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RESEARCH ARTICLE

Associations between smoking cessation and depression among the population in Northwest China

Xiaoxin Xu[1*] Xiaohua Wang[1] Yanhong Gong[1]

Abstract: Many studies have indicated a relationship between smoking cessation and a history of depression. However, few studies have examined the association between smoking cessation and current depression and even fewer evidence come from mainland China. The aim of this study is to determine the prevalence of smoking quitters, the correlates of successful smoking cessation, and its relationship with depressive symptoms in Northwest China. Methods: A total of 7,644 subjects who met the study's entry criteria were randomly selected from the urban areas of three provinces in Northwest China and interviewed using standardized assessment tools, including basic characteristics of households and detailed information on family members. All respondents provided informed consent. Results: people with depression symptom have a more than 1.5-fold risk of abstinence from smoking than those without depression (OR=1.54; 95% CI, 1.2 to 1.9) and the likelihood ratio test for two models reach statistical significance (x^2=13.2, p<0.001). Smoking quitters have a more than 1.5-fold risk of having depressive symptoms than current smokers (OR=1.54; 95% CI, 1.2 to 1.9) and the likelihood ratio test for two models is also statistically significant (x^2=6449.85, p<0.001). Conclusions: The prevalence of smoking quitters in urban areas of Northwest China is very low. After controlling certain confounders, smoking cessation is associated with current depressive symptoms. More rigorous surveys are needed to elucidate the barriers to smoking cessation in China. Government bodies in China should implement appropriate strategies and execute effective measures to mitigate its harmful consequences.

Keywords: smoking cessation, depression, Northwest China

1 Introduction

There are an estimated 301 million people in China who smoke tobacco. Approximately 52.9% of the men and 2.4% of the women in China smoke cigarettes,[1] which accounted for nearly one-third of the world's smokers in 2010. Cigarette smoking is one of major risk factors for mortality in China, with an estimated 673,000 deaths being attributable to smoking in 2005.[2] Most Chinese smokers know that smoking is harmful to their health and that smoking cessation can improve their health and well-being. However, smoking cessation is usually difficult. Though China's government has made numerous efforts to control tobacco use, the quit ratio among Chinese smokers remains low compared to developed countries.[3] This research aims to explore the possible barriers to successful smoking cessation from the perspective of psychology and to provide evidence-based suggestions for China's tobacco control policy.

Many studies have shown an association between smoking and depression in various settings, with the prevalence of cigarette smoking being significantly higher among people with current major depression than among the general population.[4] In U.S., data from the National Co-Morbidity Survey conducted from 1991 to 1992 indicated that 41.0% of persons with mental illness in the past month were current smokers, while the prevalence of current smoking among the entire population was just 28.5%.[5] The Composite International Diagnostic Interview conducted in Australia shows that after controlling for social-demographical confounders, current tobacco users had an odds ratio of 1.5 (CI 1.2 to 1.8) for any affective disorders and an odds ratio of 1.7 (CI 1.4 to 2.0) for any anxiety disorders.[6] By contrast, other studies have observed no significant associations between smoking and depressive symptoms.[7]

In addition, many studies have suggested that depression has been negatively associated with success-

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* **Correspondence to**: Xiaoxin Xu, School of Social Development and Public Policy, Beijing Normal University, Beijing 100875, China; Email: xuxiaoxin@bnu.edu.cn
[1] School of Social Development and Public Policy, Beijing Normal University, Beijing 100875, China

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ful smoking cessation. A cross-sectional study using the Beck Depression Inventory found that higher depression scores were related to lower smoking cessation self-efficacy, especially among male smokers.[8] Evidence from the 2006 behavioural Risk Factor Surveillance System data in the U.S. show that unsuccessful quitters experienced more lifetime depression and anxiety than non-quitters (OR=1.2;95% CI, 1.0 to 1.4), whereas successful quitters experienced less (OR=0.7, 95% CI, 0.6 to 0.8). Current depression prevalence was 14.3% among non-quitters, 18.8% among unsuccessful quitters, and 8.0% among successful quitters.[9] Moreover, results from many longitudinal studies indicate that higher scores on depressive symptoms negatively predicted quitting success.[10] By contrast, a meta-analysis, including 15 peer reviewed papers, concluded that a lifetime history of major depression does not appear to be an independent risk factor for cessation failure,[11] and later studies confirmed this conclusion.[12] Accordingly, the association between depression and smoking cessation is inconclusive due to the mixed results of past studies.

However, while notably few studies targeting the mental risk factors of smoking abstinence were conducted in mainland China, a cross-sectional population-based survey was conducted in Beijing in 2003. Using the Composite International Diagnostic Interview (CIDI) and involving 5926 people, this survey concluded that having a psychiatric disorder was a risk factor associated with current smoking and current heavy smoking was also associated with a history of a major depressive episode.[13]

To fill this gap in the literature, we conducted a population-based survey in Northwest China that addressed the patterns of smoking and the mental health statuses of the smokers with the following purposes: (1) to investigate the number of current, former and non-smokers and the proportion of smoking cessation in the population aged 15 years and older; (2) to identify the socio-demographic factors and other correlates of successful smoking cessation; (3) to test the association between smoking cessation and symptoms of depression. This study will contribute to the following domains by: (1) elucidating the relationship between depressive symptoms and the patterns of smoking; (2) providing support for the theory that smoking cessation may induce a relapse of depression; (3) providing firm empirical evidence to shape policy making.

2 Methods

2.1 Data source and sample selection

The data of the present study pertain to a population-based cohort study initiated in October 2006 as part of the Chinese Urban Social Protection Survey. It was conducted by the School of Social Development and Public Policy at Beijing Normal University and the Provincial Civil Affairs Sector in Northwest China.

This survey was conducted in three cities (Lanzhou and Baiyin city in the Gansu province and Xining city in the Qinghai province). Within each city, a random sample was selected using three-stage cluster sampling design. In each of the three cities, 15 street units were randomly selected randomly in the first stage using the probability proportional to the sample size. Within each selected street unit, three residential neighbourhoods were selected, again using the probability proportional to the size sample size. Within each residential neighbourhood, 200 households were then selected by simple random sampling. Household representatives were surveyed in face-to-face interviews conducted in Chinese by trained professionals from local departments of Civil Affairs. The response rate was 89%, and all respondents provided informed consent. The study was approved by the institutional ethics committee, and all respondents provided informed consent.

The survey encompassed a wide range of background characteristics of households and detailed information on each household member including social-demographic characteristics (age, gender, education level and marital status), behaviour factors (cigarette smoking, alcohol consumption and physical activity), psychosocial factors (depression, life satisfaction and social support) and economic factors (*Dibao*, occupation, expenditure on health care, debts and medical insurance). The surveyed households and household respondents totalled 2,841 and 7,644, respectively.

2.2 Measures

2.2.1 Smoking status

Respondents were divided into 4 categories in terms of their smoking status: non-smokers who did not smoke cigarettes at all in either 2005 and 2006, initial smokers who did not smoke in 2005 but smoked in 2006, former smokers who smoked in 2005 but did not smoke at all in 2006 and current smokers who smoked both in 2005 and 2006.

2.2.2 Smoking cessation

Respondents, who were classified as smokers in 2005 and who, in 2006, indicated that they had not smoke cigarettes were considered to be successful is abstaining from smoking. Smoking cessation was thus defined as 0 (current smokers) and 1 (successful quitters or former smokers).

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2.2.3 Depressive symptoms

The Center for Epidemiological Studies Depression Scale (CES-D),[14] Chinese edition, was used to measure the frequency of participants depressive symptoms. The total score of more than or equal to 16 was selected as the cutoff for possible mild to major depression.

2.2.4 Other covariates

The urban China social protection questionnaire included information on socio-demographic characteristics including age (15-24, 25-29, 30-34, 35-39, 40-49, 50-59, 60 years and older), gender (male, female), marital status (married, not married) and education (illiterate/primary school, junior high school, senior high school/technical secondary school, university degree or above) . Alcohol consumption was collapsed into four categories, "No" or , "1 to 2 times a week", "3 to 4 times a week" and "almost every day . Respondents also reported debt of household and medical insurance status (a yes/no dichotomized variable). The health-related factor was measured using the body mass index (BMI) ($<$19, 19-25 and $\geq$25 kg/m^2).

2.3 Statistical analysis

Group differences for categorical variables were examined using chi-square tests. In the first step, we analysed the association of smoking status (non-smoker, initial smoker, current smoker, and former smoker) and a range of variables. Here, differences among groups were compared using the chi-square test for categorical data.

In the second analysis, to perform the likelihood ratio test, we ran two models, one of which had a set of parameters (variables), and a second model that had all of the parameters from the first, plus another variable (depression). The dependent variable for both models was smoking cessation, which was a dichotomous variable indicating whether smokers had quit cigarette smoking during the time of the survey. All significant variables except depression, as described in Table 1, were entered as predictor variables. In turn, we tested a model containing those predictor variables against a model that contained the above variables plus the additional predictor variable of depression. Third, the likelihood ratio test was again run, but the dependent variable, different from the previous step, was a depressive symptom for both models. The depressive symptom is a dichotomized variable indicating that the subject had a CES-D score that was above sixteen.

In both models, current smoking was set as the reference category for calculating the odds of abstaining (coded as 1) versus current smoking (coded as 0). Without depressive symptoms was set as the reference category for calculating the odds of abstaining with depression (coded as 1) versus without depression (coded as 0). Covariates including socio-demographic characteristics (age, gender, marital status and education attainment), alcohol consumption, BMI, house debt and medical insurance were adjusted in all models. Finally, likelihood ratio tests were used to evaluate the difference between the two models. All statistical analyses were performed using STATA (v.12.0)

3 Results

The present analysis refers to 7644 participants who were grouped according to their status as non-smokers, initial smokers, former smokers or current smokers. The current smokers were predominantly male, reflecting the large gender gap in smoking rates in China. These 4 groups differed significantly with respect to major socio-demographic characteristics, household debt, medical insurance, BMI, alcohol consumption and symptoms of depression (Table 1).

Table 2 presents the odds ratios for the association between predictors and smoking cessation as well as the likelihood ratio test for the two models. The likelihood ratios for model 1 and model 2 were 0.1143 and 0.1208, respectively. The table also presents the chi-squared value (13.2) for the likelihood ratio test as well as the p-value ($p<0.001$) with one degree of freedom. Thus, adding depression as a predictor variable results in a statistically significant improvement in model fit.

People with depressive symptoms have more than a 1.5-fold risk of abstaining from smoking than those without depression (odds=1.5479, $p<0.001$). Compared with current smokers, certain characteristics, such as middle age (40-59), female, alcohol consumption, BMI$\geq$25 and debt were significantly associated with abstinence from smoking.

Table 3 shows the associations between predictors and depressive symptoms as well as the likelihood ratio test for the other two models. The likelihood ratios of model 3 and model 4 were 0.0387 and 0.0560, respectively, and the chi-squared value (6449.85) for the likelihood ratio test as well as the p-value ($p<0.0001$) with one degree of freedom are listed. The results indicate that adding smoking cessation as a predictor variable significantly increases the fit of the model.

Those who had quit smoking had a more than 1.5-fold risk of having depressive symptoms than current smokers (odds=1.5436, $p<0.001$). In model 4, a relatively high level of education (high than or equal to junior high school), a relatively high BMI ($\geq$25), being in debt, and having health insurance were significantly associated with having depressive symptoms.

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Table 1. Prevalence of major characteristics in non-smokers (n=5470), former smokers (n=511), initial smokers (n=341) and current smokers (n=1154)

	Nonsmokers [a]		Former Smokers [b]		Initial smokers [c]		Current smokers [d]		
Characteristic	N	%	N	%	N	%	N	%	***P***
Age									
15-24	657	15	17	3	18	5	16	1	
25-29	262	6	22	4	33	10	32	3	
30-34	320	7	49	10	26	8	81	7	
35-39	395	9	58	11	50	15	150	13	<0.001
40-49	890	20	142	28	90	27	390	34	
50-59	693	15	78	15	46	14	275	24	
>=60	1,284	29	141	28	74	22	201	18	
Gender									
Male	1,367	30	454	90	302	89	1,127	98	<0.001
Female	3,256	70	53	10	37	11	18	2	
Marital status									
Married	3,193	69	416	82	264	78	1,026	90	<0.001
Not married	1,430	31	91	18	75	22	119	10	
Education level									
Illiterate/Primary school	1,158	25	101	20	53	16	149	14	
Junior hign school	1,492	33	201	40	134	40	447	39	<0.001
Senior high school	1,346	29	163	32	105	31	428	37	
>Senior high school	595	13	41	8	47	14	118	10	
Employment									
Employed	3,278	71	360	71	234	69	795	69	0.705
Unemployed	1,345	29	147	29	105	31	350	31	
BMI									
<19	914	20	69	14	41	12	133	12	
19-<25	3,188	69	399	79	256	76	851	74	<0.001
≥25	521	11	39	8	42	12	161	14	
Alcohol consumption									
No	4,524	99	488	97	286	85	876	77	<0.001
Yes	55	1	16	3	49	15	257	23	
Self-rated health									
Good	260	6	24	5	26	8	72	6	
Average	2,308	50	275	54	178	53	602	53	0.1
Bad	2,043	44	207	41	134	40	469	41	
Expenditure on health care									
0	2,050	44	249	49	154	45	535	47	
<100	244	5	26	5	13	4	72	6	0.121
100-600	1,150	25	125	25	88	26	287	25	
>600	1,179	26	107	21	84	25	251	22	
Debt									
No	3,142	68	368	73	232	68	750	66	0.029
Yes	1,473	32	136	27	107	32	394	34	
Dibao									
No	1,587	34	161	32	121	36	360	32	0.179
Yes	3,028	66	346	68	216	64	781	68	
Medical insurance									
Uninsured	3,097	67	274	54	186	55	532	46	<0.001
Insured	1,526	33	233	46	153	45	613	54	
Social Net									
Strong	1,182	26	139	27	98	29	293	26	
Moderate	2,331	50	259	51	161	47	601	52	0.428
Weak	1,110	24	109	22	80	24	251	22	
Important events in family									
Not happened	1,283	28	152	30	95	28	315	28	0.746
Happened	3,340	72	355	70	244	72	830	72	
Depressive symptom									
No	2046	44	195	39	153	45	564	49	0.001
Yes	2596	56	309	61	186	55	580	51	

[a] Non-smokers are respondents who did not smoke cigarettes in 2005 and 2006.
[b] Former smokers are respondents who smoked in 2005 but did not smoked at all in 2006.
[c] Initial smokers are respondents who did not smoke in 2005 but smoked in 2006.
[d] Current smokers are respondents who smoked in 2005 and 2006.

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Table 2. Logistic regression predicting smoking cessation status

Characteristic	Smoking cessation status [a]							
	Model 1				Model 2			
	OR	*P*	95% CI [c]		OR	*P*	95% CI [c]	
Age								
15-24	refer				refer			
25-29	0.86	0.748	0.33	2.21	0.84	0.717	0.32	2.18
30-34	0.8	0.622	0.33	1.92	0.74	0.506	0.31	1.79
35-39	0.47	0.079	0.2	1.09	0.45	0.068	0.19	1.06
40-49	0.44	0.053	0.2	1.01	0.42	0.042	0.19	0.97
50-59	0.35	0.015	0.15	0.82	0.34	0.013	0.15	0.79
>=60	0.63	0.287	0.27	1.48	0.62	0.268	0.26	1.45
Gender								
Male	refer				refer			
Female	4.86	<0.001	2.72	8.68	5.02	<0.001	2.8	9
Marital status								
Married	refer				refer			
Not married	1.26	0.215	0.88	1.81	1.23	0.256	0.86	1.78
Education level								
Illiterate/Primary school	refer				refer			
Junior hign school	0.91	0.599	0.64	1.3	0.94	0.758	0.66	1.35
Senior high school	0.77	0.187	0.53	1.13	0.83	0.329	0.56	1.21
>Senior high school	0.71	0.193	0.42	1.19	0.82	0.456	0.49	1.38
Alcohol consumption								
No	refer				refer			
Yes	0.12	<0.001	0.07	0.21	0.12	<0.001	0.07	0.21
BMI								
<19	refer				refer			
19-<25	1.19	0.33	0.84	1.67	1.22	0.264	0.86	1.72
≥25	0.58	0.031	0.35	0.95	0.6	0.043	0.37	0.99
Debt								
No	refer				refer			
Yes	0.69	0.004	0.54	0.89	0.65	0.001	0.51	0.84
Medical insurance								
Uninsured	refer				refer			
Insured	0.84	0.169	0.66	1.08	0.86	0.236	0.67	1.1
Depressive symptom								
No					refer			
Yes					1.55	<0.001	1.22	1.96
R^2	0.1143 [b]				0.1208 [b]			
Likelihood-ratio test	LR chi2(1)=13.2				Prob > chi2=0.0003			

[a] Smoking cessation status included successful quitters (coded as 1) and current smokers (coded as 0).
[b] R^2 of model 1 =0.1143. R^2 of model 2 =0.1208.
[c] CI= confidence interval for OR.

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Table 3. logistic regression predicting Depressive symptoms

Characteristic	Depressive Symptom[a]							
	Model 1				Model 2			
	OR	*P*	95% CI[c]		OR	*P*	95% CI[c]	
Age								
15-24	refer				refer			
25-29	1.09	0.535	0.83	1.44	1.35	0.52	0.54	3.35
30-34	1.1	0.511	0.83	1.45	2.13	0.079	0.92	4.94
35-39	1.25	0.094	0.96	1.63	1.6	0.255	0.71	3.59
40-49	1.31	0.024	1.04	1.67	1.74	0.165	0.8	3.82
50-59	1.13	0.341	0.88	1.47	1.55	0.285	0.69	3.46
>=60	1.32	0.03	1.03	1.69	1.44	0.378	0.64	3.24
Gender								
Male	refer				refer			
Female	0.88	0.023	0.79	0.98	0.68	0.153	0.41	1.15
Marital status								
Married	refer				refer			
Not married	1.44	<0.001	1.24	1.68	1.24	0.227	0.88	1.74
Education level								
Illiterate/Primary school	refer				refer			
Junior hign school	0.93	0.363	0.8	1.09	0.7	0.038	0.5	0.98
Senior high school	0.8	0.01	0.68	0.95	0.54	0.001	0.38	0.77
>Senior high school	0.51	<0.001	0.41	0.63	0.26	<0.001	0.16	0.42
Alcohol consumption								
No	refer				refer			
Yes	0.87	0.205	0.7	1.08	0.89	0.394	0.67	1.17
BMI								
<19	refer				refer			
19-<25	0.77	<0.001	0.67	0.89	0.75	0.084	0.54	1.04
≥25	0.64	<0.001	0.52	0.78	0.63	0.032	0.42	0.96
Debt								
No	refer				refer			
Yes	1.92	<0.001	1.72	2.15	1.75	<0.001	1.4	2.2
Medical insurance								
Uninsured	refer				refer			
Insured	0.7	<0.001	0.63	0.79	0.71	0.002	0.57	0.89
Smoke Cessation								
No					refer			
Yes					1.54	<0.001	1.22	1.96
R^2	0.0387[b]				0.0560[b]			
Likelihood-ratio test	LR chi2(1)=6449.85				Prob > chi2=0.0000			

[a] Depressive Symptom included people with depression (coded as 1) and people without depression (coded as 0).
[b] R^2 of model 1 =0.0387. R^2 of model 2 =0.0560.
[c] CI= confidence interval for OR.

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4 Discussion

In this study, we addressed several of the gaps in the scientific literature on smoking cessation and depression, specifically in the context of China. We found that among adults in Northwest China who had previously smoked but no longer smoke in 2006 (former smokers) were more likely to be currently depressed than those who smoked in 2005 and 2006 (current smokers). Our results also showed that quitters had a higher prevalence of depressive symptoms, in fact it is not evidence of a clinical diagnosis of depression.

Different from some previous findings that supported a strong association between smoking and mental disorders,[4,5,15] we find that smoking cessation was also statistically significantly associated with depression in the context of mainland China. In our study, former smokers demonstrated higher odds of currently suffering from depression than current smokers.

Due to the cross-sectional nature of these data, while we cannot determine the direction of the relationship between the smoking cessation status of former smokers and current depression, we can suggest that there are at least two possible explanations for this association. One, former smokers may become depressed as a result of trying to quit, and two, an identified confounding factor or factors may be associated with both depression and smoking cessation.

The results of a study by Glassman et al. (1990) indicated that when individuals with a history of depression stop smoking, depressive symptoms and, in some cases, serious major depression may ensue.[4,16] Other studies have also suggested that among smokers with a history of depression, recurrence of depression tends to follow a period of smoking abstinence.[4,17,18] The results of these studies support the idea that a history of major depression disorders and smoking cessation affect the risk of a relapse of depression.

Our results also indicate that abstainers were more likely to currently experience depression than were current smokers (table 3). Moreover, we found that successful quitters had the highest rates of depression relative to current smokers, initial smokers and never smokers Table 1. If smoking cessation were to be causally linked to depression, then our findings may be another example of how smoking cessation induces the relapse of depression. In addition, the other conditions significantly associated to smoking cessation other than depressive symptoms, such as age (40-59), female, alcohol consumption, BMI$\geq$25 and debt, *et al*.

Several studies noted the role of monoamine oxidases (MAO) as a pharmacological link between smoking and neurotransmitter processes in the brains of smokers.[19] A study conducted by Fowler (1996) reported that the brains of living smokers show a 40% decrease in the level of monoamine oxidase B relative to non-smokers or former smokers.[19] As MAO B inhibition may result from tobacco smoking, smoking cessation may also affect these pathways, thereby increasing an individual's risk of depression during the period of withdrawal and thereafter.[20] These findings may explain the relationship between smoking abstinence and the re-occurrence of depression.

We were also able to examine associations between smoking cessation and depression that controlled for the existence of economic and behaviour conditions, such as house debt, alcohol consumption and BMI. Many studies exist in the developed countries to prove the impact of economic concerns on smoking cessation.[21–23] A follow-up study from the U.S. indicated that greater financial strain predicted lower abstinence rates among racially/ethnically diverse smokers.[24,25] In addition, heavy drinking has been associated with a decreased likelihood of smoking cessation,[26] and concern about weight may be a possible predictor of smoking behaviour among youth.[27] In our study, however, we found significant associations between smoking abstinence status and depression even after controlling for the existence of certain economic and behaviour conditions.

However, our finding that people with depression were more likely to be currently abstinent from smoking than those without depression is a novel one Table 2. In our study, the odds ratio for smokers with current depression was higher than those without depression, which is inconsistent with earlier findings,[4] and the likelihood ratio test for two models was statistically significant. We have no clear interpretation for this disparity, which warrants further investigation.

Our study also suffered from several limitations.[28] First, as our data are cross-sectional, great caution must be exercised in deducing causality from them.[29] Second, caution should be used when generalizing our findings to other populations as our study only targeted urban residents in Northwest China. Third, as we mainly examined the economic and behaviour factors of smoking, we did not cover all factors that influence cigarette-smoking status. Fourth, it is not known whether people were already suffered from depression before they quit smoking or if the depressive symptoms took over afterwards.

In conclusion, in the present study, given both the higher prevalence of depression and the higher risk of currently experiencing depression in smoking quitters, government bodies in China should implement appropriate strategies and execute effective measures that involve

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psychotherapy to reduce the harmful consequences associated with smoking.

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