) proposed that the shifts in the average age of puberty in addition to a possible increased prevalence of central precocious puberty in girls suggest environmental factors, specifically endocrine disrupting chemicals, can be affecting young females' development.

Fudvoye et al. (2019) and Greenspan and Lee (2018) have examined the potential effects of EDCs on pubertal timing, and they explained that pubertal timing may become abnormal due to EDCs because they can cause changes during development in different sites throughout the body including the hypothalamic GnRH network, gonadotropic cells, and gonads. These chemicals can disrupt the actions of natural hormones produced within the body because they interact with the endocrine system (Greenspan & Lee, 2018). Two groups of EDCs that can affect pubertal timing are phthalates and phenols because these include many "hormonally active chemicals with anti-androgenic and estrogenic activity" (Greenspan & Lee, 2018, p. 2). Chemicals with estrogenic properties, like BPA and other phenols, can "compete with endogenous estrogens for binding" at low concentrations, and they can have anti-androgenic properties at higher concentrations (Greenspan & Lee, 2018, p. 2). Greenspan and Lee (2018) suggested that other EDCs, including

polybrominated diphenyl ethers (PBDEs) which are found in carpeting, clothing, and furniture, can possibly impact pubertal timing. Although research on the relationship between pubertal timing and EDCs is currently limited, it is necessary for more studies to be completed because early puberty can have severe consequences. Fudvoye et al. (2019) cautioned that children who experience puberty too early are more likely to have subsequent reproduction abnormalities later in life, and they have a higher risk of developing breast cancer, angina, hypertension, and type 2 diabetes. If endocrine disrupting chemicals are contributing to an earlier onset of puberty, it is important to try to minimize exposure to these chemicals to protect the development of young girls.

Summary

During the recent decades, there has been an emphasis to explore the effects of endocrine disrupting chemicals to determine if there is a connection between EDCs and the increasing trends of childhood health problems. Currently, research is still limited, and a direct link between EDCs and health problems such as diabetes mellitus, obesity, autism spectrum disorder, attention-deficit hyperactivity disorder, and early onset of puberty is highly debated. However, recent studies reveal that there is a high probability that endocrine disrupting chemicals can be one of the contributing factors to these problems especially when people are exposed during critical developmental periods. As more research is conducted on EDCs, the public should begin examining the personal care products they purchase to look for EDCs in order to limit their exposure and their children's exposure to these harmful chemicals. The following sections will describe the methods that were used to determine parents' awareness and perceptions of endocrine

disrupting chemicals and to explore what factors are important to parents when buying personal care products for their children.

Methods

Study Design

This descriptive cross-sectional study was used to describe a specific group of people at a single point in time. A cross-sectional design is a snapshot of a population and is only concerned with responses that are recorded from that brief period (Levin, 2006). Levin (2006) explained that this design is an effective way to collect data without being concerned with the retention of the subjects, and the study can be conducted with relative ease and prompt data collection. The study used convenience sampling because this method of sampling is efficient, produces no additional cost to the primary investigator, and attains a desired sample size more easily (Etikan, Musa, & Alkassim, 2016).

Research Question

What factors influence purchasing decisions when parents buy personal care products for their children?

Setting

The University of North Georgia (UNG) is an institution of higher learning and is one of six Senior Military Colleges in the United States. There are five campuses, and they are located in Dahlonega, Gainesville, Oconee, Blue Ridge, and Cumming. The campus that was the primary focus of this study was the campus in Dahlonega, Georgia. In fall of 2019, the UNG Institutional Effectiveness office (2019) collected data about the

faculty and staff on the Dahlonega campus at the time that the data in this study was collected. They reported that there were 1,183 faculty and staff on the Dahlonega campus. There were approximately 683 (57%) females and 500 (43%) males. The ethnic population of the faculty and staff was 85.88% White, 3.47% Black or African American, 3.04% Asian, 2.96% Hispanic, 2.2% Nonresident alien, 1.27% Unknown, 0.68% Multiracial, and 0.51% American Indian or Alaska Native. 988 (84%) employees were full-time while 195 (16%) employees were part-time.

Participants & Sampling

The subjects of this study were faculty and staff from the Dahlonega campus of the University of North Georgia. These subjects were part of the convenience sample due to their proximity to the researcher and because the convenience sample assists with a higher response rate and recruitment since the primary researcher also attends UNG. In order for the study to have a 94% confidence level and a 10% margin of error, the researcher needed at least 83 responses (Raosoft, 2004). Although UNG faculty and staff on the Dahlonega campus may not be a true representation of the entire population of Dahlonega, the study revealed information about this unique subset of the city's population. Participation in this study was voluntary, and each of the participants remained anonymous.

Inclusion Criteria

These subjects were over the age of 18 and had at least one child 14 years old or younger. The participants were employed at the University of North Georgia on the Dahlonega campus and had an active UNG email.

Exclusion Criteria

Subjects that were excluded from the study were UNG students, faculty and staff that were under 18 years old, anyone who was not an active UNG employee, and faculty and staff that did not have at least one child under 14 years old. During the survey, subjects that did not fit the inclusion criteria were automatically redirected from the survey after the third question to a thank you message.

Instrumentation

The researcher created the Medina Consumer Perceptions Survey to distribute to the participants electronically through Qualtrics and can be found in appendix A. The survey evaluated the factors that the subjects consider when buying cosmetic/hygiene products for their children and assessed their awareness of endocrine disrupting chemicals found in common cosmetic/hygiene products. The participants were notified that the survey will take approximately 5 minutes to complete. An introduction page was included to explain the purpose of the study. The following sections will explain how the survey was measured and coded.

Demographics

The following questions have been developed. Question 1 asked the subject for gender demographics. Question 2 asked the subject to select his or her age range. Question 3 asked if the subject had at least one child 14 years old or younger. If the participant did not have any children in this age range, he or she was redirected from the survey because he or she did not fit the inclusion criteria.

Medina Consumer Perceptions Survey

Question 4 asked how many children the participant had. Question 5 used a matrix table to allow the subject to select the ages of each of his or her children. Question 6 used a multiple answer list for the subject to select the listed hygiene/cosmetic products he or she bought for his or her children. Question 7 used a five-point Likert scale to allow the participant to rate the importance of several purchasing factors for hygiene/cosmetic products for their children. Question 8 asked the subject how often he or she examined the ingredients of cosmetic products for his or her children. Question 9 used a multiple answer list to allow the subject to select the ingredients he or she recognized. Question 10 asked the subject how familiar he or she was with parabens. Question 11 asked the subject how familiar he or she was with bisphenol A. Question 12 asked the subject how familiar he or she was with phthalates. Question 13 asked if the subject was willing to pay more for products free of these ingredients for his or her children. If the subject selected “no” for question 13, he or she was redirected to the end of the survey. Question 14 asked how much more money the subject would be willing to pay for products free of these ingredients. After question 14, the survey was terminated, and the participant was redirected to a thank you message.

Procedures

The study was evaluated by the University of North Georgia Institutional Review Board. Upon obtaining IRB approval, the survey was electronically distributed through Qualtrics to active UNG faculty and staff email accounts through an email sent from the primary researcher or a UNG department head. The researcher contacted each department head requesting that he or she send the survey to the faculty in his or her department. The

researcher then collected remaining faculty and staff email addresses from the UNG online directory and sent an email with a description of the study and a link to the survey. The survey remained open for 4 weeks. Participants were informed that they were voluntarily consenting to participate in the survey within the recruitment email and on the first page of the survey, and they were informed that they could stop the survey at any time.

Results

The descriptive cross-sectional study was conducted to determine which factors were important to parents when purchasing cosmetic and hygiene products for their children and to assess parents' awareness of endocrine disrupting chemicals that are commonly found in cosmetic and hygiene products. The study took place between April and May of 2020. After the data was checked for incomplete responses and the Likert-scale responses were numerically coded, the survey data was analyzed using SPSS Statistics. Within this section, the results of the survey are presented.

Description of the Sample

The survey was sent via email to approximately 1,100 faculty and staff on the Dahlonega campus. There were 287 responses to the survey, and of the total responses, 87 participants indicated that they had at least one child between 0 and 14 years old, but one response was not complete. The other 200 participants indicated that they did not have at least one child 14 years or younger and were automatically directed to the end of the survey after the third question. The following description of the sample will focus on the group of 86 participants that finished the survey in its entirety and had at least one

child between 0 and 14 years old because the remaining participants were not part of the desired sample population.

The survey included several demographic questions to provide more information about the participants. Most of the sample population was female, 60.5% (n = 52) and the remaining participants were male, 39.5% (n=34). Half of the participants were between 41 and 50 years old (n = 43) and the remaining responses were as follows: 5.8% (n = 5) were between 26 and 30 years old, 38.4% (n=33) were between 31 and 40 years old, and 5.8% (n = 5) were over 50 years old. Question 4 asked participants to identify the number of children 14 years old or younger they have. Most of the participants had only one child, 50% (n = 43). 33.7% of the sample (n = 29) had 2 children, 12.8% (n = 11) had 3 children, and the remaining 3.5% (n = 3) had four or more children. The 86 participants listed the ages of each of their children, and between all the participants, they have 44 children ages seven to ten years old, 40 children ages eleven to fourteen years old, 33 children ages four to six years old, and 29 children between infancy and three years old.

Purchasing Factors

The next questions in the survey were created to answer the research question, “What factors influence purchasing decisions when parents buy personal care products for their children?” Question 5 asked the participants to mark each cosmetic/hygiene product that they bought for their children. The following choices were provided: shampoo, conditioner, body wash, toothpaste, mouthwash, deodorant, nail polish, hand soap, hand sanitizer, lotion, and sunscreen. Only 9.3% of participants (n = 8) identified that they buy all 11 products for their children. 8.1% of the participants (n =7) selected that they purchase shampoo, conditioner, body wash, toothpaste, hand soap, hand

sanitizer, and lotion for their children. The product selected the most by participants was toothpaste, 96.5% (n = 83), and the product selected the least by participants was nail polish, 26.7% (n=23). The products listed from the most purchased to least purchased by participants for their children is as follows: toothpaste, shampoo, sunscreen, body wash, hand soap, lotion, hand sanitizer, conditioner, deodorant, mouthwash, and nail polish.

The next section of the survey included a five-point Likert-scale with rankings of 1 = extremely important, 2 = very important, 3 = moderately important, 4= slightly important, 5 = not at all important. The Likert-scale was used for participants to rate how important various factors were when purchasing cosmetic and hygiene products for their children. The factors included in the Likert-scale were visual appeal, scent, brand recognition, ingredients, brand loyalty, suggested from friends/family, cost, recommended on social media, and advertisements. Table 1 describes how the participants rated each factor:

Table 1: *Summary of the Likert-scale Results for Purchasing Factors*

Factor	Top Participant Response	Percent	<i>n</i> =
Ingredients	Very important	37.2%	32
Cost	Moderately important	43%	37
Scent	Moderately important	30.2%	26
Brand Recognition	Moderately important	29.1%	25
Suggested from Family/Friends	Moderately important	29.1%	25
Brand Loyalty	Not at all important	36%	31
Visual Appeal	Not at all important	38.4%	33
Advertisements	Not at all important	52.3%	45
Recommended on Social Media	Not at all important	52.3%	45

As seen in Table 1, the factors that were most important to participants included cost, scent, ingredients, and suggestions from friends/family. These categories had the highest four cumulative percentages for the categories of extremely important and very important. 11.6% (*n* = 10) of participants chose cost as extremely important, and 32.6% (*n* = 28) of participants chose cost as very important. 14% (*n* = 12) of participants selected scent as extremely important, and 29.1% (*n* = 25) of participants selected scent as very important. 29.1% (*n* = 25) of participants chose ingredients as extremely important, and 37.2% (*n* = 32) of participants chose ingredients as very important (Figure 1 in appendix B). Finally, 10.5% (*n* = 9) of participants selected suggestions from friends and family as extremely important, and 25.6% (*n* = 22) of participants selected suggestions from friends and family as very important.

Ingredient Identification and Perception

The purpose of the final section of the survey was to identify participants' awareness and perceptions of ingredients commonly found in children's cosmetic and hygiene products. The next question in the survey asked the participants to identify how often they examine the ingredients list on products they purchase for their children. Nearly half of the participants indicated that they sometimes examine the ingredients list, 44.2% (n = 38). Only 23.3% (n = 20) selected that they always examine the ingredients. 27.9% (n= 24) selected that they check the ingredients list most of the time, and 4.7% (n = 4) selected they never analyze the ingredients list of products for their children, and these results are represented in Figure 2 in appendix B.

The participants were then asked to select which of the following ingredients that they recognize: parabens, bisphenol A, and/or phthalates. Over half of the participants recognized all three ingredients, 54.7% (n = 47). 82.6% (n = 71) participants recognized parabens, 80.2% (n = 69) participants recognized bisphenol A, and 62.8% (n = 54) participants recognized phthalates. Only 8.1% (n = 7) participants did not recognize any of the three ingredients.

The next few questions asked participants to identify how familiar they were with each of the previously mentioned ingredients. The responses ranged from very familiar, moderately familiar, slightly familiar, or not familiar at all. The top response chosen by participants indicated that they were slightly familiar with parabens (34.9%; n = 30), moderately familiar with bisphenol A (34.9%; n = 30) and slightly familiar with phthalates (36%; n = 31). The results from these questions are represented in Figures 3-5

in appendix B, and Tables 2-4 represent how familiar the participants were with each ingredient:

Table 2: *Parabens*

	Percent	<i>n</i> =
Very familiar	11.6%	10
Moderately familiar	27.9%	24
Slightly familiar	34.9%	30
Not familiar at all	24.4%	21
*Missing response	1.2%	1

Table 3: *Bisphenol A*

	Percent	<i>n</i> =
Very familiar	18.6%	16
Moderately familiar	34.9%	30
Slightly familiar	29.1%	25
Not familiar at all	17.4%	15

Table 4: *Phthalates*

	Percent	<i>n</i> =
Very familiar	9.3%	8
Moderately familiar	19.8%	17
Slightly familiar	36%	31
Not familiar at all	34.9%	30

The final two questions on the survey were used to assess the participants' willingness to spend money on products free from ingredients such as parabens, BPA, and phthalates. 82.6% (*n* = 71) of participants selected that they would pay more for products free from the previously listed ingredients. The remaining 16.3% (*n* = 14) selected that they would not pay more for these products and were redirected to the end of the survey. One response was missing from this question.

The 71 participants that marked they would pay more for products free of the ingredients were directed to the last question in the survey which asked these participants how much more they would spend on products free from these ingredients compared to other products. The participants' responses from this question are represented in Figure 6 in appendix B. A fourth of the participants selected that they would spend less than \$3.00 more, 25.6% (*n* = 22). Only 10.5% (*n* = 9) of the participants chose that they would spend at least \$8.00 more on these products compared to others. 7% (*n* = 6) of participants would spend less than \$8.00, 17.4% (*n* = 15) of participants would spend less than \$5.00, 19.8% (*n* = 17) of participants would spend less than \$2.00, and 2.3% (*n* = 2) would spend less than \$1.00 more on products free from parabens, BPA, and phthalates.

Discussion

The effects of endocrine disrupting chemicals are still being studied, but the impact of long-term exposure to EDCs may negatively affect children. Typically, parents and/or guardians purchase hygiene and cosmetic products for their children, and consequently their purchases will impact how much their children are exposed to EDCs due to personal care products. The purpose of this study was to determine which factors are important to parents when they shop for products for their children and to assess their awareness and understanding of a few EDCs commonly found in children's products. This section will describe the general findings from the study and will include recommendations for future research.

All the participants were faculty and staff at the University of North Georgia, most of the participants were between 30 and 50 years old, and many of these participants only had one child. Additionally, most of the participants had children between 7 and 14 years old. This demographic information is logical as the mean age of first-time mothers in the United States is 26.3 years old (Matthews & Hamilton, 2016). Although many of the participants had children that were at least 7 years old, these children were still susceptible to the effects of EDCs because they were still developing and physiologically different from adults. In addition, while over half of the children were at least 7 years old, 42% of the participants' children were still between 0 and 6 years old; this age group is at an even higher risk to experience the negative effects EDCs may cause.

There are many cosmetic products that children use on a regular basis, and EDCs can be present in these consumer products. The participants in the study mostly buy products for their children such as toothpaste, shampoo, sunscreen, body wash, and hand

soap. Triclosan is an endocrine disrupting chemical frequently found in toothpaste and antibacterial soaps, phthalates are found in many personal care products that have fragrances like shampoo and soaps, parabens are used as preservatives and are in cosmetics like shampoo, conditioner, soaps, and lotions, and BPA can be found in plastics used as containers to store various personal care products such as the ones bought most commonly by the participants from the study (Braun, 2017; Leppert, Strunz, Seiwert et al., 2020). The types of products the participants typically buy for their children are known to frequently have EDCs present.

There are a variety of factors that influence consumers' decisions, and the goal of the study was to determine which factors consumers value the most when purchasing products for their children. The participants rated ingredients as the most important factor they consider when they buy hygiene and consumer products for their children. However, while the consumers indicated that good ingredients were the most important to them, less than one fourth of the participants always examine the ingredients list on personal care products for their children. In fact, 44.2% of the participants only sometimes check the ingredients list. Although the participants chose ingredients as their top priority when shopping for ingredients, most of the participants do not frequently analyze the ingredients list when shopping for their children.

Additionally, the other three factors that participants indicated as most important when buying personal care products for their children included cost, scent, and recommendations from family and friends. Out of these three factors, more participants selected scent as an extremely important factor. In contrast, the factor of cost had a higher cumulative percentage between the choices of extremely and very important compared to

the other two factors. The participants indicated that factors including visual appeal, brand loyalty, advertisements, and recommendations on social media were not important when shopping for cosmetic products for their children. It can be concluded from this data that the price of a product is one of the primary factors when buying personal care products for children, but how a product smells is an underlying factor for parents when deciding which products to purchase.

It can be harmful for parents to highly value a product's scent when purchasing personal care products for their children because many products are scented using synthetic chemicals. Since the FDA does not regulate cosmetic products, companies can simply list *fragrance* or *parfum* on a product without explicitly stating which ingredients make up the scent (Food and Drug Administration, 2016). Ingredients, such as EDCs, can be hidden under the words *fragrance* or *parfum*, and consequently, many people can be exposed to EDCs like phthalates since they are commonly used in fragrances in personal care products (Braun, 2017). If parents choose hygiene products for their children based on their scent without realizing EDCs are present in the product, then they can continue to expose their children through these purchases.

Over half of the participants were able to recognize parabens, BPA, and phthalates. While most of the participants recognized all three ingredients, their familiarity with each of these ingredients varied. The participants were most familiar with BPA, and they were the least familiar with phthalates. Although the participants indicated that ingredients were the most important factor to them when purchasing personal care products for their children, they have a limited understanding of a few common ingredients in cosmetic products including parabens, BPA, and phthalates. Moreover,

most of the participants can identify these ingredients, but they lack knowledge about these ingredients. Parents from this study show interest in buying non-toxic products for their children, but because their overall comprehension of EDCs and their possible effects is lacking, they may continue to buy products with these chemicals.

Finally, 83% of the participants selected they would pay more money for products free from parabens, phthalates, and BPA. Non-toxic products are usually more expensive than their competitors due to the increased cost of higher quality ingredients. The participants' willingness to spend more money on non-toxic products supports their indication that ingredients were very important to them when buying their children hygiene products. Many of the participants would spend no more than \$8 more on a non-toxic product, but most of these parents would only pay \$2 to \$5 more on a non-toxic product. The participants indicated that they value choosing good ingredients for their children, but they still want to be fiscally responsible because cost is another important factor to them.

Summary

The data from the survey revealed that parents use a wide variety of personal care products for their children, and they most value factors such as ingredients, cost, scent, and recommendations from family and friends when shopping for these products. Although they indicated that ingredients were the most important factor to them, the participants currently only have a limited understanding of some common ingredients that may have negative effects on children. Over half of the participants were able to identify all three ingredients including parabens, BPA, and phthalates, but generally they were only slightly to moderately familiar with them. Most participants were willing to

spend more money on non-toxic products, but they were also frugal and only wanted to spend \$2 to \$5 more on products free from parabens, BPA, and phthalates.

Recommendations for Future Research

The results of the study describe the faculty and staff of the Dahlonega campus of UNG, but the results may not be a true representation of the population of Dahlonega. The socioeconomic status and level of education may be higher for employees of a university than the general population of Dahlonega. Therefore, it would be beneficial for future researchers to examine parental purchasing factors of a larger, more general population in Lumpkin County to include various socioeconomic statuses and levels of education. Future research could sample the other UNG campuses and additional universities that are part of the University System of Georgia to assess parental purchasing factors and awareness and perceptions of EDCs in higher education in various geographical regions.

Another recommendation includes assessing a group of parents that specifically have young children such as sampling parents who have children in preschools or elementary schools. Many of the parents in this study had children who were 7 years and older. It is important to assess the purchasing factors and awareness of EDCs of parents who have young children because children are more susceptible to the possible effects of EDCs earlier in their lives. Additionally, future studies could evaluate pregnant women's awareness of EDCs and usage of products with EDCs because children can still be affected in utero since EDCs can cross through the placenta.

Furthermore, children are not the only group that can be affected by endocrine disrupting chemicals. EDCs can target all major endocrine organs including the pituitary gland, hypothalamus, pineal gland, thyroid, adrenal gland, pancreas, ovaries, and testes (Schug, Janesick, Blumberg, & Heindel, 2011). Although children are impacted more by EDCs during development, adults can be negatively affected by these chemicals, and they may contribute to problems such as fertility issues, cancers, changes in metabolism, and increased adiposity (Street et al., 2018). Therefore, future research could analyze adults instead of children and focus on their perceptions of EDCs and usage of personal care products with EDCs. There are many ways adults could be exposed to EDCs in addition to cosmetic products, and future research could explore the other possible ways people may be commonly exposed and affected by EDCs beyond personal care products.

Limitations

There were several limitations in this study, and these limitations were outside of the researcher's control. The first limitation is that the researcher could not control how many faculty and staff members chose to participate in the survey. The researcher also could not control whether participants completed the survey in its entirety. Another limitation that may have resulted in low response rates centered around when the survey was distributed. The survey was administered in April 2020, and during this time, the COVID-19 pandemic resulted in significant changes to the daily operations at the University of North Georgia. At the recommendations of local, state, and federal health agencies, UNG campuses closed for in-person activities, all classes were moved online, and faculty/staff were advised to stay at home and/or minimize their time spent physically on campus. As a result, UNG faculty had to quickly transition their classes to

fully-at-a-distance. All of these mandates occurred two weeks prior to the electronic distribution of the survey, and with faculty/staff preoccupied with these new stressors, this may have affected participation in the study. The honesty of the participant responses while completing the Medina Consumer Perceptions Survey was another factor outside of the researcher's control.

Conclusion

The results from the study revealed a need for educating the public about EDCs by using platforms such as trainings, seminars, or handouts. Educating consumers is a cost-effective way to counteract the increasing negative health conditions possibly worsened by constant exposure to EDCs. By increasing awareness of endocrine disrupting chemicals, consumers will become conscious of the possible adverse effects of EDCs. More informed consumers will ideally cause a decrease in the purchasing of products with EDCs. Interventions, like educating consumers, are necessary in order to cause permanent changes. If exposure to EDCs is minimized for children, there may be a reduction in the local and global rates of childhood obesity, ADHD, ASDs, and changes in pubertal timing. Although the FDA has banned some products with certain EDCs, more research and education would benefit the public by providing evidence to convince the FDA to change policies to better protect all consumers—children and adults. The public can reduce children's exposure to endocrine disrupting chemicals by substituting toxic products with those free of EDCs, and these small, daily changes along with federal policy changes can possibly reduce the rising rates of common childhood health problems.

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APPENDIX A:

Qualtrics Survey Questions

Medina Consumer Perceptions Survey

Start of Block: Block 1

You are being asked to participate in a survey research study entitled "A Study of Consumer Perceptions of the Possible Effects of Endocrine Disrupting Chemicals on Prepubescent Development". This study is being conducted by Madison Medina, an undergraduate student at the University of North Georgia, as part of her Honors Program thesis. The goal of the study is to gain insight into consumer spending habits for cosmetic/hygiene products. The research study is anonymous. No one, including the researcher, will be able to associate your responses with your identity. The survey is expected to take approximately 5 minutes to complete. The survey will remain open for a period of four weeks.

Your participation is voluntary. You may choose not to participate and to stop participating at any time. You must be at least 18 years old to participate in this study. Accessing the survey via the provided link serves as your voluntary agreement to participate in this research study and your certification that you are at least 18 years old.

Questions regarding the purpose or procedures of the research should be directed to either the primary investigator Madison Medina at mnmedi6248@ung.edu or her faculty research advisor Andrew J. Jakiel at andrew.jakiel@ung.edu. For questions about being a research participant, please contact the chair of the Institutional Review Board (irbchair@ung.edu) or the Assistant Director for Research Integrity, Dr. Troy Smith, 3820 Mundy Mill Road, Oakwood, GA 30566, 678-717-3670, troy.smith@ung.edu.

Page Break

End of Block: Block 1

Start of Block 2

With which gender do you identify?

- Male
- Female
- Other
-

Which age group best applies to you?

- 18-25
- 26-30
- 31-40
- 41-50
- 51+
-

Do you have at least one child that is currently between 0-14 years old?

- Yes
- No

Skip To: End of Survey If Do you have at least one child that is currently between 0-14 years old? = No

Skip To: 5 If Do you have at least one child that is currently between 0-14 years old? = Yes

How many children (14 years of age or younger) do you have?

- 1
- 2
- 3
- 4+

Please indicate your total number of children and their respective ages:

	0-3 years old	4-6 years old	7-10 years old	11-14 years old	N/A
Child 1	<input type="checkbox"/>				
Child 2	<input type="checkbox"/>				
Child 3	<input type="checkbox"/>				
Child 4	<input type="checkbox"/>				
Child 5	<input type="checkbox"/>				
Child 6	<input type="checkbox"/>				
Child 7	<input type="checkbox"/>				

Please select the cosmetic/hygiene products you purchase for your child(ren):

- Shampoo
 - Conditioner
 - Body Wash
 - Toothpaste
 - Mouthwash
 - Deodorant
 - Nail Polish
 - Hand soap
 - Hand sanitizer
 - Lotion
 - Sunscreen
-

Rate how important each factor is to you when purchasing a cosmetic/hygiene product for your child(ren):

	Extremely Important	Very important	Moderately important	Slightly important	Not at all important
Cost	<input type="radio"/>				
Visual Appeal	<input type="radio"/>				
Scent	<input type="radio"/>				
Brand Recognition	<input type="radio"/>				
Ingredients	<input type="radio"/>				
Brand Loyalty	<input type="radio"/>				
Suggested from Friends/Family	<input type="radio"/>				
Advertisements	<input type="radio"/>				
Recommended on Social Media	<input type="radio"/>				

How often do you examine the ingredients list on products for your child(ren)?

- Always
 - Most of the time
 - Sometimes
 - Never
-

Please mark each ingredient that you recognize:

- Parabens
 - Bisphenol A (BPA)
 - Phthalates
 - I do not recognize any of these ingredients
-

How familiar are you with parabens?

- Very familiar
 - Moderately familiar
 - Slightly familiar
 - Not familiar at all
-

How familiar are you with Bisphenol A (BPA)?

- Very familiar
 - Moderately familiar
 - Slightly familiar
 - Not familiar at all
-

How familiar are you with phthalates?

- Very familiar
 - Moderately familiar
 - Slightly familiar
 - Not familiar at all
-

Would you pay more money for products free of the ingredients listed above?

- Yes
 - No
-

Display This Question:

*If Would you pay more money for products free of the ingredients listed above? =
Yes*

How much more would you be willing to spend on products free of the ingredients listed previously, such as parabens, phthalates, and BPA, compared to other products?

- Less than \$1.00
- Less than \$2.00
- Less than \$3.00
- Less than \$5.00
- Less than \$8.00
- More than \$8.00

APPENDIX B:

Figures

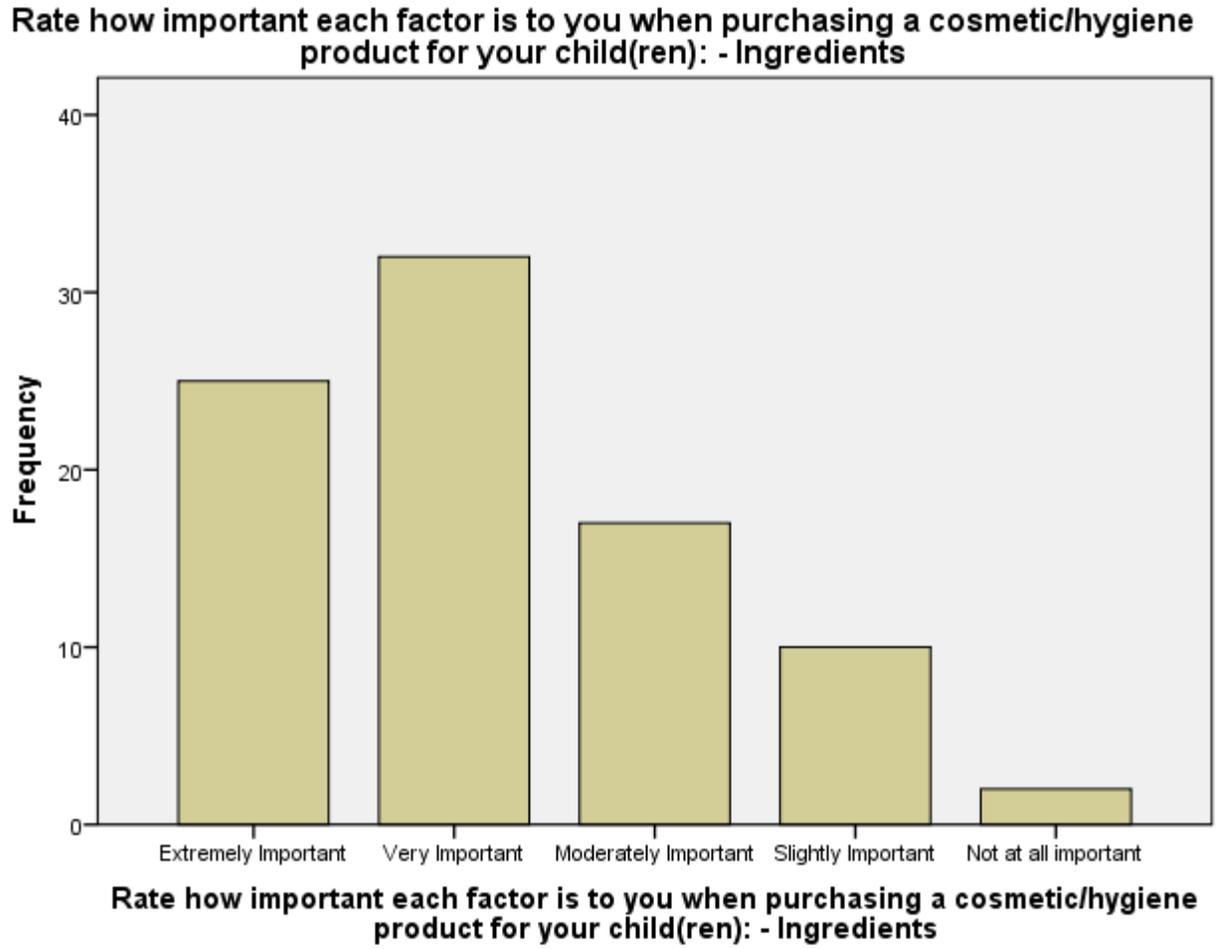


Figure 1: Importance of ingredients to participants



Figure 2: How often participants examine ingredients

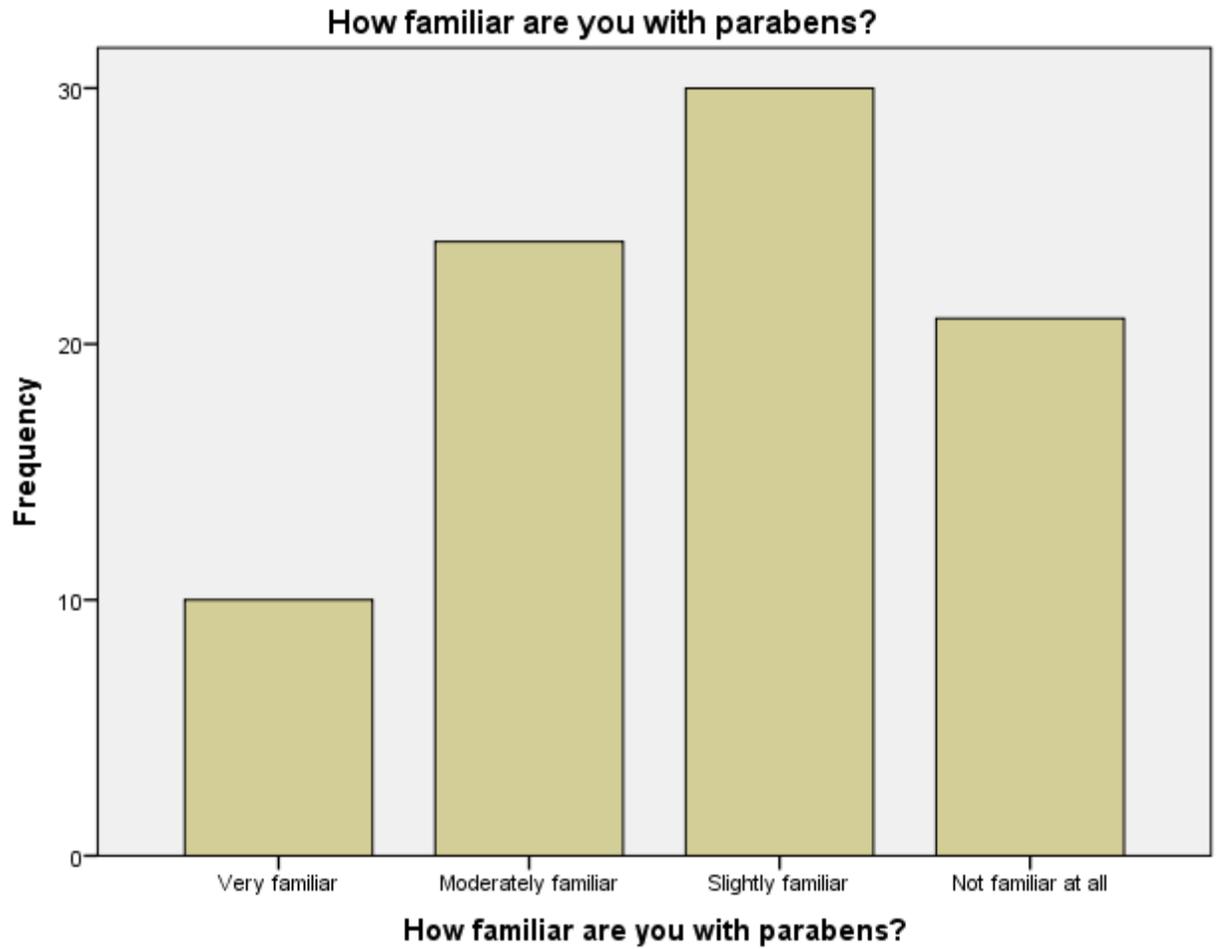


Figure 3: Participants' familiarity of parabens

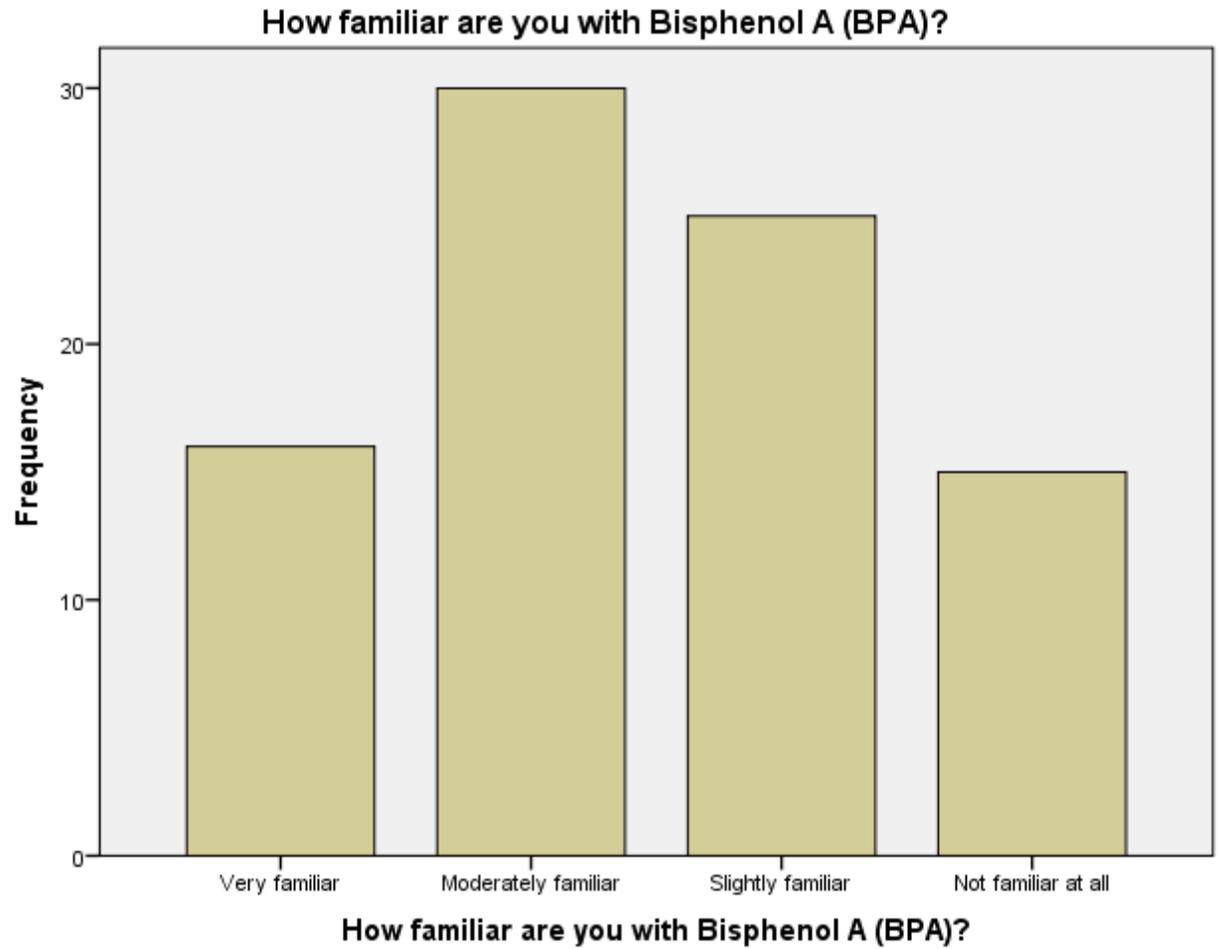


Figure 4: Participants' familiarity of BPA

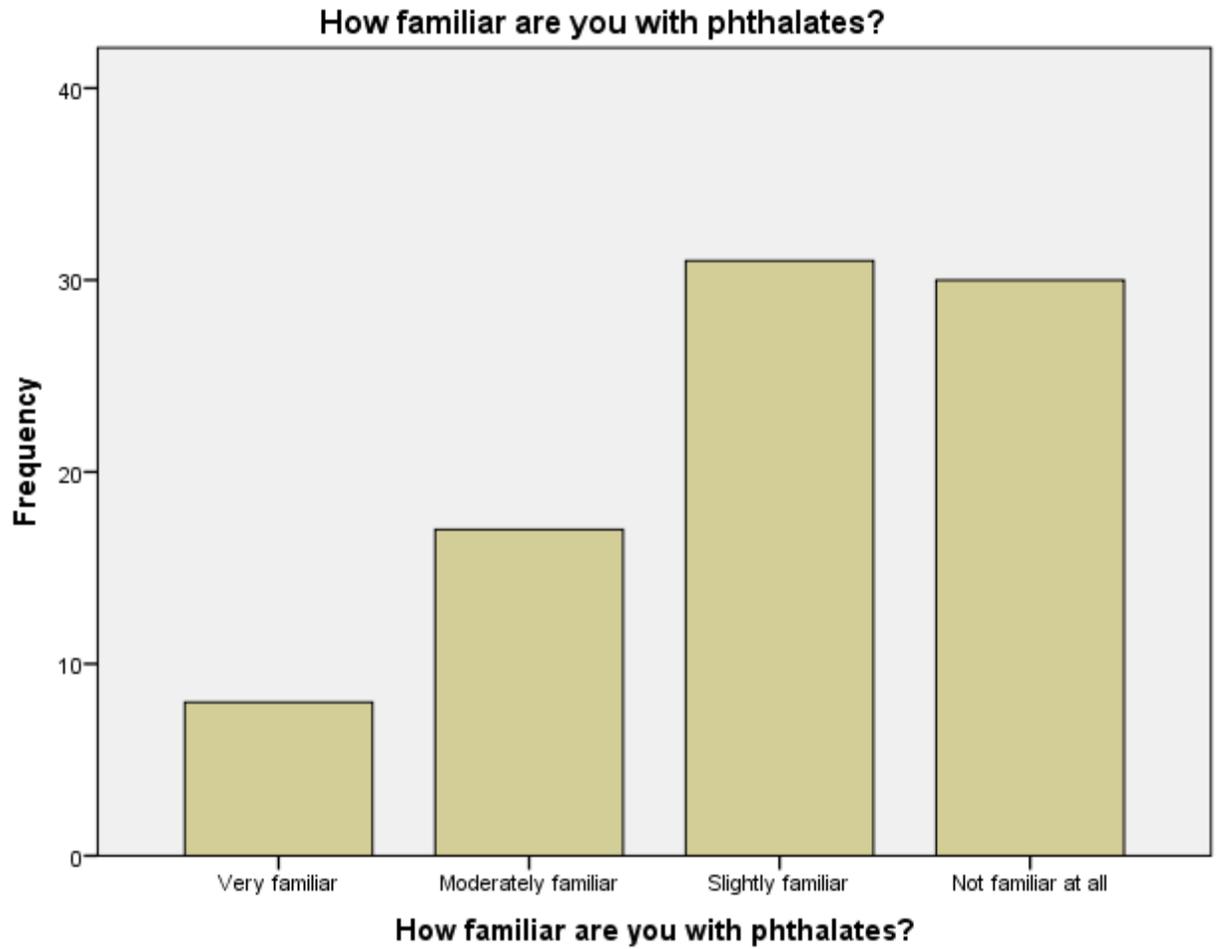
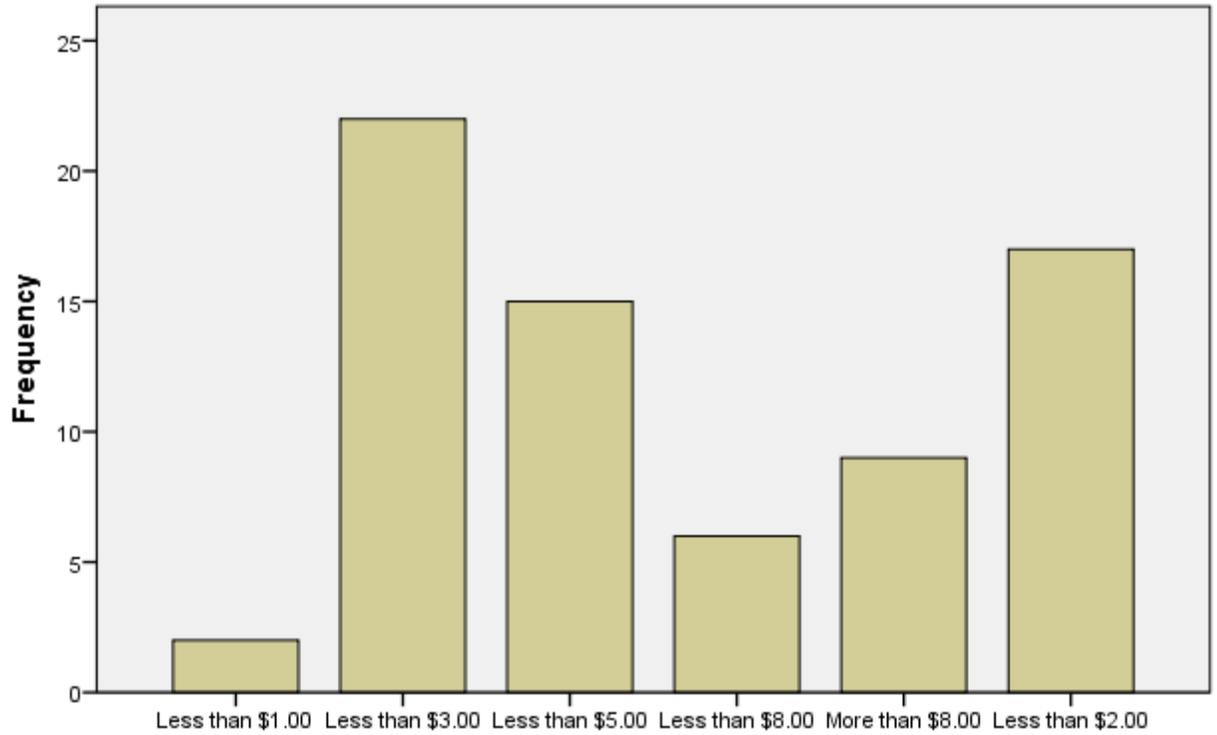


Figure 5: Participants' familiarity of phthalates

How much more would you be willing to spend on products free of the ingredients listed previously, such as parabens, phthalates, and BPA, compared to other products?



How much more would you be willing to spend on products free of the ingredients listed previously, such as parabens, phthalates, and BPA, compared to other products?

Figure 6: How much more participants would spend on products free from EDCs