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ORIGINAL ARTICLE

Depressive symptoms, smoking, and cigarette price elasticity: results from a population-based survey in Taiwan

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Abstract
Objectives To understand the association between depressive symptoms and smoking. In addition, we investigate how smokers with and without depressive symptoms may respond to cigarette price change differently.
Methods We used data drawn from a nationally representative survey in Taiwan. Totally, 13,030 male adults were included in the analysis. Depressive symptoms were measured using the Taiwanese depression questionnaire. A logistic regression model was estimated to examine the odds ratio of smoking for those with depressive symptoms versus those without depressive symptoms. Focused on smokers, the ordinary least squares multivariate regression method was used to estimate the cigarette price elasticity.
Results Compared to those without depressive symptoms, those with depressive symptoms were more likely to smoke (44.5 vs. 50.1%) and consume more cigarettes per day (18.4 vs. 21.0). The odds ratio of smoking for those with depressive symptoms, adjusted for demographic variables, was 1.3 (95% confidence interval, 1.1–1.6). The cigarette price elasticity was estimated at −0.82 and −0.41 for depressive smokers and non-depressive smokers, respectively.
Conclusions Although the association between depression and smoking had been documented, this study contributes to previous literature by investigating the extent to which cigarette price elasticities may differ between smokers with and without depressive symptoms. Results indicate that depressive smokers are more sensitive to the change of cigarette price. Therefore, tax/price increases can also be a very effective means of tobacco control for depressive smokers.

Keywords Depressive symptoms · Smoking · Cigarette price elasticity · Taiwan

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Introduction

Tobacco use kills people on a global scale; it causes one in ten deaths among adults worldwide today (World Health Organization 2008). Yet, tobacco use is still one of the leading preventable causes of death that calls for urgent actions to reverse the global epidemic (World Health Organization 2003). Among all the control measures, increasing tax is the most effective intervention to reduce demand for tobacco (Jha and Chaloupka 2000). To increase tax on tobacco products including cigarettes often leads to higher prices for these products (Chaloupka et al. 2000). The percentage change in quantity demanded resulting from a 1% change in price refers to the price elasticity of demand (Frank and Bernanke 2003). Previous evidence had indicated that the price elasticities of demand for cigarette in high-income countries cluster around −0.4, whereas they were somewhat higher, ranging from −0.5 to −1.00, in low- and mid-income countries (Chaloupka et al. 2000).

Similar to other countries in the world, tobacco epidemic has been an important public health issue, and taxation on tobacco products has been a crucial policy strategy for tobacco control in Taiwan. In 2007, self-

reported smoking rates were 39.0 and 5.7% for males and females, respectively, in Taiwan (ROC Bureau of Health Promotion 2008a, b). The association between cigarette consumption and cigarette price has also been studied in Taiwan (Lee et al. 2004, 2005; Tsai et al. 2005). Empirical evidence had indicated that the price elasticity of demand for cigarettes in Taiwan was approximately between −0.5 and −0.6 using time series data (Lee et al. 2005). Although not much, similar evidence has been revealed in the cross-sectional survey. For instance, using the National Health Interview Surveys for smokers between 2000 and 2003 in Taiwan, the cigarette price elasticities has been estimated between −0.31 and −0.53 (Lee et al. 2004).

In addition to the socioeconomic factors of the smokers that are associated with the prevalence of smoking, it has been remarked by Warner that many of today's smokers are suffering from some form of mental illness (Warner 2007). A positive relationship between mental illness and smoking is not hardly expected because smokers see their habit as having calming effect, and pleasurable relaxation is the most frequently cited motive for smoking (Klitzke et al. 1990). To date, few population-based studies examining the relationship between cigarette smoking and mental illness are available. Yet, these studies have demonstrated that people with mental illness have a higher incidence of smoking than the general population (Jorm 1999; Lasser et al. 2000; Mykletun et al. 2008; Tobias et al. 2008), and they are also the major consumers of tobacco products (Grant et al. 2004; Tobias et al. 2008). For instance, using a population-based data from the National Comorbidity Survey in the US, Lasser et al. (2000) found that current smoking rates for respondents with no mental illness, lifetime mental illness, and past-month mental illness were 23, 35, and 41%. Similar evidence has also been revealed by other studies that adults who are physiologically depressed are 40–50% more likely to smoked than adults without depression (Schoenborn and Horm 1993). In addition to the high likelihood of smoking among depressed smokers, empirical evidence indicated that they tend to smoke more cigarettes than more emotionally stable smokers (Spielberger 1986). Despite the significant body of literature associating depression with smoking, however, little knowledge is known about the cigarette price elasticity for people with mental illness, and how it differs from the other groups of smokers without depression. Having a better understanding of the differences in price response between people with and without depression is of particular policy interest in that antismoking campaign by cigarette taxation may result in different effects between these two groups of smokers.

The objective of this study is twofold. First, we examine the association between depressive symptoms and smoking. In what follows, we distinguish the extent to which smokers with and without depressive symptoms may respond differently to cigarette price change, as measured by the cigarette price elasticities. In contrast to most of the previous studies, empirical analysis is conducted using a population-based data drawn from the National Survey on Knowledge, Attitude, and Practice of Health Promotion in Taiwan (Taiwan-HPKAP).

Method

Data

The Taiwan-HPKAP was conducted between October 2002 and March 2003 by the Bureau of Health Promotion, Department of Health, Republic of China. The aim of Taiwan-HPKAP was to measure the knowledge levels, attitudes, and behavior patterns related to health promotion of the civilian non-institutionalized population aged 15 and over in Taiwan. The survey used a three-stage random sampling design with a probability proportional to size, along with face-to-face interviews, to obtain a nationally representative sample. In total, 32,660 individuals were selected, and, 26,755 of them were interviewed. As a result, the sample represents 81.9% of the targeted population in Taiwan. A more detailed account of this survey is presented elsewhere (ROC Bureau of Health Promotion 2008b). Due to a low prevalence of smoking among female population in Taiwan, we limited our sample to male adults. In addition, we limited our sample among adults aged 18 and over, because adults aged below 18 are not eligible to smoke. After further deleting the missing values of some key variables such as socioeconomic factors, 13,030 male adults were included in the analysis.

Measure of cigarette smoking

The respondents of Taiwan-HPKAP were asked to report their current status of cigarette smoking, average number of cigarettes smoked per day, and weekly expenses for cigarettes. In this study, we define current smokers as those who have ever smoked at least 100 cigarettes and continue to smoke; and cigarette consumption refers to the reported average number of cigarettes smoked per day. We also convert the expenses to daily basis and cigarette price is then measured as the ratio of cigarette expenses divided by the number of cigarette smoked.

Measure of depressive symptoms

In the Taiwan-HPKAP, depressive symptoms were determined by the Taiwanese depression questionnaire (TDQ). The TDQ is a 4-point scale (ranged from 0 to 3) of 18 items

related to mood, sleeping problem, appetite, energy, interest in normal activities, crying and feelings about the future, etc. (Lee et al. 2000). The scores of the TDQ range from 0 to 54; and a score of 19 or more is considered to be depressive symptoms. The Cronbach's alpha for the TDQ was 0.90, and the comparison of the TDQ with the structured clinical interview for DSM-III-R indicated a sensitivity of 0.89 and a specificity of 0.92 (Lee et al. 2000).

Other socio-demographic variables

In addition to cigarette consumption and the depressive symptom, several other variables reflecting the socioeconomic characteristics of each respondent are specified. The specifications of these variables are consistent with previous studies of smoking behavior in Taiwan (e.g., Lee et al. 2004). Several variables reflecting human capital (age and the education levels), monthly income, marital status, and residential locations of each respondent are included. Ages are categorized into six groups: for those between 18 and 24, 25 and 34, 35 and 44, 45 and 54, 55 and 64, and above 65 years. Education of each respondent is categorized into three groups: for those who had finished junior high school or lower (0–9 years), senior high school (10−12 years), and for those who had college degree or higher (equal to or above 13 years). Monthly income of each respondent is also defined into four groups: for those less than NT$ 10,000; between NT$ 10,000 and 39,999; between NT$ 40,000 and 79,999, and equal to or above NT$ 80,000. Three different categories of individual's marital status are also recognized: for those who had married, separated or divorced, and never married. Since smoking decision is associated with local environmental conditions, we defined three variables for individual who live in the city, urban township, or rural area.

Statistical analysis

Empirical analysis is conducted in two steps. In the first stage, we compared the distribution of demographic characteristics between those with and those without depressive symptoms using the Pearson Chi-square test. We further used a logistic regression model to calculate the adjusted odds ratios of smoking for those with depressive symptoms versus those without depressive symptoms.

In what follows, we focused on current smokers and estimated separate cigarette consumption equations for depressive smokers and non-depressive smokers using ordinary least squares multivariate regression. The independent variables in the consumption equations included cigarette price and several important socio-demographic variables. Because cigarette price and cigarette consumption are both measured in logarithms, the estimated regression coefficient of cigarette price represents the price elasticity of demand for cigarettes. To further investigate whether the differences in cigarette price elasticities between depressive and non-depressive smokers are statistically different, we estimated a cigarette consumption equation for all smokers (i.e., the pool sample). In addition to cigarette price, depressive symptoms, and several important socio-demographic variables, we included an interaction term between depressive symptoms and cigarette price as an additional independent variable in the equation. If the regression coefficient of the interaction term is statistically significant, then there is evidence that the cigarette price elasticity depends on depressive symptoms. All analyses were conducted with the statistical software Stata release 10 (StataCorp, USA, 2007).

Results

Descriptive statistics

Table 1 presents the percent distribution of socio-demographic characteristics by depressive symptoms. Among the 13,030 male respondents, 3.7% were considered to be depressive. In general, those with depressive symptoms were more likely to be younger, never married, separated or divorced, with lower educational background, poor monthly income, and living in urban areas. The results of Chi-square test showed that all the differences in selected socio-demographic characteristics were statistically significant.

Prevalence of smoking and cigarette consumption

As shown in Table 2, the overall prevalence of smoking among male adults in the Taiwan-HPKAP was 44.7%. Yet, those with depressive symptoms smoked at a higher rate of 50.1%. The odds ratio of smoking for those with depressive symptoms versus those without depressive symptoms, adjusted for demographic variables, was 1.3 (95% confidence intervals 1.1–1.6). Results further indicate that current smokers with depressive symptoms consumed more cigarettes than those without depressive symptoms. The number of cigarettes smoked per day was 21.0 and 18.4 for smokers with and without depressive symptoms, respectively (t value = 3.71; p value < 0.005).

Cigarette price elasticity among current smokers

Table 3 presents the results of multivariate regression analysis for cigarette consumption by depressive symptoms

Table 1 Demographic characteristics according to depressive symptoms

Variable	Depressive symptoms ($n = 481$)	No depressive symptoms ($n = 12{,}549$)	Test value (p value)*
Age (years)			22.82 (0.00)
18–24	16.8	16.2	
25–34	24.1	21.9	
35–44	17.7	23.0	
45–54	13.7	17.5	
55–64	8.5	9.3	
≥65	19.3	12.0	
Education (years)			8.65 (0.01)
0–9	43.5	37.5	
10–12	30.0	30.5	
≥13	26.5	32.0	
Monthly income (NT$)			60.8 (0.00)
0–9,999	44.0	27.3	
10,000–39,999	41.3	43.4	
40,000–79,999	11.7	24.3	
≥80,000	3.0	5.1	
Marital status			26.6 (0.00)
Married	49.9	62.5	
Separated/divorced/ widowed	13.2	6.1	
Never married	36.9	31.5	
Urbanization			13.10 (0.00)
City	63.7	56.6	
Urban township	17.3	15.7	
Rural township	19.0	27.7	

* Pearson Chi-square test, and the parentheses are the p values

Table 2 Smoking status according to depressive symptoms

	Current cigarette smoker		Number of cigarette smoked per day per smoker (mean ± SD)
	Prevalence (%)	OR (95% CI)[a]	
All	44.7	–	18.5 ± 10.6
Depressive symptoms	50.1	1.3 (1.1, 1.6)	21.0 ± 12.7
No depressive symptoms	44.5	Reference group	18.4 ± 10.5

OR odds ratio, *CI* confidence interval

[a] Odds ratio is estimated by the logistic model, controlling for age, education, monthly income, marital status, and urbanization

among adult male smokers in the Taiwan-HPKAP. We found that, after adjusting for demographic variables, the regression coefficients of cigarette price in logarithm were −0.82 and −0.41 for depressive smokers and non-depressive smokers, respectively. Namely, a 10% increase in cigarette price would cause a 8.2% reduction in the demand for cigarettes among depressive smokers, and the comparable figure for non-depressive smokers was 4.1%. This result points to the evidence that smokers with depressive symptoms are more sensitive to cigarette price change compared to the other cohort. Moreover, results (data not shown) from the pool sample model indicated that the cigarette price elasticity for all smokers was estimated at −0.4, and that the difference in cigarette price elasticity between depressive smokers and non-depressive smokers was statistically significant ($p < 0.001$).

Discussion

Although enormous empirical evidence has been provided for smoking behavior in many countries, little is known about the association between smoking and depressive symptoms. To fulfill this gap, this paper investigates how depression is related to smoking decision. In addition, we examine the extent to which the cigarette price elasticities may differ between smokers with and without depressive symptoms. Using data from a nationally representative survey in Taiwan, results show that male adults with depressive symptoms were more likely to be current smokers and consumed more cigarettes than those without depressive symptoms. In addition, the cigarette price elasticities for depressive smokers and non-depressive smokers were −0.82 and −0.41, respectively.

Price elasticity measures the sensitivity of quantity demand to changes in price. In this study, we found that the overall price elasticity of demand for cigarettes was estimated at −0.4, which falls within the previously reported range of −0.3 and −0.5 (Lee et al. 2004). More importantly, we further found that the cigarette price elasticity for smokers with depressive symptoms was higher than that for smokers without depressive symptoms. Why were depressive smokers more sensitive to cigarette price change? Because previous studies have revealed an inverse relationship between cigarette price elasticity and socioeconomic status (Chaloupka et al. 2000), one possible explanation might be that depressive smokers are more likely to be poor and less educated (Franks et al. 2007). Yet, our results also showed that depressive symptoms had an independent effect on the cigarette price elasticity. Thus, future research should investigate mechanisms linking depressive symptoms to cigarette price elasticity. Nevertheless, in an era of many smokers suffering from mental illness, our finding may shed some light on tobacco control policy. A direct tax policy will result in different effects between depressed and non-depressed smokers. In addition to the direct tax imposed on the cigarette products,

Table 3 Ordinary least squares estimations of cigarette consumption (in logarithm) among smokers

	Depressive smokers		Non-depressive smokers	
	b (95% CI)	*p* value	b (95% CI)	*p* value
Log (price)	−0.82 (−1.00, −0.63)	<0.001	−0.41 (−0.44, −0.37)	<0.001
Age (referent: ≥65 years)				
18–24	0.48 (0.05, 0.91)	0.030	0.06 (-0.02, 0.14)	0.147
25–34	0.65 (0.31, 1.00)	<0.001	0.20 (0.13, 0.26)	<0.001
35–44	0.60 (0.27, 0.92)	<0.001	0.21 (0.15, 0.27)	<0.001
45–54	0.52 (0.20, 0.85)	0.002	0.25 (0.19, 0.31)	<0.001
55–64	0.57 (0.19, 0.95)	0.003	0.12 (0.06, 0.19)	<0.001
Education (referent: 0–9 years)				
10–12	−0.10 (−0.32, 0.12)	0.378	−0.06 (−0.10, −0.03)	0.002
≥13	−0.37 (−0.66, −0.08)	0.013	−0.25 (−0.30, −0.20)	<0.001
Monthly income (referent: NT$ 0−9,999)				
10,000–39,999	0.06 (−0.14, 0.26)	0.570	0.03 (–0.01, 0.07)	0.160
40,000–79,999	0.07 (−0.24, 0.38)	0.664	0.05 (−0.00, 0.09)	0.063
≥80,000	0.26 (−0.43, 0.96)	0.452	0.03 (−0.07, 0.12)	0.565
Marital status (referent: married)				
Separated/divorced/widowed	0.02 (−0.24, 0.28)	0.886	−0.05 (−0.11, 0.00)	0.058
Never married	0.00 (−0.25, 0.25)	0.970	−0.03 (−0.07, 0.01)	0.194
Urbanization (referent: rural township)				
City	−0.02 (−0.23, 0.20)	0.883	0.01 (−0.03, 0.04)	0.616
Urban township	−0.15 (−0.40, 0.11)	0.262	0.02 (−0.03, 0.06)	0.473
Constant	3.05 (2.72, 3.38)	<0.001	2.96 (2.90, 3.02)	<0.001
Adjusted R^2	0.29		0.12	

b regression coefficient, *CI* confidence interval

cigarette price can be increased implicitly by other indirect policy mechanisms. For instance, antismoking policy may be implemented through the channel of increasing the transaction costs of smokers to access cigarette products. Regardless of the different sources of policy implement to increase price, due to the different price responses, cigarette tax/price or other indirect policy mechanism associated with the cigarette price can be a more effective means of tobacco control for depressive smokers.

An interesting question may be raised: could such evidence be explained away by differences in demographic characteristics between those with and without depressive symptoms? Consistent with previous studies, we found that the association between cigarette smoking and depressive symptoms is significant even after controlling for important demographic variables. Thus, if the association is not an artifact, what is the direction of causality? The traditional explanation assumes cigarette smoking as a means of self-medication to people with depressive symptoms, but recent evidence suggests a correlation between cigarette smoking and subsequent depression (Goodman and Capitman 2000; Klungsoyr et al. 2006; Wu and Anthony 1999). Due to the cross-sectional nature of Taiwan-HPKAP data, we are not able to further investigate whether depressive symptoms cause smoking or vice versa. However, our results may provide a different angle to look at the cigarette taxation policy. In addition to the socio-demographic factors, our study continues to confirm that depression is positively associated with smoking decision. Moreover, the price response significantly differs between depressed and non-depressed smokers. Due to the recent economic recession and the increasing unemployment, an increasing rate of population with depression symptom can be expected. Since our results show that depressive smokers are more sensitive to cigarette price change, the taxation policy of cigarette can be more effective during the economic recession periods.

The strength of this study lies in using data from a large population-based survey with a high response rate through the face-to-face interview. However, we could have common problems in survey research such as cross-sectional design and recall bias. For instance, cigarette price and the quantity of cigarette consumed may be possibly endogenous. One way that has been proposed to address this issue in the study of the US is to apply the state-level cigarette taxes as the proxy for observed cigarette price (we thank the comments made by the reviewers for this observation). However, this approach cannot be appropriately applied to

the case in Taiwan since there is a unique cigarette tax implemented in the entire nation. Therefore, there is no variation of cigarette tax in the cross-sectional analysis. As a alternative, we follow previous studies using the observed cigarette price to estimate the cigarette price elasticities (Tsai et al. 2005). Additionally, due to the nature of the cross-sectional survey, the direction of causality between smoking and mental illness cannot be clearly investigated. Future research can address this issue more appropriately by employing a longitudinal data.

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