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Income elasticity of demand for tanning bed usage: evidence from survey data

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ABSTRACT

Using data on U.S. adults from the National Health Interview Survey (NHIS), we estimate the causal income elasticity of tanning bed usage conditional upon use. While controlling for individual characteristics, we employ instrumented probit and count data estimation to show that tanning bed usage is a normal good that is a necessity for all adults, women and men alike. Results suggest an income elasticity magnitude of 0.823 for all adults, which implies that a 10 percent increase in instrumented income increases tanning bed usage by 8.23 percent. When examining 18-25 year olds, the magnitude increases to 1.563—a 10 percent increase in instrumented income causes a 15.63 percent increase in tanning bed usage. The findings add to research on health behaviors and suggest that policymakers wanting to discourage tanning bed usage may have to tax consumption considerably or enhance public health campaigns to prevent and curb usage.

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1. Introduction

Tanning's allure stems partly from symbolism of a youthful glow or a carefree summer. At least that is how it is sold to the public, as a normal part of a beauty routine. Nevertheless, the International Agency for Research on Cancer (IARC) categorizes tanning devices as agents that cause cancer (El Ghissassi et al., 2009). The IARC's analysis of over 20 epidemiological studies concludes that melanoma risk increases by 75% when tanning devices are used before age 30. Recent evidence shows that the cost of direct medical care for cases of melanoma - a disease that occurs when the pigment-producing cells that give color to the skin become cancerous - attributable to exposure to tanning devices is \$343.1 million annually. Importantly, these cases are projected to lead to a total economic loss of \$127.3 billion over the lifetime of the individuals affected (Waters & Adamson, 2018). Beyond these costs, tanning-related illness can lead to loss of productivity and early deaths among tanning bed users.

While the threat of cancer may discourage some people from tanning, tanning salons are still a \$2.7 billion industry in the United States (Thomas, 2020). According to Shaltz (2011), indoor tanning bed technology began spreading in the United States in the 1970's.

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Since that time, usage of tanning beds has become more commonplace. In fact, the tanning industry is a major employer with around 60,000 employees spread across over 7,000 establishments (Thomas, 2020).

The usage of tanning beds and risks connected with their use have been well publicized. More specifically, tanning bed usage is associated with higher rates of skin cancer incidence.¹ With a push by some legislators to generate revenue while discouraging usage, the Patient Protection and Affordable Care Act (ACA) instituted a 10 percent excise tax on tanning bed usage beginning in 2010.² At the time of the passage of the ACA, no empirical research existed on the price elasticity of demand for tanning bed usage or the income elasticity of demand for tanning bed usage. In essence, policymakers put a tax in place with a lack of empirical information on the nature of demand.³

To provide new knowledge on the demand for tanning bed usage, we conduct the first empirical estimate of the income elasticity of demand for tanning bed usage among U.S. adults. We undertake our analysis to describe the demand for tanning bed usage more accurately. The study employs a two-step hurdle model approach using instrumented probit and instrumented count data estimation. Our estimation technique accounts for the nonnegative discrete nature of data on tanning bed usage. Additionally, the empirical method closely mimics research on the income elasticity of demand for smoking – another example in the economics of health behaviors. The findings we present should help better explain the nature of demand for tanning bed usage and possible implications for policies to reduce usage.

Our empirical results from the National Health Interview Study reveal that tanning bed usage is a normal good that is a necessity. Specifically, the total income elasticity of demand for all U.S. adults has magnitude of 0.823 in our statistically significant results. In other words, a 10 percent increase in instrumented income leads to a 8.23 percent increase in tanning bed usage. When performing estimation separately for women and men, we report statistically significant magnitudes of 0.506 and 0.647, respectively. A 10 percent increase in instrumented income causes a 5.06 percent increase in tanning bed usage for women while a 10 percent increase in instrumented income causes a 6.47 percent increase in tanning bed usage for men. When we examine 18-25-yearolds, the results are an alarming 15.63 percent increase in usage from a 10 percent increase in income. Our results add to the public health literature by examining the type of product that works well for a tax with a goal of changing consumption behavior. The normality and necessity of tanning bed usage suggest that policymakers should be cognizant that individuals may not substantively reduce usage because of an incremental tax. In comparison, the tax on cigarettes, while differing by state, is generally higher (Blog, 2020, January 2020). Thus, the excise tax on tanning may be a nuisance tax instead of behavior changing tax. As an alternative, expanding public health campaigns to

¹For examples of the risks and the correlation with skin cancer incidence, see Murray and Turner (2004), Cust et al. (2011), Boniol, Autier, Boyle, and Gandini (2012), Guy et al. (2017), Héry et al. (2010), Lim et al. (2011), and Wehner et al. (2012).

²Farley (2010) highlights that Senate Democrats proposed the tanning bed usage tax as an alternative to a tax on cosmetic surgery. Additionally, some legislators specifically hoped that teenagers would be discouraged from tanning bed usage by the tax. Estimates from the Joint Committee on Taxation (2010) indicate that \$2.7 billion was estimated to be generated from the tax by 2019.

³To date, research on the price elasticity of demand for tanning bed usage does not exist. Moreover, to our knowledge, pricing data does not exist to estimate the price elasticity of demand for tanning bed usage.

discourage usage amoung younger adults ages 18–25 years old may help better prevent usage before it becomes habitual.

This paper is divided into five sections. Section 2 discusses relevant literature and hypotheses concerning our study. Section 3 provides details on the data we utilize and the econometric model. Section 4 contains a discussion of our results while section 5 concludes.

2. Relevant literature and hypotheses

2.1. Industry overview

The allure of tanning continues to outweigh the risks for some individuals. Although an increasing number of people are aware of the dangers of overexposure to UV lighting, indoor tanning usage remains significantly robust. Guy, Berkowitz, Holman, and Hartman (2015) find that while 2 million fewer individuals engaged in tanning between 2010 and 2013, 9.7 million people continue to use indoor tanning. Between 2020 to 2025, Thomas (2020) projects tanning industry revenue growth at an annualized rate of 3.5% culminating in an industry revenue forecast of \$3.1 billion for 2025.

According to Thomas (2020), customers aged 18 to 39 represent 54.1% of tanning industry revenue. Customers over the age of 40 represent 29.1% of total revenue. Usage by customers typically slows between ages 40 and 49 as customers seem to become more worried with the negative health consequences of tanning and less concerned with appearance. Thomas (2020) also notes that usage by customers over age 50 has increased as these users continue tanning or return to tanning. Above age 50 customers may associate a tan with youth and return to tanning to increase attractiveness. Alternatively, some customers may return to tanning before a resort vacation or a cruise to get a base tan. These individuals may generally spend less time outside because of work requirements but have the income for expensive destination vacations, typically in warmer climates. Attaining a base tan before a vacation to prepare skin for exposure is a top tanning myth that continues to persist (Government of New Brunswick, 2020).

According to the American Suntanning Association (2019), indoor tanning is a lifestyle choice. The desire for a tan has maintained itself as individuals believe that they are more attractive with a tan. The tanning bed industry is aware that its customer base is seeking a tan shade depth on which a white t-shirt highly contrasts. While spray tans do darken the skin, spray tans do not provide as dark of a shade. ProSun International, a tanning bed and spray tanning booth manufacturer, notes that tanning beds are easier to use and provide longer-lasting results than spray tans. Spray tans require that the skin be completely shaved and exfoliated and that the customer not bathe for at least eight hours post spray (Admin, 2017). Thus, many customers prefer the ease of a tanning bed that requires less time and preparation. Many customers choose the shade coloring, not just the depth of shade, from a tanning bed. Frequent spray tans can equate to an orange tone which is undesirable, while frequent tanning bed usage equates with a darker brown tone (Brucculieri, 2018). The weakness of less-preferred coloring may equate with a reluctance of customers to stop using tanning beds unless they are willing to accept a lower standard of tan shade and depth quality.

2.2. Addictive or not?

Goodman (1990) defines addiction as " ... a process whereby a behavior, that can function both to produce pleasure and to provide escape from internal discomfort, is employed in a pattern characterized by (1) recurrent failure to control the behavior (powerlessness) and (2) continuation of the behaviour despite significant negative consequences (unmanageability)." Moreover, three primary alternative economic models consider addictive behavior - perfectly rational, irrational, and imperfectly rational, according to Cawley (2008) and Cawley and Ruhm (2011).⁴ While there are competing definitions and theoretical models for addiction, research suggests that tanning bed usage is addictive for some users. Guy et al. (2015) find that frequency of tanning bed usage is higher for both males and females who are former smokers and heavy drinkers but not overweight or obese. K. C. Robinson and Fisher (2014) present that tanning more closely matches the addiction characteristics associated with alcohol and nicotine. They find that tanners react to naltrexone in line with opioid use including the corresponding physiological dependence. A study by Mays, Atkins, Ahn, and Tercyak (2017) finds similar results. Young adult women who were frequent tanners had the strongest association with depression.

Mosher and Danoff-Burg (2010) study 421 college students using the Cut-down, Annoyed, Guilty, and Eye-opener (CAGE) and Diagnostic and Statistical Methods of Mental Disorders (DSM-IV-TR) measures that screen for alcoholism and substanceabuse disorders, respectively. The authors find that, among participants who use tanning beds, 31% meet CAGE criteria and 39% fit DSM-IV-TR criteria for addiction to indoor tanning. Moreover, tanners scoring positive for addiction also present with more symptoms of anxiety and are more frequently users of alcohol, marijuana, and other substances. Stapleton et al. (2016) use the Behavioral Addiction Indoor Tanning Screener (BAITS) to evaluate it for identifying tanning addiction. While the study focuses on the validity of BAITS, the results show that respondents with a higher tendency of indoor tanning addiction exhibit diminished control behavior.

According to the American Suntanning Association (2019) and Goldin (2014), tanning bed usage may not be addictive because the attraction to ultraviolet exposure follows similar biological pathways to activities such as sex and exercise. Additionally, research such as Chung, Gordon, Veledar, and Chen (2010), Gillen and Markey (2012), and J. K. Robinson, Kim, Rosenbaum, and Ortiz (2008) shows that some may choose tanning because of a belief in being more attractive with a tan. With the evidence and arguments in mind concerning addiction or choice, we argue that our income elasticity of demand estimate should align with the claim that tanning bed usage is addictive for some users. For policymakers, the hold that tanning may have on some of its users increases the difficulty of changing a health behavior by a small excise tax.

⁴The perfectly rational addiction model stems from Becker and Murphy (1988), where a rational utility-maximizing individual chooses addiction with stable preferences. Loewenstein (2001), Loewenstein (1999), and Bernheim and Rangel (2004) display the irrational model that features decision making under the guise of emotional experience at the point of consumption. The imperfectly rational model describes addiction in situations where consumers have imperfect information about the chance of becoming addicted. Orphanides and Zervos (1995) and Wang (2007) serve as examples of the imperfectly rational model.

2.3. Social media

The tanning industry presents itself as part of the beauty industry that includes elements such as hair coloring, pedicures, and manicures (Thomas, 2020). In terms of tanning, social media has changed the tanned body from a summer focus to a year-round goal. Social media posts present the tanned body as a healthy body, called the tanned ideal (University of South Australia, 2020). For instance, celebrities acting as social influencers focusing on physical attractiveness may post vacation pictures during winter from beaches worldwide (Aol, 2017). Alternatively, posts may document a social influencer's physical fitness. The pictures are usually part of a social influencer's story to promote themselves or sell a product (University of South Australia, 2020). Similar to a written work, the setting of the story also matters. Using desirable landscapes such as beaches helps invoke feelings of vacation and freedom. Moreover, fitness photos encourage and reinforce the idea of a positive body (Bates, 2020).

Individuals who seek to emulate what they see on social media may post beach or fitness photos to display their picture-ready bodies. The focus is on showing skin and a tan becomes de rigeur for the picture. In practical terms, a tan obscures some of the cellulite and other skin imperfections that a person may have. Thus, social media reinforces an ideal tan (University of South Australia, 2020). The positive reaffirmation from social media can feed into addictive behavior. If a person receives more positive feedback from a post with a tan, the person may be more likely to continue to tan (Myrick, Noar, Sontag, & Kelley, 2020). Social media also magnifies the roles of friends and influencers. Friends may give poor advice about the risks of tanning (Myrick et al., 2020). For example, not everyone knows their risk of melanoma (QIMR Berghofer Medical Research Institute, 2020) Furthermore, the return from friends liking a post may outweigh the risk of potential future cancer from tanning.

In essence, vanity through social media may, in part, drive tanning demand. Additionally, it may be the case that users of tanning beds demand beauty that leads to a derived demand for tanning. Therefore, usage of tanning can become sticky because efforts to reduce tanning may involve changing the demand for beauty and the reaffirmation from social media.

2.4. Elasticity

Research on the price elasticity of demand for tanning bed usage is nonexistent. Even so, an article by Williams (2012) on the European Union (EU) suggests that the magnitude of the price elasticity of demand for tanning bed usage is likely in the region of -0.5 to -2.0. The author makes this argument on the basis that EU member states report price elasticity of demand estimates for tobacco usage that are between -0.5 and -0.7. The presumption is that tanning beds cannot be less sensitive to changes in prices than cigarettes, as cigarettes are likely more addictive than tanning beds. Moreover, Gallet and List (2003) conduct a meta-analysis of 86 studies to show that the median price elasticity of demand for cigarettes is -0.40 in the short run and -0.44 in the long run. Chaloupka and Warner (2000) also confirm that most studies of the price elasticity of demand center on the magnitude of -0.4. Furthermore, Álvarez, Golpe, Iglesias, and Ingelmo (2020) add to this finding by showing that the income elasticity of demand for

cigarettes is 0.403 during economic expansions while the elasticity measures 3.595 in recessionary periods. Martín Álvarez, Almeida, Galiano, and Golpe (2020) also employ Granger causality methods to show that cigarette sales are sensitive to gross domestic product in expansions and to unemployment in recessions.

A meta-analysis by Gallet (2007) on the price elasticity of demand for alcohol shows that the median price elasticity is -0.518 in the short run and -0.816 in the long run. Additionally, Wagenaar, Salois, and Komro (2009) also conduct a meta-analysis of 112 studies and report an overall price elasticity of demand for alcohol of -0.51. Provided tanning bed use is not more addictive than cigarettes or alcohol, we argue it is unlikely that the price elasticity of demand for tanning bed usage is smaller in absolute magnitude than 0.51.

To our knowledge, precise price and quantity demanded data for tanning bed usage does not exist to estimate the price elasticity of demand. However, precise income and quantity demanded data for tanning bed usage does exist to estimate the income elasticity of demand.⁵ According to Hubbard and O'Brien (2017), the magnitude of the income elasticity of demand can reveal the nature of demand for a product, which may narrow the possible range of values for the price elasticity of demand. Specifically, the estimate of the income elasticity of demand reveals whether tanning bed usage is a normal or inferior good, where a positive income elasticity indicates the good is normal and a negative income elasticity indicates the good is inferior. If usage is a normal good, a magnitude of the income elasticity of demand between 0 and 1 shows that tanning bed usage is a necessity. A magnitude of greater than 1, meanwhile, reveals that tanning bed usage is a luxury. Moreover, a necessity or luxury designation tells us whether demand for tanning bed usage is more inelastic or more elastic, respectively. In essence, the necessity or luxury designation helps reveal the nature of demand for tanning bed usage, whether inelastic or elastic, and helps to narrow the possible values for the price elasticity of demand. Because we argue that tanning bed usage is addictive for some users, we hypothesize that the magnitude of the income elasticity of demand for tanning bed usage will be between 0 and 1 to show that tanning bed usage is a necessity. We test our hypothesis that tanning bed usage is a necessity using the empirical strategy we employ in section 3.

2.5. Determinants and gender

Guy et al. (2017) evaluate indoor tanning trends and their association with sunburn for U.S. adults. Using data from the 2010, 2013, and 2015 National Health Interview Survey, the authors show that tanning among adults is more common among women than men, individuals aged 18–29 years old, non-Hispanic whites, and those living in the Midwest U.S. census region. The authors also reveal that the most common users of tanning beds are Non-Hispanic white females aged 18–21 years, with at least 20.4% reporting usage of a tanning bed in the previous year. Coups and Phillips (2011) conduct a review of the determinants of indoor tanning by examining 34 research articles published between 2000 and 2008 on the correlates of indoor tanning. Similar to Schneider and Krämer (2010), who also survey the literature, the authors report that a typical user of tanning beds is female, Caucasian, and a young adult or late adolescent. Other correlates examined in the studies

⁵For more details on our data source, please see section 3.

Coups and Phillips (2011) briefly summarize include education, income, employment status, marital status, and regional place of residence in the U.S. among others.

While research shows that women use tanning beds more than men, men also tan.⁶ Moreover, as Schneider and Krämer (2010) and Coups and Phillips (2011) indicate, correlates of tanning bed usage may vary by gender. For instance, Guy et al. (2015) use data from the 2010 and 2013 National Health Interview Surveys and find an increase in frequency of male users over age 40 with only a slight reduction in usage by males over age 50. Additionally, the study finds a higher frequency of male usage in the Northeast region of the United States. In another case, Ezzedine et al. (2008) use the SU.VI.MAX cohort in France and report that employment status is not a significant predictor of tanning bed usage for men. Given the previous research findings, we hypothesize that women are more likely to use tanning beds than men and use tanning beds more frequently than men. We further hypothesize the magnitude of the income elasticity of demand for tanning bed usage will be between 0 and 1 for women and men while varying in magnitude for women and men.

3. Data

To evaluate the income elasticity of demand for U.S. adults, we use data from the National Health Interview Survey (NHIS) via IPUMS Health Surveys . The data are a national pooled cross section of the civilian U.S. non-institutionalized population with data in any given year coming from approximately 35,000 households containing around 87,500 individuals. Data in our analysis is weighted to account for sampling design features such as the oversampling of persons aged 65 or over who are black, Hispanic, or Asian and to use the data as nationally representative of the individual civilian U.S. non-institutionalized adult population age 18 and over. Because data on tanning bed usage is only reported in years 2005, 2008, 2010, 2013, and 2015, we limit our study to these years. The initial dataset contains 471,170 observations. After dropping observations with missing data or non-response data, the final dataset contains 116,930 observations.

Tables 1, 2, 3 display sample-weighted trends for our dependent variables tanning bed user and annual tanning bed usage for our study for all respondents and by gender. Tanning bed user indicates whether a respondent used a tanning bed in the previous calendar year. In Table 1, the probability of using a tanning bed in a particular year ranges from a low of 3.4 percent in 2015 to a high of 14.9 percent in 2008. Overall, the probability of using a tanning bed in the previous year in gent in the previous year is 8.0 percent. Looking only at respondents who used a tanning bed in the previous year in Table 1, the average amount of tanning bed usage varies from a low of 9.247 times per year in 2008 to a high of 19.412 times per year in 2010. The average amount of tanning bed usage overall is 12.647 times per year. The standard deviation of tanning bed usage is 25.921, which indicates a variance of 671.898. With a variance that is significantly higher than the mean, there appears to be evidence of overdispersion.⁷ We conduct t-tests of the probability of using a tanning bed in a particular year and, for respondents who have used a tanning bed in the previous year, the average amount of

⁶G.T.L. entered the lexicon in 2009 with *Jersey Shore's* Mike "The Situation" Sorrentino continual reference to gym, tan, and laundry as the key activities to do daily to stay attractive.

⁷Overdispersion occurs when the conditional mean is smaller than the conditional variance of the dependent variable, according to Cameron and Trivedi (2010). To address overdispersion, we use negative binomial estimation, which we discuss more in section 3.1.

Variable	Year	Obs	Mean	St. Dev.
User	2005	23,182	0.143	0.350
	2008	16,368	0.149	0.356
	2010	21,831	0.053	0.224
	2013	28,028	0.040	0.196
	2015	27,521	0.034	0.181
	Total	116,930	0.080	0.271
Usage	2005	3,176	10.402	23.742
	2008	2,350	9.247	21.281
	2010	986	19.412	32.685
	2013	1,072	18.338	31.319
	2015	912	16.874	27.621
	Total	8,494	12.647	25.921

 Table 1. Summary statistics of tanning variables for all respondents by year, restricted and weighted sample.

Notes: User is whether respondent used a tanning bed in the past year. Usage is the self-reported number of times a respondent used a tanning bed in the past year.

	3			
Variable	Year	Obs	Mean	St. Dev.
User	2005	12,973	0.171	0.377
	2008	9,067	0.179	0.383
	2010	12,002	0.082	0.274
	2013	15,321	0.062	0.242
	2015	15,040	0.052	0.221
	Total	64,403	0.105	0.307
Usage	2005	2,043	13.493	28.236
-	2008	1,506	11.359	24.242
	2010	784	20.918	34.078
	2013	851	19.343	32.524
	2015	723	17.756	26.728
	Total	5.907	15,167	28,710

Table 2. Summary statistics of tanning variables for women by year, restricted and weighted sample.

Notes: User is whether respondent used a tanning bed in the past year. Usage is the self-reported number of times a respondent used a tanning bed in the past year.

tanning bed usage by gender. Our t-test results indicate that women have a higher probability of tanning bed usage in a particular year (p < 0.001) and a higher average amount of tanning bed usage (p < 0.001). The t-test results add support to our hypothesis that women are more likely to use tanning beds than men and use them more frequently than men.

The key regressor of interest in this study is the log of total family income in 2015 dollars. In this dataset, income data is originally in categorical ranges. To assign an income value to each income range, we follow Currie, Decker, and Lin (2008) and Case, Lubotsky, and Paxson (2002) by using March Current Population Surveys (CPS) data to determine an income value for each income range.⁸ We undertake transforming our income data to

⁸The online appendix for Currie et al. (2008) describes the income assignment process in detail. As stated in the online appendix, "... for each income category in each year, we calculate the mean total household income in the CPS for households who head's education matches that of the reference person in the household and whose income falls into that category. For households containing both a reference person and a spouse, we used the education of the male (whether he was the reference person or not) to match income information across the datasets." Furthermore, in the case of households containing both a reference person and a spouse of the same gender, we used the education of the household member with the higher level of education to match income information across the datasets.

Variable	Year	Obs	Mean	St. Dev.
User	2005	10,209	0.113	0.316
	2008	7,301	0.117	0.322
	2010	9,829	0.023	0.149
	2013	12,707	0.017	0.129
	2015	12,481	0.015	0.123
	Total	52,527	0.054	0.225
Usage	2005	1,133	5.427	12.165
	2008	844	5.883	14.841
	2010	202	13.852	26.256
	2013	221	14.474	25.883
	2015	189	13.733	30.460
	Total	2,589	7.470	17.865

Table 3. Summary statistics of tanning variables for men by year, restricted and weighted sample.

Notes: User is whether respondent used a tanning bed in the past year. Usage is the self-reported number of times a respondent used a tanning bed in the past year.

be able to estimate the income elasticity of demand. Our study's other variables of interest include price, gender, age, race, ethnicity, health status, and educational attainment. Because precise pricing data on tanning bed usage does not exist, we use data from the Bureau of Labor Statistics on the Consumer Price Index (CPI) for the major group of other goods and services by U.S. Census region as a proxy for price.⁹ We employ the CPI for the major group of other goods and services as a proxy for price because it includes tanning salon services pricing as one of many components in its item structure. Control variables consist of labor market status, hours worked per week, marital status, and number of children in a respondent's family. Our correlates align with those that Guy et al. (2017), Schneider and Krämer (2010), and Coups and Phillips (2011) consider.

Weighted descriptive statistics for our final dataset are available in Table 4. For the primary variables of interest, we measure average family income in constant 2015 U.S. dollars and average family income is \$78,261.54.¹⁰ The gender breakdown is 51.1 percent female and 48.9 percent male. Average age is 46.218 years. Race measures show that 81.9 percent of the sample is white, 11.9 percent is black, and 6.3 percent is other race. Ethnicity breaks into 13.9 percent Hispanic and 86.1 percent non-Hispanic. Respondents self-report an average health status between "good" and "very good". For highest educational attainment, 1.4 percent of the sample has a doctoral degree, 1.3 percent has a professional degree, 7.8 percent has a master's degree, 19.0 percent has a bachelor's degree, 10.9 percent has an associate's degree, 19.8 percent completed some college, 26.0 percent has a high school degree, and 13.8 percent has less than a high school degree.

Control variables for labor force status indicate that 63.3 percent of the sample is employed, 4.5 percent is unemployed, and 32.1 percent is out of the labor force. The average amount of hours worked in the past week is 25.236. Marital status indicators show that 57.3 percent of the sample is married, 3.3 percent is living with a partner,

⁹To protect confidentiality, the NHIS does not provide geographic residence information that is lower than the four U.S. census regions in its public use data. Therefore, we use proxy price data at the U.S. census region level. We are aware of only one study by Asdigian et al. (2019) that gathers tanning bed pricing data in 6 U.S. cities. The authors collect data that oversamples young adult neighborhoods and is not designed to be nationally representative.

¹⁰The minimum value for family income is \$-1,036.769 and is correct as it is possible to have losses. A negative income only applies to 7 observations in our final dataset.

Variable	Obs	Mean	St. Dev.	Min	Max
Primary Variables					
Family Income (2015 dollars)	116,930	78,261.541	63,801.780	-1,036.769	294,686.188
Real Price Proxy (2015 dollars)	116,930	3.974	0.224	3.637	4.505
Female	116,930	0.511	0.500	0	1
Male	116,930	0.489	0.500	0	1
Age	116,930	46.218	17.477	18	85
White	116,930	0.819	0.385	0	1
Black	116,930	0.119	0.323	0	1
Other Race	116,930	0.063	0.242	0	1
Hispanic	116,930	0.139	0.345	0	1
Non-Hispanic	116,930	0.861	0.345	0	1
Health $(1 = poor \dots 5 = excellent)$	116,930	3.748	1.070	1	5
Doctoral	116,930	0.014	0.116	0	1
Professional	116,930	0.013	0.113	0	1
Masters	116,930	0.078	0.268	0	1
Bachelors	116,930	0.190	0.392	0	1
Associates	116,930	0.109	0.312	0	1
Some College	116,930	0.198	0.398	0	1
High School	116,930	0.260	0.439	0	1
Less Than High School	116,930	0.138	0.345	0	1
Control Variables					
Employed	116,930	0.633	0.482	0	1
Unemployed	116,930	0.045	0.208	0	1
Out of Labor Force	116,930	0.321	0.467	0	1
Hours Worked (in last week)	116,930	25.236	21.784	0	95
Married	116,930	0.573	0.495	0	1
Living With Partner	116,930	0.033	0.178	0	1
Widowed	116,930	0.058	0.233	0	1
Divorced or Separated	116,930	0.120	0.324	0	1
Never Married	116,930	0.217	0.412	0	1
Number of Children	116,930	0.744	1.095	0	9

Table 4. Descriptive statistics restricted and weighted sample.

5.8 percent is widowed, 12.0 percent is divorced or separated, and 21.7 percent is never married. The average number of children is 0.744 per family.

3.1. Econometric model

Using an approach that closely follows Kenkel, Schmeiser, and Urban (2014), who estimate the income elasticity of demand for smoking, we employ a two-step hurdle model approach using probit and count data estimation. We use probit estimation because our first dependent variable, tanning bed user, is binary and the linear probability model may yield negative predicted values that are not feasible. We employ count data estimation for our second dependent variable, tanning bed usage per year, only has nonnegative integer values. We prefer count data estimation to ordinary least squares because negative predicted values that are not credible can occur for annual tanning bed usage when using ordinary least squares. Furthermore, the distribution of values for tanning bed usage per year is not normal. Values are heavily skewed to outcomes of no usage per year and usage of 1 time per year with a long tail of higher values.

The specific estimators we use are probit with average marginal effects and negative binomial estimation, with sample weighting to adjust for sample design and provide estimates that are nationally representative of the U.S. civilian, non-institutionalized population. We employ negative binomial estimation to address overdispersion. 1166 👄 N. R. MEREDITH ET AL.

The specification below displays the estimating equation:

$$T_{its} = \alpha + \beta \ Income_{its} + \gamma Z_{its} + \delta X_{its} + r_s + d_t + \varepsilon_{its} \tag{1}$$

 T_{its} depicts the tanning bed choices of individual *i* at time *t* in region *s*. The main explanatory variable is total family income, which we log to estimate the income elasticity of demand and denote using *Income_{its}*.¹¹ Other primary variables of interest include price, gender, age, race, ethnicity, health status, and educational attainment, which we represent with Z_{its} . Control variables, which we denote by X_{its} , include employment status, hours worked in the past week, marital status, and family size. Region of residence and year dummies are also controlled for and depicted by r_s and d_t , respectively.¹² The error term is represented by the idiosyncratic ε_{its} .

Our study features two different variables on tanning bed decisions, which are whether a respondent has used a tanning bed in the previous year and annual tanning bed usage. While using a tanning bed is binary, annual tanning bed is nonnegative and discrete. When we use annual tanning bed usage as a dependent variable, we limit the sample to tanning bed users only. To calculate the income elasticity for our binary tanning bed user specification, we follow Kenkel et al. (2014), where $\varepsilon_{Income} = \beta/\bar{T}$ and \bar{T} is the average rate of using a tanning bed in the sample.¹³

3.2. Potential endogeneity

Potential endogeneity of tanning bed decisions stemming from unobservable characteristics such as noncognitive skills could influence the relationship between income and tanning bed decisions. Noncognitive skills can be defined as skills such as motivation, persistence and personality traits, according to Heckman, Stixrud, and Urzua (2006). Currie (2009) also states that noncognitive skills can be measures of mental well-being.

Our estimates of the income elasticity of demand will be biased if endogeneity exists dues to factors such as noncognitive skills. Because the bias could be negative or positive, we do not attach an expected direction to it. The decision to tan may be multifaceted and multifactorial. For example, highly motivated individuals could be more likely or less likely to tan due to misinformation, confirmatory bias, prior beliefs, and attitudes.

We do not quantify the potential bias from noncognitive skills because other omitted factors may exist. To explore potential endogeneity empirically, we employ an instrumental variables approach to test for endogeneity using a method from Wooldridge (2019, pp. 515–516). The instrumental variable we employ is a family's total regional industry sector income per capita. We build our measure using data from the Bureau of Economic Analysis on personal income by North American Industry Classification System (NAICS) at the sector level and state.¹⁴ We compute the total personal income at the NAICS sector level per industry for each U.S. census region and divide it by the

In full detail, the elasticity calculation is
$$\varepsilon_{lncome} = \frac{\partial T}{\partial lncome} = \frac{\partial T}{\partial lncome} = \frac{\partial T}{\partial lncome} = \frac{\beta}{T}$$

¹¹We convert negative income values and income values of 0 to 1 to ensure all variables are identified when we conduct our estimation. This conversion only applies to 7 observations of our final dataset.

¹²To protect confidentiality, the NHIS does not provide geographic residence information that is lower than the four U.S. census regions in its public use data. $\partial T/\tau$

¹⁴Data are from table CAINC5N: Personal Income by Major Component and Earnings by NAICS Industry available at https://apps.bea.gov/regional/downloadzip.cfm

total population of each U.S census region. We match the regional NAICS sector industry income per capita to each NHIS individual with a matching NAICS sector industry of employment. We then compute the sum of all regional sector industry incomes per capita within each family.¹⁵

Our instrumental variable resembles what Goldsmith-Pinkham, Sorkin, and Swift (2020) refer to as the shocks part of a Bartik (1991) instrument. Similar to Borusyak, Hull, and Jaravel (2018), who argue that exogeneity or consistency of the instrumental variable comes from the shocks part of a Bartik (1991) instrument, we assume that changes in regional industry sector income per capita are as-good-as randomly assigned. We also follow Borusyak et al. (2018) by assuming that a shock-level law of large numbers applies, which means that regional industry sector income per capita includes many sufficiently independent shocks and that each has a small average exposure. We expect a positive relationship between a family's total regional industry sector income per capita and total family income as relative economic improvements in a regional industry should translate into higher incomes for individuals working in that sector.

4. Results

Results of our endogeneity test using the approach of Wooldridge (2019, pp. 515–516) indicate rejection of the null hypothesis that log income can be treated as an exogenous regressor (C-statistic = 7.785 and p = 0.01). Therefore, we employ instrumental variables probit and instrumental variables exponential estimation as our preferred specification. We present our empirical results in Tables 5, 6, 7, 8, 9 All of the tables report robust standard errors. We carry out Wald tests to evaluate whether there are differences between coefficient estimates for women and men overall. The Wald tests reveal that estimation should be conducted separately for women and men (Chi-Squared statistics \ge 905.34 and p < 0.01).¹⁶ We explicitly test whether the income elasticity is different for men and women by interacting log income and female gender and adding it as a separate regressor to our estimating equation. Our tests show that the income elasticity magnitude is significantly different for women and men regardless of estimation technique (p < 0.10).¹⁷ Therefore, we estimate all respondents together with a gender dummy for women in addition to running separate estimation for men and women. Variables of interest that include log income, price, gender, age, race, ethnicity, health status, and educational attainment are reported in each table. Tables 5 and 7 presents results using ordinary least squares. Tables 6 and 9 show results using probit and negative binomial estimation. Tables 8, 10, and 11 show results using instrumental variables probit and instrumental variables exponential estimation. Similar to Kenkel et al. (2014), using an instrumental variable approach allows us to estimate the causal effect of income on tanning bed usage. We interpret our instrumental variables results in Tables 8, 10, and 11 as causal and note that the exogenous variation in income comes

¹⁵We perform our computation process of our instrumental variable before dropping any observations from our dataset to ensure that we attain a precise magnitude for each family.

¹⁶We also run Chow tests when using ordinary least squares for estimation. Our Chow tests uncover that estimation should be performed separately for women and men (F-statistic \ge 12.54 and p < 0.01).

¹⁷Tables showing our test results are available from the authors upon request.

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	All Respondents		Women		Men	
_	(1) User	(2) Log Usage	(3) User	(4) Log Usage	(5) User	(6) Log Usage
Log Income	0.003**	0.045**	0.004**	0.031	0.002	0.091***
	(0.001)	(0.018)	(0.002)	(0.023)	(0.001)	(0.028)
Real Price Proxy	0.115***	0.489	0.095**	0.389	0.127***	0.416
	(0.028)	(0.479)	(0.043)	(0.584)	(0.037)	(0.880)
Female	0.058***	0.458***				
	(0.002)	(0.033)				
Age	-0.002***	-0.009***	-0.003***	-0.014***	-0.001***	0.001
	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)	(0.002)
White	0.041***	0.195***	0.067***	0.234***	0.014***	0.100
	(0.003)	(0.060)	(0.005)	(0.086)	(0.004)	(0.075)
Black	-0.034***	-0.335***	-0.048***	-0.451***	-0.019***	-0.172**
	(0.004)	(0.073)	(0.005)	(0.110)	(0.005)	(0.082)
Hispanic	-0.051***	-0.431***	-0.080***	-0.518***	-0.021***	-0.247***
	(0.003)	(0.046)	(0.004)	(0.066)	(0.003)	(0.057)
Health	0.003***	0.018	0.005***	0.011	0.002*	0.036
	(0.001)	(0.016)	(0.001)	(0.022)	(0.001)	(0.022)
Doctoral	-0.034***	-0.158	-0.072***	-0.342*	-0.020***	-0.035
	(0.006)	(0.123)	(0.011)	(0.188)	(0.007)	(0.148)
Professional	-0.032***	-0.255*	-0.066***	-0.329	-0.017**	-0.152
	(0.007)	(0.134)	(0.013)	(0.226)	(0.008)	(0.135)
Masters	-0.026***	-0.076	-0.053***	-0.124	-0.004	-0.054
	(0.004)	(0.080)	(0.007)	(0.108)	(0.006)	(0.107)
Bachelors	-0.007*	-0.065	-0.024***	-0.196**	0.003	0.096
	(0.004)	(0.066)	(0.006)	(0.090)	(0.005)	(0.079)
Associates	0.007*	0.095	0.003	0.021	0.007	0.177**
	(0.004)	(0.069)	(0.006)	(0.093)	(0.005)	(0.087)
Some College	0.012***	0.106*	0.007	0.018	0.012**	0.219***
	(0.004)	(0.063)	(0.005)	(0.088)	(0.005)	(0.076)
High School	0.002	0.097	0.005	0.090	-0.001	0.067
	(0.003)	(0.060)	(0.005)	(0.084)	(0.004)	(0.066)
Income Elasticity	0.036**	0.045**	0.040**	0.031	0.045	0.091***
	(0.015)	(0.018)	(0.018)	(0.023)	(0.027)	(0.028)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589

Table 5. OLS results for all respondents and by gender.

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

solely from our instrumental variable – a family's total regional industry sector income per capita.

Table 5 presents baseline results using ordinary least squares. When using ordinary least squares, we take the natural log of annual tanning bed usage to estimate the income elasticity of demand. The first two columns of Table 5 present the results for all respondents with a binary female gender regressor. The third and fourth columns and the fifth and sixth columns present results for women only and men only, respectively. The first column in each set of two columns displays results for the dependent variable tanning bed user, while the second column in each set of two columns presents results for the dependent variable to user, while log of annual tanning bed usage. The income elasticity row of the table displays the income elasticity coefficient that we calculate from the log of family income coefficient.

The first column of Table 5 indicates that income correlates positively with an increased probability of using a tanning bed for all respondents. The calculated income

	All Respondents		Women		Men	
	(1) User	(2) Usage	(3) User	(4) Usage	(5) User	(6) Usage
	Margins	Neg. Bin.	Margins	Neg. Bin.	Margins	Neg. Bin.
Log Income	0.003***	0.091***	0.004**	0.062**	0.002*	0.107**
	(0.001)	(0.028)	(0.002)	(0.031)	(0.001)	(0.048)
Real Price Proxy	0.089***	0.478	0.077*	0.314	0.068**	1.029
	(0.026)	(0.712)	(0.040)	(0.768)	(0.034)	(1.341)
Female	0.057***	0.573***				
	(0.002)	(0.059)				
Age	-0.002***	-0.014***	-0.003***	-0.020***	-0.001***	0.000
	(0.000)	(0.002)	(0.000)	(0.002)	(0.000)	(0.003)
White	0.039***	0.273**	0.063***	0.187	0.015***	0.249
	(0.003)	(0.133)	(0.005)	(0.192)	(0.004)	(0.167)
Black	-0.040***	-0.731***	-0.056***	-0.934***	-0.022***	-0.455**
	(0.004)	(0.159)	(0.006)	(0.233)	(0.005)	(0.185)
Hispanic	-0.045***	-0.596***	-0.067***	-0.523***	-0.021***	-0.666***
	(0.002)	(0.117)	(0.003)	(0.141)	(0.003)	(0.110)
Health	0.003***	-0.027	0.005***	-0.065**	0.002*	0.055
	(0.001)	(0.026)	(0.002)	(0.031)	(0.001)	(0.043)
Doctoral	-0.035***	-0.654***	-0.060***	-0.943***	-0.020***	-0.264
	(0.007)	(0.176)	(0.010)	(0.247)	(0.007)	(0.211)
Professional	-0.028***	-0.506**	-0.048***	-0.538	-0.015**	-0.296
	(0.007)	(0.242)	(0.011)	(0.355)	(0.007)	(0.231)
Masters	-0.021***	-0.248	-0.041***	-0.385**	-0.003	0.003
	(0.004)	(0.158)	(0.006)	(0.192)	(0.006)	(0.194)
Bachelors	-0.004	-0.185	-0.017***	-0.477***	0.004	0.272**
	(0.004)	(0.122)	(0.006)	(0.147)	(0.005)	(0.138)
Associates	0.010**	-0.053	0.009	-0.194	0.009	0.208
	(0.005)	(0.125)	(0.007)	(0.155)	(0.006)	(0.140)
Some College	0.013***	0.037	0.010*	-0.168	0.013**	0.463***
	(0.004)	(0.118)	(0.006)	(0.148)	(0.005)	(0.129)
High School	0.005	-0.025	0.012**	-0.141	-0.000	0.186
	(0.004)	(0.116)	(0.006)	(0.145)	(0.004)	(0.127)
Income Elasticity	0.036***	0.091***	0.039**	0.062**	0.046*	0.107**
	(0.014)	(0.028)	(0.017)	(0.031)	(0.027)	(0.048)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589

Table 6. Probit average marginal effects and negative binomial results for all respondents and by gender.

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

elasticity measures at 0.036 and is significant at the five percent level. The first column also shows a positive correlation between women and the probability of tanning bed usage. Having statistical significance at the one percent level, the coefficient for the female binary indicator shows that women, relative to men, correlate with a 5.8 percentage point increase in the probability of using a tanning bed. The second column of Table 5 shows that income positively associates with the annual amount of tanning bed usage conditional upon being a tanning bed user. With statistical significance at the five percent threshold, the calculated income elasticity measures 0.045. The female binary correlate in the second column is statistically significant at the five percent level. The estimate suggests that women, relative to men, use tanning beds 45.8 percent more annually. The total elasticity of the demand for tanning bed usage for all respondents with respect to income equals the sum of the user elasticity in the first column and the conditional

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Table 7. IV stage 1 results for all respondents and by gender.

	All					
	Respondents		Women		Men	
Dependent Variable: Log Income	(1) User	2 (Usage)	(3) User	4 (Usage)	(5) User	6 (Usage)
Family Regional Industry Income Per	0.034***	0.040***	0.034***	0.046***	0.038***	0.036***
Capita (thousands of 2015 dollars)						
	(0.002)	(0.008)	(0.003)	(0.010)	(0.003)	(0.012)
Real Price Proxy	0.050	-0.079	-0.011	-0.147	0.097	0.391
	(0.086)	(0.346)	(0.116)	(0.414)	(0.128)	(0.649)
Female	-0.001	-0.007				
	(0.007)	(0.028)				
Age	0.004***	0.005***	0.004***	0.005***	0.004***	0.006***
	(0.000)	(0.001)	(0.000)	(0.001)	(0.000)	(0.002)
White	0.131***	0.128**	0.091***	0.057	0.173***	0.216**
	(0.015)	(0.064)	(0.020)	(0.085)	(0.022)	(0.096)
Black	-0.090***	-0.127	-0.158***	-0.151	0.004	-0.098
	(0.017)	(0.087)	(0.023)	(0.119)	(0.026)	(0.127)
Hispanic	-0.175***	-0.234***	-0.155***	-0.155***	-0.191***	-0.344***
	(0.010)	(0.047)	(0.013)	(0.059)	(0.015)	(0.077)
Health	0.126***	0.143***	0.135***	0.145***	0.112***	0.135***
	(0.003)	(0.013)	(0.004)	(0.016)	(0.005)	(0.022)
Doctoral	0.960***	0.852***	0.949***	1.035***	0.980***	0.728***
	(0.026)	(0.109)	(0.041)	(0.153)	(0.033)	(0.157)
Professional	1.015***	0.822***	0.975***	0.889***	1.042***	0.743***
	(0.028)	(0.160)	(0.037)	(0.165)	(0.039)	(0.273)
Masters	0.816***	0.682***	0.861***	0.657***	0.773***	0.704***
	(0.014)	(0.061)	(0.019)	(0.068)	(0.022)	(0.113)
Bachelors	0.624***	0.463***	0.651***	0.442***	0.597***	0.486***
	(0.013)	(0.061)	(0.018)	(0.068)	(0.019)	(0.112)
Associates	0.431***	0.316***	0.444***	0.287***	0.413***	0.345***
	(0.014)	(0.060)	(0.018)	(0.068)	(0.020)	(0.111)
Some College	0.357***	0.201***	0.378***	0.171**	0.339***	0.238**
	(0.013)	(0.061)	(0.018)	(0.068)	(0.020)	(0.112)
High School	0.236***	0.219***	0.223***	0.179***	0.242***	0.265**
	(0.012)	(0.057)	(0.016)	(0.064)	(0.018)	(0.105)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589
F-statistic for weak identification	238.06	27.73	134.17	21.56	136.30	8.53

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

demand elasticity in the second column. In this case, our total elasticity of demand for tanning bed usage is 0.081. In other words, a 10 percent increase in income correlates with a 0.81 increase in tanning bed usage among all respondents.

The third column of Table 5 displays that income associates positively with an increase in the probability of using a tanning bed or women. With statistical significance at the five percent level, our calculated income elasticity has a magnitude of 0.040. The fourth column of Table 5 indicates a statistically insignificant relationship between income and the annual amount of tanning bed usage for women, conditional on using a tanning bed in the past year. Therefore, the total elasticity of tanning bed usage for women is 0.040. More specifically, a 10 percent increase in income correlates with a 0.40 percent increase in tanning bed usage among women.

	All Respondents		Women		Men	
	(1) User	(2) Usage	(3) User	(4) Usage	(5) User	(6) Usage
	Margins	Exponential	Margins	Exponential	Margins	Exponential
Log Income	0.066***	0.351	0.053*	0.046	0.035†	0.208
	(0.019)	(0.419)	(0.030)	(0.398)	(0.022)	(0.745)
Real Price Proxy	0.093***	0.514	0.080*	0.288	0.070*	1.012
	(0.030)	(0.713)	(0.042)	(0.765)	(0.037)	(1.384)
Female	0.062***	0.575***				
	(0.004)	(0.058)				
Age	-0.002***	-0.015***	-0.004***	-0.020***	-0.001***	-0.001
	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.006)
White	0.038***	0.245*	0.063***	0.187	0.011*	0.221
	(0.006)	(0.144)	(0.008)	(0.194)	(0.007)	(0.223)
Black	-0.041***	-0.674***	-0.054***	-0.929***	-0.024***	-0.417**
	(0.006)	(0.160)	(0.010)	(0.232)	(0.006)	(0.195)
Hispanic	-0.042***	-0.539***	-0.065***	-0.529***	-0.018***	-0.606**
	(0.006)	(0.149)	(0.008)	(0.151)	(0.007)	(0.292)
Health	-0.004	-0.061	-0.002	-0.063	-0.001	0.038
	(0.003)	(0.066)	(0.005)	(0.065)	(0.003)	(0.111)
Doctoral	-0.072***	-0.883**	-0.085***	-0.938**	-0.040**	-0.365
	(0.013)	(0.399)	(0.021)	(0.475)	(0.017)	(0.591)
Professional	-0.070***	-0.701*	-0.078***	-0.497	-0.039**	-0.402
	(0.015)	(0.426)	(0.023)	(0.510)	(0.019)	(0.609)
Masters	-0.061***	-0.425	-0.071***	-0.373	-0.025	-0.110
	(0.013)	(0.322)	(0.020)	(0.319)	(0.016)	(0.542)
Bachelors	-0.041***	-0.301	-0.046**	-0.463**	-0.015	0.184
	(0.012)	(0.219)	(0.018)	(0.230)	(0.014)	(0.373)
Associates	-0.017*	-0.138	-0.014	-0.182	-0.005	0.132
	(0.010)	(0.186)	(0.015)	(0.197)	(0.011)	(0.306)
Some College	-0.009	-0.014	-0.008	-0.160	0.002	0.404*
	(0.009)	(0.145)	(0.013)	(0.164)	(0.010)	(0.220)
High School	-0.010	-0.082	0.001	-0.133	-0.008	0.124
	(0.006)	(0.149)	(0.009)	(0.162)	(0.007)	(0.247)
Income Elasticity	0.823***	0.351	0.506*	0.046	0.647†	0.208
	(0.238)	(0.419)	(0.286)	(0.398)	(0.407)	(0.745)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589

 Table 8. IV stage 2 probit average marginal effects and exponential results for all respondents and by gender.

Robust standard errors in parentheses

+ significant at 12%; * significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

The fifth and sixth columns of Table 5 show our results for men. The fifth column reveals a positive and statistically insignificant relationship between income and the probability of using a tanning bed. The sixth column shows that income positively associates with the annual amount of tanning bed usage conditional upon use and with statistical significance at the one percent threshold. We calculate a magnitude of 0.091 for the income elasticity. The total elasticity of demand for men, therefore, is 0.091. A 10 percent increase in income correlates with a 0.91 increase in tanning bed usage for men.

Our ordinary least squares estimates in Table 5 suggest that tanning bed usage is normal and a necessity. The results from Table 5 also indicate that women are more likely than men to tan and that, conditional upon use, women tan more than men. The

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	All Respondents		Women		Men	
	(1) User	(2) Usage	(3) User	(4) Usage	(5) User	(6) Usage
	Margins	Neg. Bin.	Margins	Neg. Bin.	Margins	Neg. Bin.
Log Income	-0.067	0.122	-0.111	0.435	-0.043	-0.213
	(0.083)	(0.250)	(0.103)	(0.295)	(0.146)	(0.410)
Log Income Squared	0.004	-0.002	0.007	-0.018	0.003	0.016
	(0.004)	(0.013)	(0.005)	(0.015)	(0.007)	(0.021)
Real Price Proxy	0.694***	0.478	0.490*	0.332	0.708**	1.008
	(0.204)	(0.712)	(0.259)	(0.770)	(0.349)	(1.342)
Female	0.453***	0.573***				
	(0.016)	(0.059)				
Age	-0.015***	-0.014***	-0.021***	-0.020***	-0.007***	0.000
	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)
White	0.359***	0.273**	0.493***	0.173	0.168***	0.242
	(0.034)	(0.133)	(0.047)	(0.195)	(0.051)	(0.168)
Black	-0.373***	-0.732***	-0.441***	-0.953***	-0.264***	-0.456**
	(0.045)	(0.158)	(0.059)	(0.234)	(0.067)	(0.186)
Hispanic	-0.420***	-0.597***	-0.535***	-0.526***	-0.248***	-0.656***
	(0.026)	(0.117)	(0.033)	(0.140)	(0.041)	(0.112)
Health	0.024***	-0.027	0.030***	-0.063**	0.024*	0.053
	(0.008)	(0.026)	(0.010)	(0.031)	(0.013)	(0.043)
Doctoral	-0.339***	-0.652***	-0.519***	-0.908***	-0.248**	-0.297
	(0.078)	(0.179)	(0.116)	(0.251)	(0.107)	(0.211)
Professional	-0.259***	-0.501**	-0.393***	-0.506	-0.189*	-0.370
	(0.073)	(0.245)	(0.109)	(0.361)	(0.099)	(0.233)
Masters	-0.188***	-0.247	-0.307***	-0.373*	-0.039	-0.016
	(0.040)	(0.159)	(0.050)	(0.193)	(0.066)	(0.196)
Bachelors	-0.039	-0.185	-0.118***	-0.469***	0.038	0.261*
	(0.031)	(0.122)	(0.040)	(0.148)	(0.051)	(0.141)
Associates	0.071**	-0.053	0.052	-0.199	0.084	0.206
	(0.033)	(0.124)	(0.042)	(0.154)	(0.055)	(0.141)
Some College	0.096***	0.037	0.064*	-0.164	0.122**	0.456***
	(0.029)	(0.119)	(0.037)	(0.148)	(0.048)	(0.130)
High School	0.038	-0.025	0.073**	-0.143	-0.005	0.184
	(0.028)	(0.116)	(0.036)	(0.145)	(0.045)	(0.127)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589

 Table 9. Probit average marginal effects and negative binomial results for all respondents and by gender.

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

evidence supports our hypotheses that tanning bed usage is a necessity and that women are more likely to use tanning beds than men and use tanning beds more frequently than men. We also find that the magnitude of the total income elasticity of demand varies for women and men. Furthermore, the size of the income elasticity of demand aligns with the argument that tanning bed usage is addictive for some users.

Table 6 reveals the probit results with average marginal effects and negative binomial estimation. Table 6 follows an organizational pattern that is identical to Table 5. The first column of Table 6 shows a positive correlation between income and the probability of tanning bed usage. Specifically, the calculated elasticity is 0.036 with statistical significance at the one percent threshold. The female binary indicator in the first column is statistically significant at the one percent level and

	All Respondents		Women		Men	
	(1) User	(2) Usage	(3) User	(4) Usage	(5) User	(6) Usage
	Margins	Exponential	Margins	Exponential	Margins	Exponential
Log Income	0.062***	0.341	0.030	0.223	0.032	-0.264
	(0.021)	(0.480)	(0.036)	(0.467)	(0.022)	(0.843)
ACA x Log Income	0.013	0.020	0.051*	-0.450	-0.007	1.414*
	(0.017)	(0.446)	(0.029)	(0.481)	(0.019)	(0.773)
Real Price Proxy	0.099***	0.527	0.103**	0.087	0.065*	1.603
	(0.031)	(0.785)	(0.045)	(0.813)	(0.037)	(1.548)
Female	0.063***	0.575***				
	(0.004)	(0.058)				
Age	-0.002***	-0.015***	-0.004***	-0.019***	-0.001***	-0.002
	(0.000)	(0.003)	(0.000)	(0.003)	(0.000)	(0.006)
White	0.038***	0.250*	0.065***	0.173	0.012*	0.290
	(0.007)	(0.145)	(0.009)	(0.197)	(0.007)	(0.229)
Black	-0.041***	-0.671***	-0.054***	-0.875***	-0.023***	-0.456**
	(0.007)	(0.167)	(0.011)	(0.245)	(0.006)	(0.194)
Hispanic	-0.042***	-0.540***	-0.066***	-0.483***	-0.019***	-0.706**
	(0.007)	(0.164)	(0.009)	(0.167)	(0.007)	(0.315)
Health	-0.005	-0.060	-0.002	-0.071	-0.000	0.074
	(0.003)	(0.068)	(0.005)	(0.067)	(0.003)	(0.120)
Doctoral	-0.074***	-0.858*	-0.091***	-1.010**	-0.035*	0.081
	(0.014)	(0.440)	(0.021)	(0.513)	(0.019)	(0.680)
Professional	-0.071***	-0.699	-0.084***	-0.546	-0.033	0.372
	(0.015)	(0.472)	(0.023)	(0.506)	(0.021)	(0.828)
Masters	-0.063***	-0.414	-0.078***	-0.383	-0.020	0.175
	(0.013)	(0.335)	(0.020)	(0.324)	(0.018)	(0.607)
Bachelors	-0.042***	-0.291	-0.050***	-0.459**	-0.010	0.422
	(0.012)	(0.229)	(0.019)	(0.231)	(0.015)	(0.422)
Associates	-0.018*	-0.128	-0.015	-0.194	-0.002	0.348
	(0.010)	(0.197)	(0.016)	(0.201)	(0.012)	(0.346)
Some College	-0.010	-0.003	-0.009	-0.167	0.004	0.592**
	(0.009)	(0.157)	(0.014)	(0.168)	(0.010)	(0.260)
High School	-0.010	-0.074	0.000	-0.142	-0.006	0.297
	(0.006)	(0.160)	(0.000)	(0.166)	(0.007)	(0.281)
Income Elasticity	0.777***	0.341	0.288	0.223	0.599	-0.264
	(0.263)	(0.480)	(0.343)	(0.467)	(0.407)	(0.843)
ACA x Income Elasticity	0.158	0.020	0.486*	-0.450	-0.136	1.414*
	(0.213)	(0.446)	(0.276)	(0.481)	(0.352)	(0.773)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	116,930	8,496	64,403	5,907	52,527	2,589

Table 10. IV stage 2 probit average marginal effects and exponential results for all respondents and b	y
gender.	

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Widowed, Divorced or Separated, and Number of Children

indicates that women, relative to men, correlate with a 5.7 percentage point increase in the probability of using a tanning bed. The second column of Table 6 reveals, conditional upon use, a positive correlation between income and annual tanning bed usage that is statistically significant at the one percent level. Namely, the calculated income elasticity has a magnitude of 0.091. The female binary indicator in the second column shows statistical significance at the one percent level and indicates that women use tanning beds 77.4 percent more per year than men,

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	All Respondents		Women		Men		
	(1) User	(2) Usage	(3) User	(4) Usage	(5) User	(6) Usage	
	Margins	Exponential	Margins	Exponential	Margins	Exponential	
Log Income	0.210***	-0.397	0.197***	-0.080	0.220***	-0.460	
	(0.016)	(0.565)	(0.031)	(0.697)	(0.017)	(0.474)	
Real Price Proxy	0.122	0.093	0.094	-0.161	0.139	-1.151	
	(0.099)	(1.188)	(0.148)	(1.323)	(0.125)	(2.471)	
Female	0.095***	0.971***					
	(0.036)	(0.111)					
Age	0.003	-0.063	-0.000	-0.050	0.006*	-0.017	
-	(0.002)	(0.044)	(0.004)	(0.050)	(0.003)	(0.050)	
White	0.028	0.440**	0.061	0.506**	-0.002	-0.068	
	(0.026)	(0.177)	(0.045)	(0.225)	(0.028)	(0.226)	
Black	-0.043	-0.457	-0.054	-0.349	-0.040	-1.222***	
	(0.037)	(0.381)	(0.052)	(0.410)	(0.064)	(0.411)	
Hispanic	-0.050**	-0.556***	-0.082**	-0.447**	-0.023	-0.561***	
•	(0.024)	(0.166)	(0.038)	(0.205)	(0.031)	(0.204)	
Health	-0.027***	0.016	-0.020*	-0.091	-0.032***	0.281**	
	(0.007)	(0.112)	(0.011)	(0.122)	(0.011)	(0.131)	
Doctoral							
Professional	0.167*	0.039	0.312***	0.118			
	(0.089)	(0.487)	(0.095)	(0.596)			
Masters	-0.103**	-0.599	-0.114**	-0.548			
	(0.044)	(0.652)	(0.048)	(0.756)			
Bachelors	0.011	-0.034	0.031	-0.219	-0.000	-0.059	
	(0.015)	(0.220)	(0.031)	(0.245)	(0.018)	(0.377)	
Associates	-0.013	0.211	0.016	-0.158	-0.029	0.135	
	(0.019)	(0.240)	(0.037)	(0.259)	(0.025)	(0.371)	
Some College	0.036**	0.317	0.053*	-0.025	0.034*	0.821***	
-	(0.015)	(0.238)	(0.031)	(0.284)	(0.019)	(0.277)	
High School	0.001	0.046	0.036	-0.141	-0.016	0.019	
	(0.009)	(0.195)	(0.029)	(0.235)	(0.018)	(0.232)	
Income Elasticity	1.563***	-0.397	0.971***	-0.080	3.189***	-0.460	
	(0.119)	(0.565)	(0.153)	(0.697)	(0.242)	(0.474)	
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	
Region Effects	Yes	Yes	Yes	Yes	Yes	Yes	
Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	
Observations	12,868	1,714	6,745	1,321	6,030	393	

Table	11.	IV	stage	2	probit	average	marginal	effects	and	exponential	results	for	18–25	year	old
respor	nder	nts a	and by	/ q	ender.										

Robust standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%

Control Variables include: Employed, Unemployed, Hours Worked, Married, Living With Partner, Divorced or Separated, and Number of Children

relative to men and conditional upon tanning bed usage.¹⁸ The total elasticity of demand for tanning bed usage is 0.127. A ten percent increase in income associates with a 1.27 percent increase in tanning bed usage.

The third column of Table 6 shows that income has a positive relationship with the probability of using a tanning bed for women. With statistical significance at the five percent level, the calculated elasticity measures 0.039. The fourth column of Table 6 also displays a positive association between income and annual tanning bed usage with statistical significance at the five percent threshold. The calculated elasticity

¹⁸To interpret coefficients for a dummy variable in a count data estimated model, coefficients must be adjusted, according to Cameron and Trivedi (2010, pp. 343–346). To adjust a dummy variable coefficient, $\hat{\beta}$, the following operation is performed: [exp($\hat{\beta}$)-1]. For example, in the second column of Table 6, the adjustment for the coefficient for women is [exp(0.573)-1] = 0.774, which is 77.4% in percentage form.

magnitude is 0.062. In other words, the total income elasticity of demand for women's tanning bed usage is 0.101. A 10 percent increase in income correlates with a 1.01 percent increase in tanning bed usage.

The fifth column of Table 6 indicates a positive and statistically significant relationship between income and the probability of tanning bed usage for men at the ten percent level. The calculated elasticity measures 0.046. At the same time, the sixth column of Table 6 shows, conditional upon use, a positive relationship between income and annual tanning bed usage at the five percent level of statistical significance. The calculated elasticity is 0.107. The total income elasticity of demand for men is 0.153. The magnitude implies that a 10 percent increase in income correlates with a 1.53 percent increase in tanning bed usage for men.

Table 7 displays first-stage results and F-statistics as part of our preferred instrumental variables approach. Each table column differs according to the dependent variable we use in the second stage. Our F-statistics exceed a critical value of 10 in columns 1–5, as Staiger and Stock (1997) recommend. Because column 6 presents a F-statistic of 8.80 that is less than 10, we adopt a just-identified instrumental variables specification to avoid a potential weak instrument problem, as Angrist and Pischke (2009) advise. All columns of Table 7 indicate a positive correlation between a family's total regional industry sector income per capita in thousands of 2015 dollars and the log of family income at the one percent level of statistical significance.

Table 8 shows our preferred specification results for instrumental variables probit with average marginal effects and instrumental variables exponential estimation. Table 8 has an organizational structure that aligns with Tables 5 and 6. Column 1 indicates that additional income leads to an increase in the probability of tanning bed usage. The calculated elasticity is 0.823 with statistical significance at the one percent level. The binary indicator for female gender is statistically significant and shows that women, relative to men, correlate with a 6.2 percentage point increase in the probability of tanning bed usage. Column 2 reveals, conditional upon use, that there is no statistically significant relationship between income and tanning bed usage. The female binary indicator shows statistical significance at the one percent threshold and displays that, relative to men and conditional upon usage, that women use tanning beds 77.7 percent more per year than men. The total income elasticity of demand has a magnitude of 0.825. A ten percent increase in income results in an 8.25 percent increase in tanning bed usage.

The third column of Table 8 shows a positive causal relationship between income and the probability of using a tanning bed for women. The calculated elasticity has a magnitude of 0.506 with statistical significance at the ten percent level. Conditional on tanning bed use in the past year, the fourth column indicates no statistically significant relationship between income and annual tanning bed usage for women. Therefore, the total income elasticity of demand has a magnitude of 0.506, which means that a - ten percent increase in income triggers a 5.06 percent increase in tanning bed usage.

The fifth column of Table 8 reveals a positive effect of income on the probability of using a tanning bed for men. With a magnitude of 0.647, the calculated elasticity has statistical significant at the twelve percent level. The sixth column shows no statistically significant relationship between income and tanning bed usage for men, conditional upon use. The total income elasticity of demand indicates that a ten percent increase in income leads to a 6.47 increase in tanning bed usage.

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The results in Tables 5, 6, and 8 indicate the significance of using instrumental variable probit with average marginal effects and instrumental variables exponential estimation. Compared to the results in Tables 5 and 6, the magnitude of the total income elasticity of demand for tanning bed usage is larger for all respondents, women, and men when using instrumental variables probit with average marginal effects and instrumental variables exponential estimation in Table 8. The estimates in Table 8 still support our hypotheses that tanning bed usage is a necessity and that women are more likely to use tanning beds than men and use tanning beds more frequently than men. We also report the total income elasticity of demand varies for women and men in magnitude. Specifically, the value of the income elasticity of demand in Table 8 ranges from 0.825 for all respondents to 0.505 for women to 0.647 for men. Furthermore, the magnitude of the elasticity values suggest that the demand for tanning bed usage is relatively inelastic, which aligns with the argument that tanning bed usage is addictive for some users. Demand appears the most inelastic for women. With this evidence in mind, policymakers wanting to reduce usage of tanning beds may have to institute taxes in excess of the ten percent usage tax enacted by Patient Protection and Affordable Care Act to substantively reduce tanning bed usage.

4.1. Robustness checks

As our first robustness check, we test whether the income elasticity varies by the level of income by adding a quadratic term, log income squared, to our estimating equation. We present probit with average marginal effects and negative binomial estimates in Table 9.¹⁹ The coefficient on the log income squared term is not statistically significant in Table 9. Therefore, the evidence indicates that the income elasticity does not appear to depend on the level of income.

For our second robustness check, we repeat the estimation of our preferred specification and include imputed income values to increase the size of our dataset. We include imputed income values because research such as Currie et al. (2008) notes that using the NHIS can result in substantive data loss when only including respondents with reportedWe compute the total personal income at the NAI incomes.²⁰ Additionally, National Center for Health Statistics (2018) confirms that nonresponse rates for total family income data are high. We employ all five imputed income possibilities available in the NHIS to reestimate our preferred specification. While magnitudes fluctuate to a limited extent, none of the preferred results in Table 8 vary significantly when using additional observations that contain imputed income data.

The third robustness check we conduct examines whether our elasticity estimates fluctuate before and after the ACA's tanning usage tax became effective in 2010. We carry out Wald tests to evaluate whether there are differences between coefficient estimates

¹⁹We attempted estimation using instrumental variables probit with average marginal effects and instrumental variables estimation by squaring our instrumental variable to instrument for log income squared, but we were unable to attain convergence using either a maximum likelihood or two-step estimator for instrumental variable probit. We were also unable to obtain convergence using a general method of moments estimator or control-function estimator for instrumental variables exponential estimation.

²⁰Within our study, the greatest loss of data comes from missing or non-response data on tanning bed usage. More precisely, we begin with 471,170 observations initially and lose 122,265 observiations from missing or non-response data on tanning bed usage. Asking respondents about tanning bed usage was part of the core questionnaire of the NHIS in 2008 and 2013 while it was only part of the cancer control supplemental questionnaire in 2005, 2010, and 2015.

overall for the pre-ACA (i.e., 2005 and 2008) and ACA (i.e., 2010, 2013, and 2015) periods. Results support conducting separate estimation for the pre-ACA and ACA periods (Chi-Squared statistics \geq 93.55 and p < 0.001). To more specifically evaluate the pre-ACA and ACA income elasticity measures, we add an interaction term for the ACA period and log of family income to look for differences. Results of our estimation appear in Table 10. For all respondents, the total income elasticity pre-ACA has a magnitude of 0.777 while the ACA magnitude is statistically insignificant. Women have a total income elasticity in the pre-ACA period that is statistically insignificant while the ACA period has a magnitude of 1.414. While the results of our robustness check indicate some fluctuations in the size of the income elasticity of demand is between 0 and 1 for all respondents and women. The magnitude for men suggests that the income elasticity of demand for men may depend on the time period we evaluate.

As our fourth robustness check, we evaluate our preferred specification for young adults aged 18 to 25 years. Guy et al. (2017), Coups and Phillips (2011), and Schneider and Krämer (2010) demonstrate that tanning bed usage is more common among younger adults. Therefore, our elasticity magnitudes could be different among this age group. We present our results for young adults in Table 11. We obtain total income elasticity of demand magnitudes of 1.563 for all young adults, 0.971 for young women, and 3.189 for young men, with statistical significance at the one percent level. Our results show that tanning bed usage is a luxury for young adults and young men while remaining a necessity for young women. The magnitudes suggest that younger adults have a more elastic demand for tanning bed usage relative to all adults. Consequently, public health education policies such as the Indoor Tan-Free Skin Smart Campus initiative from Centers for Disease Control and Prevention (2021) could help significantly reduce tanning bed usage by educating young adults about the risks of tanning before they move into a higher income bracket after graduating college. As a consequence, there could be a significant reduction in associated health and economic costs that pertain to tanning bed usage.

5. Conclusions

The empirical results of this study show that the income elasticity of demand for tanning bed usage falls in a range that suggests tanning bed usage is a necessity. We argue that these findings are, in part, due to addictive behavior from some users, which is reinforced by social media. Furthermore, some users are willing to ignore or downplay the risks from tanning bed usage to try to obtain the positive social return of increased attractiveness from tanning. The pervasiveness of social media posts of tanned individuals induces sticky demand for some users. We also find that the magnitude of the income elasticity of demand is less for women than men. The overall results suggest that reducing tanning bed usage may necessitate a larger usage tax. Encouragingly, we also find that public health education efforts that are targeted toward young adults may be helpful in significantly reducing usage and its associated costs. 1178 🛞 N. R. MEREDITH ET AL.

This study is the first to estimate an income elasticity of demand for tanning bed usage for the U.S. adult population. We employ instrumental variables probit with average marginal effects and instrumental variables exponential estimation because we argue that it provides accurate estimates given the nature of the data. Probit estimation constrains estimates to produce predicted values of the dependent variable between 0 and 1. Count data exponential estimation ensures that negative values of tanning bed usage, a nonnegative variable, cannot result.

Our study has limitations. First, the instrumental variables approach limits explaining variation in income to variation in a family's total regional industry sector income per capita. Second, we only provide estimates for the U.S. and our results may not apply well in other parts of the world. Third, our dependent variable, usage of a tanning bed in the past year, is self-reported and could be inaccurate due to survey respondent error. Finally, the most recent data for our analysis occurs in 2015 and it is possible that the relationship between income and tanning bed usage has changed in the more recent past.

Further research should explore the price elasticity of demand for tanning bed usage if precise price and quantity demanded data become available. If data become available, panel data estimation should be conducted to control for unobserved heterogeneity. If access to restricted NHIS data can be obtained, future research should use alternative instruments such as the earned income tax credit to further examine the causal relationship between family income and tanning bed usage.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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