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Original Research

Obesity and Prescription of Smoking Cessation Medications

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Abstract

Background: Tobacco use and obesity remain the primary and secondary preventable causes of mortality and morbidity in the United States. The objective of this study was to examine differences in prescription of smoking cessation medications among smokers with different body mass index (BMI) classifications.

Methods: A retrospective cross-sectional study was conducted using the National Health and Nutrition Examination Survey data (1999 - 2008). The study included smokers 18 years and older who self-reported their smoking status. The outcome variable was an indicator for whether or not the smoker received an FDA-approved smoking cessation medication. Multivariate logistic regression analyses were conducted to assess the association between the outcome variable and the main independent variable (BMI classification) controlling for other covariates.

Results: The study found that 2.72% of normal weight smokers were prescribed cessation medications, while 1.57% and 2.54% of overweight and obese smokers were prescribed cessation medications, respectively. Overweight smokers were less likely to be prescribed cessation medications as compared to normal weight smokers, however this finding was observed only after controlling for self-perceived weight. In addition, smokers who perceived themselves as overweight had a higher likelihood of being prescribed cessation medications. Older smokers, women, non-Hispanic whites, and smokers with a college degree or above, higher income and public insurance were more likely to receive smoking cessation medications.

Conclusions: Self-perceived overweightness is positively associated with the prescription of cessation medications. This finding probably indicates that lower prescription of cessation medications among overweight smokers is driven by provider (instead of patient) preferences, thereby raising concerns about healthcare inequities among overweight/obese smokers.

INTRODUCTION

Smoking remains the leading preventable cause of morbidity and mortality, with an estimated 438,000 deaths per year in the United States (US) [1]. An additional 8.6 million Americans suffer from diseases caused by smoking [1]. Smoking is associated with the occurrence of 80-90% of chronic obstructive pulmonary diseases (COPD) [2], 11% of cardiovascular diseases (CVD) [3], 87% of male lung cancers, and 70% of female lung cancers [4-8]. It is also strongly associated with the occurrence of other cancers, anemia, neuropsychiatric disorders, venous thromboembolism, and increased mortality among patients with type 2 diabetes [9-12]. On average, the life expectancy of a regular smoker is approximately 13 years shorter than that of a non-smoker [13]. The total annual healthcare expenditure due to smoking for public and private payers is as high as $96 billion US dollars [14].

Smoking cessation is highly recommended by World Health Organization (WHO) and Centers for Disease

Control and Prevention (CDC) [15,16]. However, recent evidence shows that despite the benefits of smoking cessation, there is an initial increased risk of weight gain, diabetes, and hypertension following smoking cessation. Yeh et al. found that compared with adults who never smoked, the hazard ratios (HRs) of diabetes among former smokers, new quitters, and continuing smokers were 1.22 (95% CI, 0.99 to 1.50), 1.73 (95% CI, 1.19 to 2.53), and 1.31 (95% CI, 1.04 to 1.65), respectively, and the highest risk occurred in the first 3 years after cessation (HR: 1.91, 95% CI: 1.19 to 3.05) [17]. Iino et al. found a significant increase in HbA(1c) levels, diastolic blood pressure and fasting blood glucose levels following smoking cessation [18]. Other studies have also observed an increased risk of type 2 diabetes in the early years after smoking cessation. [19-22]

In the United States, there were approximately 9 million smokers who were obese in 2002, which contributed to approximately 20% of total US smokers [23]. These smokers with higher body mass index (BMI) may be more vulnerable to post-cessation weight gain. In addition, heavy smokers, defined as those who smoke 15 cigarettes and above per day, experience more weight gain following smoking cessation than light smokers, defined as those who smoke less than 15 cigarettes per day [24].

Even though the risks of smoking cessation are not likely to outweigh its benefits, the potential risk of post-cessation weight gain, coupled with the increased risk of diabetes may deter overweight and obese smokers from quitting [18,24]. Thus it will be interesting to explore if BMI affects smoking cessation prescription patterns. The objective of this study was to examine differences in cessation medication prescription among smokers with different BMI classifications.

METHODS

Data sources and study design

A retrospective cross-sectional study was conducted using the National Health and Nutrition Examination Survey (NHANES) data. The NHANES data is designed to assess the health and nutritional status of Americans by conducting interviews and physical examinations. The surveys are conducted annually by the National Center for Health Statistics since 1999, using a complex multistage sampling design to obtain a representative sample of the civilian, non-institutionalized population of the United States [25].

The datasets were composed of four parts: demographics, examination, laboratory and questionnaire. This study included the datasets of demographics and questionnaire for ten consecutive years (1999-2008), comprising of 32,146 subjects. The NHANES datasets were downloaded from http://www.cdc.gov/nchs/nhanes/nhanes/nhanes_questionnaires.htm.

All smokers 18 years and older were included in this study. Study subjects were identified as smokers if they answered 'yes' to the question 'Do you now smoke cigarettes?'.

Outcome measures

The outcome variable of interest was a binary variable measuring whether or not the smoker was prescribed a Food and Drug Administration (FDA)-approved cessation medication, bupropion or varenicline. Bupropion is an antidepressant also used for smoking cessation [26]. Varenicline is a new partial nicotinic receptor agonist-antagonist which can reduce the craving in smokers in the absence of nicotine, and can also be used in combination with nicotine replacement treatment (NRT) [26-30].

Independent variables

The Andersen's Behavioral model was used to select relevant independent variables in this study. The model consists of predisposing, enabling, and need factors which determine the prescribing pattern of smoking cessation medications [31]. Ten years of data collected as 2-year cross-sections were combined, and year was controlled for using binary variables for each of the five 2-year cross-sections.

Predisposing factors included age, gender, race/ethnicity and marital status. Age was measured in years and controlled for as a continuous variable. Race/ethnicity was grouped into four categories: non-Hispanic white, non-Hispanic black, Hispanics and other races/ethnicities. Marital status was grouped as married and unmarried; the unmarried group included individuals who were never married, divorced, separated, widowed, or living with a partner.

Enabling factors consisted of community and personal enabling resources which included education, family income and insurance status in the NHANES data. Education was grouped into four levels: less than high school, high school, college, and more than college. Family income was measured as poverty income ratio (PIR), which is the ratio of family income to the corresponding federal poverty guidelines. The variable was controlled for as a continuous measure (ratio) in the multivariate analysis. Insurance status was grouped into four categories: uninsured, covered by public insurance (Medicare or Medicaid), covered by private insurance, and other insurance.

Need factors included BMI classification and presence of any relevant chronic conditions. BMI classification was the main independent variable and was grouped

into: normal weight (BMI<25.0), overweight (25<=BMI<30) and obese (BMI>=30) [32]. Weight was also measured using another survey item capturing "self-perceived" weight. Presence of relevant chronic conditions was measured as a binary variable for the presence of comorbidities such as hypertension, diabetes, asthma, CVD, and/or cancer.

Statistical analysis

Chi-square tests were performed to obtain the descriptive statistics assessing the frequencies and associations of the independent variables with the outcome variable. Each independent variable was initially tested in a univariate logistic regression model to obtain unadjusted odds ratios (OR) with 95% confidence intervals (95% CI). After assessing multicollinearity among independent variables, all the predisposing, enabling and need characteristics, along with the variables for year of inclusion in the data were included in two multivariate logistic regression models. The first logistic regression model did not include the measure for self-perceived weight and the second one did. Interaction assessment analyses were carried out using the Chunk test. All the OR and CI estimates were adjusted for sample weights since a complex multistage sampling design was used in the NHANES datasets. National estimates based on relative standard error (SE) that was lower than 30% in NHANES were considered to be reliable; all estimates used in this study met this reliability criterion. All statistical analyses were conducted using SAS version 9.2 (SAS Institute, Cary, NC) statistical package at *a priori* significance level of 0.05. This study was approved by the Institutional Review Boards (IRBs) at the University of Houston, for the Protection of Human Subjects.

RESULTS

Sample characteristics

A total of 7,743 respondents were identified as current adult smokers among 32,146 subjects from combined NHANES datasets (1999-2008). Based on the smokers' BMI, 41.73% (n=3,172) of the smokers had normal weight, followed by overweight (32.45%, n=2,395) and obese (25.82%, n=1,883). Majority of the smokers were adults under 65 years of age (94.13%, n=6,961), and more than half were males (58.67%, n=4,637). Most of the smokers were non-Hispanic white (73.06%, n=3,849), followed by non-Hispanic black (11.91%, n=1,851) and Hispanic (10.92%, n=1,770). Less than half of the smokers were married (45.67%, n=3,265).

Examining the enabling characteristics revealed that majority of the smokers were less than college educated (59.33%, n=5,247), but above the federal poverty level (77.15%, n=5,170). Approximately 28.27% (n=2,368) of the smokers were uninsured, 50.88% (n=3,186) were covered by private insurance, and 14.88% (n=1,675) by public insurance (Medicare or Medicaid).

Most smokers did not have any pre-existing relevant chronic conditions (53.88%, n=4,633). The comparisons of socio-demographic and health characteristics are summarized in Table 1.

Logistic regressions

Results of univariate (unadjusted OR) and the two multivariate (adjusted OR) logistic regression analyses are presented in Table 2. Based on the univariate analysis older smokers, women, non-Hispanic whites, more educated smokers with higher family income, insured smokers, and smokers with higher self-perceived weight have a higher likelihood of receiving smoking cessation medications.

In the first multivariate logistic regression (without controlling for self-perceived weight) the BMI classification has no statistically significant association with prescription of smoking cessation medications. Older smokers were more likely to receive smoking cessation medications (OR of age: 1.172, 95% CI: 1.096-1.253), however this relationship was quadratic. The likelihood of receiving smoking cessation medications increased along with the increase in age until a peak value at age 48 years and plateaued after that. Men were less likely to receive cessation medications as compared to women (OR: 0.488, 95% CI: 0.332-0.718). Non-Hispanic black (OR: 0.433, 95% CI: 0.247-0.760) and Hispanic smokers (OR: 0.433, 95% CI: 0.195-0.963) were less likely to be prescribed cessation medications as compared to non-Hispanic white smokers. The smokers who had a college degree or higher (had a college degree, OR: 2.163, 95% CI: 1.116-4.192; degree above college, OR: 2.785, 95% CI: 1.361-5.699) were more likely to receive cessation medications compared to smokers who didn't have a high school diploma. Smokers with higher family income had a higher likelihood of receiving cessation medications (OR: 1.169, 95% CI: 1.007-1.358). The smokers with public insurance (Medicare or Medicaid) were more likely to be prescribed cessation medications compared to uninsured smokers (OR: 3.270, 95% CI: 1.387-7.709).

Once self-perceived weight was included there was only one significant change in the results. Overweight individuals were less likely to receive cessation medications (OR: 0.455, 95% CI: 0.216-0.959). On the other hand, smokers who perceived themselves as overweight were more likely to be prescribed cessation medications (OR: 1.859, 95% CI: 1.013-3.411). Multicollinearity or significant interactions were not detected within the final models.

Table 1. Comparison of characteristics among adult smokers with and without smoking cessation medication

Variables	%[a], N= 7,743	With Cessation Medication N= 142			Without Cessation Medication N= 7,601			p-value
		Frequency	Weighted Frequency (million)	(%)	Frequency	Weighted Frequency (million)	(%)	
Weight								
Normal	41.73	56	2.84	49.39	3116	101.51	41.55	.1557
Overweight	32.45	27	1.27	22.09	2368	79.87	32.69	
Obese	25.82	51	1.64	28.52	1832	62.91	25.75	
Age								
≥65	5.87	15	0.33	5.60	767	14.71	5.88	.8592
<65	94.13	127	5.56	94.40	6834	235.59	94.12	
Gender								
Female	41.33	78	3.46	58.74	3028	147.88	59.08	.0002*
Male	58.67	64	2.43	41.26	4573	102.41	40.92	
Race/ethnicity								
Non-Hispanic White	73.06	97	5.09	86.42	3752	180.70	72.19	<.0001*
Non-Hispanic Black	11.91	25	0.33	5.60	1826	30.20	12.07	
Hispanic	10.92	14	0.20	3.40	1756	27.78	11.10	
Other race/ethnicity	4.10	6	0.27	4.58	267	11.61	4.64	
Marital status								
Married	45.67	64	2.76	46.86	3201	117.01	45.67	.8341
Unmarried	54.33	78	3.13	53.14	4542	139.17	54.33	
Education								
Below high school	28.44	37	0.87	14.77	3133	71.91	28.77	.0004*
High school	30.89	35	1.54	26.15	2042	77.50	31.00	
College	28.61	44	2.20	37.35	1782	71.02	28.41	
Above college	12.03	26	1.28	21.73	633	29.53	11.81	
Family income with respect to FPG								
Below FPG	26.45	37	1.12	19.02	2536	62.03	24.78	.1383
Above FPG	77.15	105	4.77	80.98	5065	188.26	75.22	
Insurance Status								
Non insured	28.27	21	0.82	13.92	2347	71.60	28.61	.0014*
Public	14.88	47	1.46	24.79	1628	36.66	14.65	
Private	50.88	67	3.27	55.52	3119	127.09	50.78	
Other insurance	5.96	7	0.33	5.60	507	14.94	5.97	
Presence of relevant chronic conditions								
Yes	46.12	70	2.72	46.18	3040	98.71	39.44	.1676
No	53.88	72	3.17	53.82	4561	151.59	60.56	

a. Percentage of entire population; These values are not raw proportions and have been adjusted using sample weights
* *p*-value shows statistical significant at a priori confidence level of less than 0.05
Abbreviations: NHANES = the National Health and Nutrition Examination Survey; PIR = poverty income ratio; FPG = federal poverty guidelines

DISCUSSION

Previous studies examining the association of BMI with smoking behaviors found that smokers had a lower BMI as compared to nonsmokers [33-35]. This is the first study that assessed the association between BMI classification and smoking cessation medication prescription. The study found that self-perceived body weight and BMI classification could be potential factors influencing receipt of smoking cessation treatment.

Lower prescription of smoking cessation medications among overweight and obese smokers could be due to two main factors – patient preferences or provider beliefs/prescribing patterns. Smokers with higher BMI might be inherently different from normal weight individuals. Overweight and obese individuals might either be less concerned about health risks, or these individuals might be concerned about the post-cessation weight gain and its associated health risks. Thus, overweight and obese individuals might prefer not to use smoking cessation medications.

Table 2. Results from univariate and multivariate logistic regressions of cessation medication prescription using NHANES

Variables	Univariate		Multivariate			
			Without Self-perceived weight		With Self-perceived weight	
	Unadjusted Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio	95% Confidence Interval	Adjusted Odds Ratio	95% Confidence Interval
Weight						
Normal	1	1	1	1	1	1
Overweight	0.569	0.291-1.114	0.577	0.288-1.156	0.455*	0.216-0.959
Obese	0.933	0.575-1.512	0.871	0.516-1.470	0.616	0.324-1.174
Self-perceived weight						
Right weight	1	1	--	--	1	1
Overweight	1.940*	1.136-3.312	--	--	1.859*	1.013-3.411
Underweight	1.266	0.566-2.830	--	--	1.355	0.609-3.016
Age	1.143*	1.069-1.222	1.172*	1.096-1.253	1.163*	1.088-1.243
Age*Age	0.999*	0.998-0.999	0.998*	0.998-0.999	0.998*	0.998-0.999
Gender						
Female	1	1	1	1	1	1
Male	0.459*	0.311-0.676	0.488*	0.332-0.718	0.549*	0.371-0.813
Race/ethnicity						
Non-Hispanic White	1	1	1	1	1	1
Non-Hispanic Black	0.396*	0.232-0.674	0.433*	0.247-0.760	0.461*	0.257-0.827
Hispanic	0.262*	0.125-0.551	0.433*	0.195-0.963	0.435*	0.194-0.973
Other races/ethnicity	0.980	0.414-2.322	0.860	0.380-1.948	0.836	0.369-1.896
Marital status						
Married	1	1	1	1	1	1
Unmarried	0.931	0.603-1.437	1.348	0.861-2.110	1.372	0.879-2.137
Education						
Below high school	1	1	1	1	1	1
High school	1.850	0.929-3.684	1.501	0.716-3.150	1.452	0.684-3.084
College	2.869*	1.536-5.358	2.163*	1.116-4.192	2.058*	1.053-4.025
Above college	4.017*	2.204-7.321	2.785*	1.361-5.699	2.689*	1.297-5.576
Family income with respect to FPG	1.194*	1.054-1.353	1.169*	1.007-1.358	1.163*	1.001-1.350
Insurance status						
Non insured	1	1	1	1	1	1
Public	3.182*	1.577-6.422	3.270*	1.387-7.709	3.251*	1.361-7.764
Private	2.236*	1.225-4.081	1.269	0.706-2.279	1.282	0.717-2.289
Other insurance	2.013	0.756-5.360	1.678	0.613-4.592	1.687	0.632-4.506
Presence of relevant chronic conditions						
Yes	1	1	1	1	1	1
No	0.751	0.505-1.119	0.910	0.573-1.445	0.903	0.569-1.435
Year of entry into data						
1999-2000	1	1	1	1	1	1
2001-2002	1.593	0.617-4.114	1.655	0.628-4.361	1.658	0.623-4.412
2003-2004	1.938	0.902-4.162	1.897	0.867-4.151	1.883	0.860-4.124
2005-2006	2.174	0.996-4.745	1.988	0.896-4.408	1.942	0.883-4.268
2007-2008	0.648	0.316-1.327	0.674	0.323-1.404	0.683	0.330-1.414

* *p*-value shows statistical significant at a priori confidence level of less than 0.05

Abbreviations: NHANES = the National Health and Nutrition Examination Survey; PIR = poverty income ratio; FPG = federal poverty guidelines

On the other hand, healthcare providers might not prefer prescribing cessation medications to an overweight or obese smoker due to concerns about the potential weight gain associated with smoking cessation. Recent evidence also shows an initial increase in the risk of diabetes shortly after smoking cessation, which could be a cause for concern among the providers [17]. Providers could also believe that obese individuals lack self-control, which is needed for achieving a successful quitting attempt [36].

In order to partially tease out which of these two factors might be influencing smoking cessation medication use, we controlled for self-perceived weight. Our study showed that smokers who perceived themselves as overweight had a higher probability of receiving smoking cessation medications. Also, lower prescription among overweight smokers was observed only after controlling for self-perceived weight. This possibly indicates that smokers with higher BMI are not concerned about weight gain post smoking cessation. In fact, the ones who are more aware of their health behavioral problems (smoking and excess weight) are probably more proactive about seeking corrective treatments. Our finding is also suggestive of the fact that the association between smoking cessation medication use and BMI classification is *probably* driven by provider beliefs and practice patterns. Thus, our findings raise concerns about provider-induced healthcare inequities among overweight and obese individuals.

Our study also found that younger smokers were less likely to be prescribed a smoking cessation medication. However, this effect plateaued after age 48. Past literature reported that smokers aged 18 to 24 were less likely to use chemical aids to quit, possibly due to lack of more comprehensive health insurance [37]. Elderly (age>65) were reported to have a low rate of smoking cessation treatment possibly due to other chronic health problems requiring their active attention [38]. Our finding of the highest smoking cessation prescription among middle aged smokers was consistent with these reports. Men were less likely to receive smoking cessation medications as compared to women. A possible explanation could be that women tend to pay more attention to personal health, and are more likely to ask for prescriptions [39,40]. Non-Hispanic whites were more likely to receive smoking cessation medications compared to other races indicating racial disparities in smoking cessation medication prescription [41].The racial disparity is similar to other prescription medication studies [42].

Our findings were also consistent with a previous study conducted by Lillard et al., which reported that higher education was positively associated with receiving a smoking cessation medication [43]. More educated individuals are more aware of treatment options, and are probably proactive in seeking the appropriate options. Higher income was also found to be positively associated with receiving a smoking cessation medication prescription. Other studies also found that smokers with higher income are generally more likely to stop smoking and have better access to health care services including prescription drugs [39,44,45]. Insured smokers were more likely to receive cessation drugs compared to uninsured smokers. This finding was consistent with a study conducted by LaRowe et al., and probably indicates better access to care among insured smokers [41]. In summary, we observed a higher prescription of smoking cessation medications among smokers with higher socioeconomic status. This pattern is similar to most other studies on drug prescribing patterns and intentions to quit smoking [41,46].

Potential weight gain continues to be an important barrier to quitting smoking, and the increased risk of developing diabetes following cessation may elevate this concern further [24,47]. Considering the long term benefits of smoking cessation, specific interventions among obese smokers that combine smoking cessation interventions with weight gain prevention might considerably improve smoking cessation prescription among overweight and obese individuals.

Future studies are needed to explore if lower rates of smoking cessation medication receipt among overweight and obese smokers is driven by provider beliefs and prescription patterns. If smoking cessation medication prescription among overweight and obese smokers is lower due to provider concerns about post-cessation weight gain or provider's negative attitudes against overweight/obese smokers, then that raises serious concerns about the equity in quality of care. In that case, provider level interventions are essential to reduce weight-based disparities.

There are certain limitations to this study. Firstly, causal relationship cannot be established with a cross-sectional study design. Second, the NHANES dataset is based on household interviews, while disease and outcome measures are based on the diagnostic data available in the datasets. In addition, weight and height used to calculate BMI are self-reported. Therefore, incomplete and erroneous records, and lack of clinical details may have led to patient misclassification. However, these misclassifications are likely to be equivalent across groups. Third, some of the health conditions, such as pregnancy, cancer and depression, were not included in the analysis due to unavailability or failure to meet the reliability criterion. Furthermore, the utilization rate of NRT, another possible quitting aid, was too low in the NHANES datasets to be controlled for as a potential confounder in our study.

CONCLUSIONS

Lower prescription of cessation medications among overweight smokers was observed only after controlling for self-perceived weight. In addition smokers who perceived themselves as overweight had a higher likelihood of using cessation medications. These findings *probably* indicate that lower prescription among overweight smokers is driven by provider preferences, thereby raising concerns about health care inequities among overweight and obese smokers.

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ETHICS APPROVAL

This study was approved by the Institutional Review Boards (IRBs) at the University of Houston, for the Protection of Human Subjects.

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COMPETING INTERESTS

None declared.

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