



A longitudinal examination of the relationship between smoking and panic, anxiety, and depression in Chinese and German students

Kristen L. Lavalley, Xiao Chi Zhang, Silvia Schneider, Jürgen Margraf^{*}

Mental Health Research and Treatment Center, Ruhr-Universität Bochum, Germany

ARTICLE INFO

Keywords:

Smoking
Panic
Anxiety
Depression
Mental health
Longitudinal
Cross-cultural
China
Germany

ABSTRACT

The present study examines the relationship between smoking and panic, depression, and anxiety over time and across two cultures, using data from the BOOM studies. The relationship between smoking and anxiety disorders, including panic requires further exploration, in order to reconcile inconsistent, contradictory findings and cross-cultural differences. Participants in the present study included 5,416 Chinese university students and 282 German university students. Participants completed surveys assessing smoking, panic, depression, and anxiety. Multiple logistic regressions were used to examine predict later mental health from smoking, as well as later smoking from mental health. In sum, across the regressions, smoking at baseline did not predict higher panic or depression at follow-up in either German or Chinese students. It did predict lower anxiety in German students. Anxiety at baseline, but not depression, predicted increased likelihood of smoking at follow-up in German students. The relationship between smoking and anxiety disorders is one that will require further exploration, in order to reconcile inconsistent, contradictory findings and cross-cultural differences. The present data point to a relationship between anxiety and later smoking, and also to a negative, though small, relationship between smoking and later anxiety in German students, and no prospective relationship in either direction in Chinese students.

1. Introduction

Addictions and anxiety disorders frequently occur comorbidly (Kushner, Abrams, & Borchardt, 2000). In particular, a line of research has indicated a predictive relationship between cigarette smoking and panic disorder, and other panic-related disorders, such as agoraphobia (a complication of panic disorder) (Zvolensky, Feldner, Leen-Feldner, & McLeish, 2005). One comprehensive review indicated that smoking rates in individuals with panic are higher than in those without panic, and rates range from about 39% (currently smoke) to about 77% (smoked at time of onset), with an average of about 40% across studies. Further, smokers are more likely than nonsmokers to report panic, as well as other anxiety disorders and depression (Zvolensky et al., 2005). One illustrative major epidemiological study, with over 4000 participants ages 15–54 from the National Comorbidity Survey, provided strong evidence in a U.S. sample, with results showing that smokers were more likely to have a history of panic attacks than were nonsmokers. When diagnoses were combined, 58.9 to 61.3% of those with a history of any panic related problems reported being current smokers,

with smoking increasing with the number of psychiatric diagnoses (Lasser et al., 2000).

Research into the order of effects between smoking and anxiety points to smoking as a predictive risk factor for developing panic attacks and panic disorder, while panic problems appear to serve to maintain smoking behavior, in a feedback loop. The predisposition for both anxiety and anxiety-reducing motives for smoking (i.e., anxiety sensitivity, as well as general fearfulness and sensitivity to bodily distress), precedes the entire process. The model for this loop and a review can be found in Zvolensky & Bernstein (Zvolensky & Bernstein, 2005), and updated in (Zvolensky, Bernstein, Marshall, et al., 2006). Nicotine dependence is associated with higher rates of depression and anxiety disorders, including panic, in the U.S. (Breslau, Kilbey, & Andreski, 1991). Nicotine dependence is also associated with higher rates of panic attacks and panic disorder in a large-scale study of German smokers and nonsmokers (Nelson & Wittchen, 1998). Across studies, about 5% of daily smokers, as compared with about 2% of nonsmokers, report panic-related problems (Zvolensky et al., 2005). The relationship between smoking and panic attacks appears to be independent of

Abbreviations: BOOM, Bochum Optimism and Mental Health Studies; DASS-21, Depression Anxiety Stress Scales; FAS, Family Affluence Scale.

* Corresponding author at: Bochumer Fenster 3/ 01 Massenbergrstraße 9-13 D-44787, Bochum

E-mail address: juergen.margraf@ruhr-uni-bochum.de (J. Margraf).

<https://doi.org/10.1016/j.abrep.2021.100347>

Received 11 February 2021; Received in revised form 7 April 2021; Accepted 9 April 2021

Available online 15 April 2021

2352-8532/© 2021 The Authors.

Published by Elsevier Ltd.

This is an open access article under the CC BY-NC-ND license

(<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sociodemographic characteristics, other comorbid disorders, and symptom overlap between substance abuse and panic disorder (Zvolensky, Schmidt, & Stewart, 2003), though some of the relationship between smoking and panic is attenuated when accounting for other substance abuse (Zvolensky et al., 2005). Some longitudinal research suggests that the direction of effects is stronger from smoking to panic, than from panic to smoking (Zvolensky et al., 2005; Johnson et al., 2000). Further, people with panic have more intense smoking withdrawal-related anxiety symptoms (Zvolensky, Lejuez, Kahler, & Brown, 2004), and thus find smoking cessation difficult (Lasser et al., 2000; Zvolensky et al., 2005; Zvolensky, Feldner, Eifert, & Brown, 2001). There is also evidence for relationships between panic and alcohol use/dependence, and marijuana dependence (Zvolensky, Bernstein, Marshall, et al., 2006; Zvolensky, Bernstein, Sachs-Ericsson, et al., 2006).

Despite increased awareness of the importance of replication across cultures, most studies into smoking and panic have been conducted in Western nations, limiting the generalizability of the findings. However, social factors and cultural background are widely recognized as potentially important influences in mental health (Pickett, James, & Wilkinson, 2006; Bromet et al., 2011; Jacobi et al., 2014; Maercker et al., 2015). Universal validity is not a given for psychological theories that have not been tested or may even not be amenable to testing across cultural boundaries. For theories to be truly transcultural, they must be studied cross-culturally (Brink, 1999). So far, smoking and panic have been examined in Russian populations, with smoking and anxiety sensitivity predicting agoraphobic avoidance, but not panic in that population (Zvolensky, Kotov, Antipova, & Schmidt, 2003). Few studies have examined the relationship in Asian populations, and there are few data from Germany.

1.1. Present study

The present study is a large-scale, longitudinal examination of the relationship between smoking and panic-related problems in two countries, Germany and China, using data from the “Bochum Optimism and Mental Health (BOOM) Studies” (Margraf & Schneider, unpublished manuscript), which aim to enhance integrated knowledge of the causes and consequences of positive mental health and mental health problems cross-culturally and over time. We hypothesized that the relationships between smoking and panic would be positive in both Germany and China, with stronger effects from time one smoking to later anxiety.

2. Method

2.1. Procedure

The present study utilizes a subset of data from the BOOM (Bochum Optimism and Mental Health) study, a large-scale, cross-cultural, longitudinal investigation of risk and protective factors in mental health (Maercker et al., 2015; Margraf & Schneider, unpublished manuscript). For a comprehensive overview of the full study design, aims, measures, and participants, see Margraf and Schneider (unpublished manuscript). The Ethics Committee of the Faculty of Psychology of the Ruhr-Universität Bochum (RUB) approved the study in Germany. Approval to administer the questionnaires was granted by the Faculty of Psychology at Ruhr-Universität Bochum on May 12, 2011 and renewed on September 2013. The approvals for the German site were communicated to the participating Chinese universities, which acknowledged and accepted these approvals for data collection in China. Data were collected between 2011 and 2016 through three professional opinion research institutes. Participants in the present study were recruited via the internet (German and Chinese) and paper mailings (Chinese). Participants gave their informed consent orally after being informed about anonymity and voluntariness of the survey. Written consent was not obtained, as it was not required by the local ethics commissions, as

personally identifying information was not collected. Participation took less than an hour at each time point (average of about 45 minutes).

2.2. Participants

Participants in the present study included 5,416 Chinese university students and 282 German university students, who participated both the second and the third follow up surveys in the BOOM studies (Bochum Optimism and Mental Health Studies), which aim to investigate risk and protective factors of mental health in representative and student samples. Participant demographics, including age, are provided in Table 1.

China. As the data were anonymized from the very beginning of data collection, no statement by an institutional board/ethics committee was required for China. The original Chinese sample at baseline consisted of 13,581 university students from Capital Normal University Beijing, Hebei United University, Shanghai Normal University, Guizhou Finance and Economics University, and Nanjing University with baseline data collected from 2012 to 2013. Of those, 12,744 students participated again in the first follow up study between 2013 and 2014. In the second follow up study from 2014 to 2015, there were 10,499 students. In the third follow up study from 2015 to 2016, there were 5,917 students. Participants, mainly freshmen, were recruited during their first study month via an invitation postal mailing. The response rate was 94.5%. Data were gathered by an online or a paper-pencil questionnaire in Chinese administered in a group testing session. Participants received 10 RenMinB (approximately 1.3 Euros) as financial compensation.

Germany Data collection at Ruhr-Universität Bochum was via an online portal, with data collection beginning in 2011. The Ethics Committee of the Faculty of Psychology of Ruhr-Universität Bochum approved the study on May 12, 2011 and renewed on October 2012. The German sample at baseline consisted of 7,890 students from RUB from 2012 to 2015. In the first follow up study, 1,608 students participated again. In the second follow up study, 730 students participated again. In the third follow up study, 572 students participated again. German students were recruited by an e-mailed invitation with a link leading to

Table 1
Demographics and descriptive statistics for predictors and outcomes.

	German Students		Chinese Students	
	N	%	N	%
Full sample	282	100%	5,416	100%
Gender				
Female	179	63.5%	3,051	59.9%
Male	103	36.5%	2,045	40.1%
Alcohol consumption BL				
No	45	16.0%	2,962	55.3%
Yes	236	84.0%	2,390	44.7%
Smoking BL				
No	227	80.0%	4,764	88.6%
Yes	54	19.2%	614	11.4%
Smoking FU				
No	223	79.6%	4,802	88.8%
Yes	57	20.4%	607	11.2%
Panic follow-up				
No	271	97.1%	5,635	88.6%
Yes	8	2.9%	672	11.4%
	Mean	SD	Mean	SD
Age	24.92	4.56	19.08	1.13
FASII	5.45	1.66	2.37	2.01
Health state	76.32	18.40	86.42	13.29
Anxiety BL	2.52	3.11	3.30	3.82
Depression BL	4.19	4.26	2.71	3.79
Anxiety FU	2.02	2.89	2.78	3.65
Depression FU	4.10	4.66	2.35	3.62

Note. BL = Baseline, FU = Follow-up

an online questionnaire, administered in German. The link was sent to all students enrolled at RUB in 2012 and only sent to freshmen at RUB from 2013 to 2015. Students were offered the opportunity to take part in a draw for a gift coupon (20 euro) or a tablet computer.

2.3. Measures

Depression, Anxiety and Stress. Negative mental health was assessed using the widely-used Depression Anxiety Stress Scales (DASS-21) (Henry & Crawford, 2005). This short form of the DASS-42 (Lovibond & Lovibond, 1995) assesses a broad range of psychological distress symptoms. It is composed of three 7-item subscales for depression, anxiety and stress symptoms over the past week. The subscales may serve as outcome measures and as screening and monitoring instruments (Bayram & Bilgel, 2008; Dahm, Wong, & Ponsford, 2013; Ng et al., 2007). Items are rated on a 4-point likert scale from 0 (did not apply to me at all) to 3 (applied to me very much or most of the time). Responses can be averaged within subscale or across all three for a total item score. Psychometric properties are well established in both clinical and non-clinical samples (Henry & Crawford, 2005; Ng et al., 2007) and are comparable for the short and long versions (Lovibond & Lovibond, 1995; Antony, Bieling, Cox, Enns, & Swinson, 1998). In addition, unpublished data from the present authors indicate scale appropriateness for cross-cultural research, with measurement invariance across cultures. In the present study, overall Cronbach's alpha was $\alpha = 0.92$ in Germany, 0.90 in China. The reliability of each subscale was $\alpha_{\text{depression}} = 0.884$; $\alpha_{\text{anxiety}} = 0.780$; $\alpha_{\text{stress}} = 0.851$ in Germany, and $\alpha_{\text{depression}} = .875$; $\alpha_{\text{anxiety}} = .855$; $\alpha_{\text{stress}} = .772$ in China.

Panic. Panic was assessed in the second follow-up with the DASS-Anxiety subscale and one single question (Margraf, Cwik, Pflug, et al., 2017; Margraf, Schneider, Soeder, & Becker, 1996; Margraf, Cwik, Suppiger, et al., 2017): "In the last 12 months, did you suddenly feel a rush of intense fear, horror or the feeling of intense discomfort? And this was accompanied by complaints such as fear of dying or going crazy, dyspnea or lump in the throat, heart racing or pain in the chest, sweating, dizziness, nausea?" Participants responded to both questions with a single response from the following three choices: "This happened in the last 12 months." "That was a while ago." Or "I've never had that." Participants responding affirmatively (happened in the last 12 months) to this question, and having at least a moderate anxiety score (DASS-21 ≥ 5) (Lovibond & Lovibond, 1995), were defined as having panic in the last 12 months.

2.4. Predictors

Quality of health. Overall current quality of health was assessed using the validated EuroQol (EQ- 5D-3L) (The EuroQol Group, 2013, 1990; Brooks, 1996). Participants rated current health status on a scale (EuroQol VAS) ranging from 0 (worst imaginable health) to 100 (best imaginable health).

Family affluence and social class. Socioeconomic status was assessed with the Family Affluence Scale (FAS) (Boyce, Torsheim, Currie, & Zambon, 2006). The FAS is, a four-item measure of family wealth, developed in the WHO Health Behavior in School-aged Children Study. Questions include (either with 2 or 3 response alternatives): "Does your family own a car, van or truck?", "Do you have your own bedroom for yourself?", "During the past 12 months, how many times did you travel away on holiday with your family?", and "How many computers does your family own?". The FAS total score is calculated by summing up the responses to these items. Convergent validity is established via correlations with the Gross National Product across 35 countries (Boyce et al., 2006). The reliability was $\alpha = 0.524$ in German students and $\alpha = 0.641$ in Chinese students. The Cronbach's alpha values were low, as FAS II has only 4 items. In this situation, mean inter-item correlation values should be reported and an optimal range from 0.2 to 0.4 is recommended by Briggs and Cheek (1986). In our study, the mean inter-item correlations

value was 0.23 in the German sample and 0.30 in the Chinese sample.

Substance use. Current smoking was assessed using one item in Germany: "Do you smoke regularly?" Answer categories were "no", "yes, sometimes" and "yes, regularly". For the present analyses the two latter categories were combined into "yes", which was coded as 1. "No" was coded as 0. In China, current smoking was also assessed with one item: "Do you smoke?" Answer categories were "four times or more a week", "2 or 3 times a week", "2–4 times a month", "once a month", and "never". "Never" was coded as 0, and the other four categories were coded as 1.

Frequency of alcohol consumption was assessed using one item: "How often do you drink alcohol?" Answer categories were never, once a month, 2 to 4 times a month, 2 to 3 times a week and 4 times a week and more. The first category "never" was coded as 0, and the last four categories were coded as 1. Alcohol consumption was not significantly correlated with any health variables in the German sample. In the Chinese sample, alcohol consumption correlated very low with the health variables. Therefore, alcohol consumption was excluded from the further analyses.

2.5. Statistical analyses

Statistical analyses were conducted using SPSS Statistics Version 21.0 (IBM Corp., 2012). Missing values are generally between 0 and 2.5% in the German sample and 0.1% to 3.6% in Chinese sample, depending on the measure. For descriptive and univariate statistics, missing data were excluded. Further, as assessment method can have an influence on the data (Zhang, Kuchinke, Woud, Velten, & Margraf, 2017), the impact of data collection method was examined. In our data, the method of data collection was found not to be correlated with the outcomes (smoking depression and anxiety), so it was not included in our analyses.

To predict the presence of smoking at the follow-up, we conducted two multiple logistic regressions (one with the German and one with the Chinese sample), including the predictors anxiety, depression, health state, and smoking at baseline, and controlling for gender and family affluence. To predict the presence of panic at the follow-up, we conducted two multiple logistic regressions (one with the German and one with the Chinese sample) with predictors including smoking, health state anxiety and depression from baseline, and controls for gender and family affluence. To predict the state of anxiety and depression (separately) at follow-up, we conducted four stepwise multiple linear regressions, one for each outcome variable and for the German and Chinese samples. The first step contained predictors baseline health state, anxiety, depression, and controls for gender and family affluence. In the second step, smoking at baseline was added as an additional predictor. The same analysis was conducted once for the German student sample and once for the Chinese student sample. Data used in the current analyses are available in the online Supporting Information File.

3. Results

3.1. Descriptive statistics and baseline correlations

Table 1 presents data on participant demographics and descriptive statistics for the predictors and outcomes at baseline. Gender percentages were almost the same in both German and Chinese samples. The German sample was older and from more affluent families than the Chinese sample.

The correlations among the predictors are shown in Table 2. Correlations indicated a positive relationship between baseline smoking and concurrent anxiety and depression, as well as follow-up anxiety, depression, and panic, in the Chinese student sample. Baseline anxiety and depression were not significantly related to follow-up smoking in the Chinese student sample. Baseline smoking was related to slightly lower follow-up anxiety in the German student sample. Baseline anxiety

Table 2

Correlations among the psychological predictors within country, with Germany below diagonal, China above diagonal.

		Baseline							Follow-up			
		Gender	FASII	Health state	Alcohol	Smoking	Anxiety	Depression	Smoking	Anxiety	Depression	Panic
Baseline	Gender	1	-0.127**	-0.060**	0.436**	0.349**	0.121**	0.157**	0.353**	0.128**	0.169**	0.013
	FASII	0.068	1	-0.023	-0.073**	-0.056**	-0.097**	-0.086**	-0.061**	-0.072**	-0.073**	-0.022
	Health state	-0.047	0.106	1	-0.004	-0.039**	-0.194**	-0.195**	-0.002	-0.167**	-0.156**	-0.067**
	Alcohol	0.128*	0.101	0.069	1	0.345**	0.142**	0.165**	0.240**	0.098**	0.113**	0.027*
	Smoking	-0.011	-0.056	-0.098	0.041	1	0.231**	0.255**	0.509**	0.124**	0.141**	0.028*
	Anxiety	-0.086	-0.128*	-0.397**	-0.033	-0.032	1	0.870**	0.099	0.368**	0.335**	0.133**
	Depression	0.02	-0.163**	-0.368**	-0.04	0.016	0.629**	1	0.098	0.336**	0.363**	0.098**
	Follow-up	Smoking	0.037	-0.107	-0.114	0.029	0.797**	0.163**	0.178**	1	0.189**	0.211**
	Anxiety	-0.036	-0.153*	-0.223**	-0.089	-0.130*	0.479**	0.349**	-0.083	1	0.883**	0.329**
	Depression	0.071	-0.189**	-0.233**	-0.065	0.022	0.388**	0.597**	0.035	0.649**	1	0.243**
	Panic	0.003	-0.02	-0.201**	0.017	-0.029	0.163**	0.119*	-0.034	0.239**	0.181**	1

Note: * Correlation significant at the 0.05 level (2-tailed); ** Correlation significant at the 0.01 level (2-tailed).

and depression were related to higher follow-up smoking in the German student sample.

3.2. Multivariate regressions

Results from the multiple logistic regressions are presented in Table 3a. In the German sample, health state at baseline was the only significant predictor for the presence of panic at follow-up. No significant predictor was found for the presence of smoking at follow-up. In the Chinese sample, health state at baseline, anxiety at baseline, depression at baseline, and family affluence scale all significantly predicted the presence of panic at follow-up. For the presence of smoking at follow-up, gender, health state at baseline, and depression at baseline were significant predictors.

Table 3b shows the results from the multiple linear regressions. In the German sample, family affluence and depression at baseline significantly predicted depression at follow-up, in the first step and remained

Table 3a

Results from the logistic regressions predicting panic and smoking.

Outcome = Panic at follow-up	Germany		China	
	Odds Ratio	95% CI	Odds Ratio	95% CI
R ²	0.16		0.06	
Gender (female as reference)	1.15	[0.23–5.78]	1.09	[0.81–1.46]
FASII	1.03	[0.65–1.61]	0.89**	[0.82–0.95]
Health state baseline	0.96*	[0.93–0.99]	0.99**	[0.98–0.99]
Smoking (no as reference)	2.08	[0.23–18.92]	0.97	[0.65–1.47]
Anxiety baseline	1.13	[0.89–1.43]	1.23***	[1.16–1.31]
Depression baseline	0.99	[0.81–1.22]	0.90**	[0.85–0.96]
Smoking at follow-up		Germany		China
R ²		0.71		0.41
		Odds Ratio		Odds Ratio
Gender (female as reference)	2.63	[0.85–8.09]	8.56***	[6.35–11.53]
FASII	0.84	[0.61–1.14]	0.97	[0.91–1.02]
Health state baseline	1.01	[0.98–1.04]	1.01**	[1.00–1.02]
Smoking baseline	283.19***	[77.53–1034.34]	10.19***	[8.08–12.86]
Anxiety baseline	1.32**	[1.09–1.61]	1.02	[0.96–1.08]
Depression baseline	0.99	[0.86–1.14]	1.03	[0.97–1.08]

Note. * p = .05. ** p = .01. *** p = .001.

Table 3b

Standardized regression coefficients from the multiple linear regressions predicting depression and anxiety.

	Depression Follow-Up		Anxiety Follow-Up	
	Germany	China	Germany	China
Step 1				
R ²	0.37	0.15	0.24	0.15
Gender	0.058	0.113***	-0.003	0.078***
FASII	-0.107*	-0.036**	-0.096	-0.037**
Health state at baseline	-0.005	-0.089***	-0.032	-0.101***
Anxiety at baseline	0.015	0.068*	0.420***	0.293***
Depression at baseline	0.567***	0.263***	0.054	0.043
Step 2				
R ²	0.37	0.15	0.26	0.15
Gender	0.058	0.107***	-0.008	0.073***
FASII	-0.107*	-0.036**	-0.105	-0.037**
Health state at baseline	-0.004	-0.089***	-0.047	-0.102***
Anxiety at baseline	0.015	0.066*	0.405***	0.292***
Depression at baseline	0.567***	0.261***	0.058	0.041
Smoking at baseline	0.002	0.018	-0.126*	0.015

Note. * p = .05. ** p = .01. *** p = .001.

significant predictors in the second step, in which smoking at baseline was added as an additional predictor. For anxiety at follow-up, anxiety at baseline was a significant predictor in both steps. In the second step, smoking at baseline significantly negatively predicted anxiety at follow-up.

In the Chinese sample, gender, family affluence scale, health state at baseline, anxiety at baseline, and depression at baseline were all significant predictors for depression at follow-up at the both steps. For anxiety at follow up, gender, family affluence scale, health state at baseline, and anxiety at baseline were significant predictors at both steps.

In sum, across the regressions, smoking at baseline did not predict higher panic or depression at follow-up in either German or Chinese students. It did predict lower anxiety in German students. Anxiety at baseline, but not depression, predicted increased likelihood of smoking at follow-up in German students.

4. Discussion

To our knowledge, this is the first large-scale, longitudinal, prospective study to examine the relationship between smoking and panic and anxiety in Chinese samples, and the second in German samples. Prior research, primarily conducted in Western countries, and in particular, the U.S., indicates a positive predictive relationship between cigarette smoking and panic disorder, and other panic-related problems, such as agoraphobia (a complication of panic disorder) (Zvolensky et al.,

2005), as well as other anxiety disorders and depression (Zvolensky et al., 2005). Research in German populations has so far been consistent with prior results, with nicotine dependence associated with higher rates of panic attacks and panic disorder (Nelson & Wittchen, 1998). In the present study, we found concurrent zero-order positive correlations between smoking and anxiety in the Chinese, but not German sample. However, inconsistent with prior research, smoking did not predict panic, longitudinally, in either the German students, or the Chinese students. Anxiety did predict the presence of increased smoking in the German students, but not the Chinese students. Further, in the examination of the predictive nature of smoking for anxiety and depression at the follow-up, smoking did not predict either depression or anxiety in Chinese students. However, surprisingly, and contrary to prior research and our predictions, smoking negatively predicted later anxiety in German students. Thus, in sum, anxiety predicted increased later smoking in Germans, and smoking predicted lowered anxiety in German students.

The prospective prediction of smoking from anxiety is consistent with past research. Interestingly, this prediction strength is indeed stronger than in past research indicating that anxiety is merely a maintaining factor in smoking, rather than a predictor of increase in smoking. The nature of the prediction of decreasing anxiety from smoking in German students may be a fluke artifact of our particular dataset. It may also be that in this sample of German students, who live in a country where smoking is more common than in the U.S. (Lampert, von der Lippe, & Mueters 2013; Scholten et al., 2018 Naurath & Jones, 2007), both fitting in with the crowd and adopting smoking specifically as a coping mechanism may serve to reduce student anxiety, especially in individuals with preexisting high levels of anxiety. More anxious students were more likely to increase smoking, and increased smoking was perhaps in turn, related to reduced anxiety. Of course, any potential psychological benefit of smoking is likely outweighed by the negative impact on physical health and increased risks for smoking-related disease, such as lung cancer.

Smoking was completely unrelated to either panic, depression or anxiety in Chinese students. With one of the highest rates of smoking in the world (Naurath & Jones, 2007), perhaps any potential psychological effects of smoking that may stem from stigma are non-present in China, diluting the effects of smoking on mental health. In the Chinese social interactions, smoking is more likely a social skill and associated with freedom and charisma (Ho et al., 2010). The offering and acceptance of cigarettes is seen as a traditional Chinese gesture of goodwill. Thus, smoking may have more social significance and wider acceptance for people in China than in Germany. Smoking may thus have more macro-level determination than in Germany, and may therefore be less of a personal coping strategy.

This study has a number of strengths, including the large sample size, examination of the phenomena in cultures less well-represented in research than the United States, and thorough assessments using standardized instruments. Because of the homogenous sample, age, gender and socioeconomic characteristics were less likely to confound the effects of the psychological predictors. Moreover, we investigated the psychological predictors within a longitudinal design. Although there are several strengths associated with the study, there are also limitations. The first is that the panic variable was not ideally assessed. It was a combination of anxiety scale ratings plus one panic item. That panic item, further, was not ideally translated into English. The word dyspnea, which means shortness of breath, is a rarely used word in U.S. English vernacular, and may not have been understood by all participants. A second limitation of the study lies in the measurement of smoking. It may be that smoking measured as a continuous, rather than a dichotomous variable, would have been more sensitive to effects. Finally, the reliability of some instruments, particularly the FAS, was low, which may have impacted the robustness of the final results.

5. Conclusions

In sum, the present data from Germany provides evidence that is suggestive of the effects of anxiety on later smoking, as well as evidence of a negative (but weak) relationship between smoking and later anxiety. However, findings from the sample of Chinese students did not provide any evidence of such effects in Chinese students. The relationship between smoking and anxiety disorders, including panic, is one that will require further exploration in order to reconcile inconsistent, contradictory findings and cross-cultural differences.

Ethics approval and consent to participate

The Ethics Committee of the Faculty of Psychology of the Ruhr-Universität Bochum approved the study in Germany. Approval to administer the questionnaires was granted by the Faculty of Psychology at Ruhr-Universität Bochum on May 12, 2011 and renewed on September 2013. The approvals for the German site were communicated to the participating Chinese universities, which acknowledged and accepted these approvals for data collection in China. Participants gave their informed consent orally after being informed about anonymity and voluntariness of the survey. Written consent was not obtained, as it was not required by the local ethics commissions, as personally identifying information was not collected.

CRedit authorship contribution statement

Kristen L. Lavallee: Writing - original draft, Writing - review & editing, Investigation. **Xiao Chi Zhang:** Data curation, Formal analysis, Investigation, Methodology, Validation, Writing - original draft. **Silvia Schneider:** Conceptualization, Investigation, Supervision. **Jürgen Margraf:** Conceptualization, Funding acquisition, Investigation, Methodology, Supervision, Project administration, Resources.

Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

We appreciate the contribution of the participants in this study, as well as Angela Bieda, Julia Brailovskaia, Pia Schönfeld, and Julia Velten for their assistance in data collection and management. The authors thank the participants in the study, as well as a their team of research assistants.

Funding Sources

This study was supported by Alexander von Humboldt Professorship awarded to Jürgen Margraf by the Alexander von Humboldt-Foundation.

References

- Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment, 10*(2), 176–181. <https://doi.org/10.1037/1040-3590.10.2.176>.
- Bayram, N., & Bilgel, N. (2008). The prevalence and socio-demographic correlations of depression, anxiety and stress among a group of university students. *Social Psychiatry and Psychiatric Epidemiology, 43*(8), 667–672. <https://doi.org/10.1007/s00127-008-0345-x>.
- Briggs, S. R., & Cheek, J. M. (1986). The role of factor analysis in the evaluation of personality scales. *Journal of Personality, 54*, 106–148.
- Boyce, W., Torsheim, T., Currie, C., & Zambon, A. (2006). The family affluence scale as a measure of national wealth: Validation of an adolescent self-report measure. *Social Indicators Research, 78*(3), 473–487. <https://doi.org/10.1007/s11205-005-1607-6>.

- Breslau, N., Kilbey, M. M., & Andreski, P. (1991). Nicotine Dependence, Major Depression, and Anxiety in Young-Adults. *Archives of General Psychiatry*, *48*(12), 1069–1074.
- Brink, P. J. 1999. "Transcultural versus cross-cultural." *Journal of transcultural nursing: official journal of the Transcultural Nursing Society / Transcultural Nursing Society* 10 (1):7.
- Bromet, E., Andrade, L. H., Hwang, I., Sampson, N. A., Alonso, J., de Girolamo, G., ... Kessler, R. C. (2011). Cross-national epidemiology of DSM-IV major depressive episode. *BMC Medicine*, *9*. <https://doi.org/10.1186/1741-7015-9-90>.
- Brooks, R. (1996). EuroQol: The current state of play. *Health Policy*, *37*(53–72).
- Dahm, J., Wong, D. N., & Ponsford, J. (2013). Validity of the Depression Anxiety Stress Scales in assessing depression and anxiety following traumatic brain injury. *Journal of Affective Disorders*, *151*(1), 392–396. <https://doi.org/10.1016/j.jad.2013.06.011>.
- Henry, J. D., & Crawford, J. R. (2005). The short-form version of the Depression Anxiety Stress Scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*, *44*, 227–239. <https://doi.org/10.1348/014466505X29657>.
- Ho, M. G., Ma, S., Chai, W., et al. (2010). Smoking among rural and urban young women in China. *Tobacco Control*, *19*, 13–18.
- IBM SPSS statistics for Windows, Version 24.0. (2016). IBM Corp. NY: Armonk.
- Jacobi, F., Hofler, M., Siebert, J., Mack, S., Gerschler, A., Scholl, L., ... Wittchen, H. U. (2014). Twelve-month prevalence, comorbidity and correlates of mental disorders in Germany: The Mental Health Module of the German Health Interview and Examination Survey for Adults (DEGS1-MH). *International Journal of Methods in Psychiatric Research*, *23*(3), 304–319. <https://doi.org/10.1002/mpr.1439>.
- Johnson, J. G., Cohen, P., Pine, D. S., Klein, D. F., Kasen, S., & Brook, J. S. (2000). Association between cigarette smoking and anxiety disorders during adolescence and early adulthood. *Jama-Journal of the American Medical Association*, *284*(18), 2348–2351. <https://doi.org/10.1001/jama.284.18.2348>.
- Kushner, M. G., Abrams, K., & Borchardt, C. (2000). The relationship between anxiety disorders and alcohol use disorders: A review of major perspectives and findings. *Clinical Psychology Review*, *20*(2), 149–171. [https://doi.org/10.1016/S0272-7358\(99\)00027-6](https://doi.org/10.1016/S0272-7358(99)00027-6).
- Lampert, T., von der Lippe, E., & Mueters, S. (2013). Prevalence of smoking in the adult population of Germany: results of the German Health Interview and Examination Survey for Adults (DEGS1). *Bundesgesundheitsblatt Gesundheitsforschung Gesundheitsschutz*, *56*(5–6), 802–808. <https://doi.org/10.1007/s00103-013-1698-1>.
- Lasser, K., Boyd, J. W., Woolhandler, S., Himmelstein, D. U., McCormick, D., & Bor, D. H. (2000). Smoking and mental illness - A population-based prevalence study. *Jama-Journal of the American Medical Association*, *284*(20), 2606–2610. <https://doi.org/10.1001/jama.284.20.2606>.
- Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states - comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy*, *33*(3), 335–343. [https://doi.org/10.1016/0005-7967\(94\)00075-U](https://doi.org/10.1016/0005-7967(94)00075-U).
- Maercker, A., Zhang, X. C., Gao, Z. H., Kochetkov, Y., Lu, S., Sang, Z. Q., ... Margraf, J. I. (2015). Personal value orientations as mediated predictors of mental health: A three-cultural study of Chinese, Russian, and German university students. *International Journal of Clinical and Health Psychology*, *15*(1), 8–17. <https://doi.org/10.1016/j.ijchp.2014.06.001>.
- Margraf, J., Cwik, J. C., Pflug, V., & Schneider, S. (2017). Structured clinical interviews for mental disorders across the life span: Psychometric quality and further development of the DIPS Open Access Interviews. *Zeitschrift für Klinische Psychologie und Psychotherapie*, *3*, 176–186.
- Margraf, J., Cwik, J. C., Suppiger, A., & Schneider, S. (2017). DIPS Open Access: Diagnostic Interview for Mental Disorders. [DIPS Open Access: Diagnostisches Interview bei psychischen Störungen.] Bochum: Mental Health Research and Treatment Center, Ruhr-Universität Bochum.
- Margraf, J., & Schneider, S. (unpublished manuscript). "Bochum Optimism and Mental Health (BOOM) Research Program: Background, methods and aims."
- Margraf, J., Schneider, S., Soeder, U., & Becker, E. S. (1996). "Diagnostisches Interview bei psychischen Störungen (F-DIPS) [Diagnostic Interview for Psychological Disorders]." Unpublished Manuscript, Technische Universität Dresden.
- Naurath, N., & Jones, J. M. (2007). Smoking Rates Around the World – How Do Americans Compare? *Gallup News Service*.
- Nelson, C. B., & Wittchen, H. U. (1998). Smoking and nicotine dependence - Results from a sample of 14- to 24-year-olds in Germany. *European Addiction Research*, *4*(1–2), 42–49. <https://doi.org/10.1159/000018929>.
- Ng, F., Trauer, T., Dodd, S., Callaly, T., Campbell, S., & Berk, M. (2007). The validity of the 21-item version of the Depression Anxiety Stress Scales as a routine clinical outcome measure. *Acta Neuropsychiatrica*, *19*(5), 304–310. <https://doi.org/10.1111/j.1601-5215.2007.00217.x>.
- Pickett, K. E., James, O. W., & Wilkinson, R. G. (2006). Income inequality and the prevalence of mental illness: A preliminary international analysis. *Journal of Epidemiology and Community Health*, *60*(7), 646–647. <https://doi.org/10.1136/jech.2006.046631>.
- Scholten, S., Velten, J., & Margraf, J. (2018). Mental distress and perceived wealth, justice and freedom across eight countries: The invisible power of the macrosystem. *PLoS One*, *13*(5), Article e0194642. <https://doi.org/10.1371/journal.pone.0194642>.
- The EuroQol Group. (1990). EuroQol—a new facility for the measurement of health-related quality of life. *Health Policy*, *16*(3), 199–208.
- The EuroQol Group (2013). EQ-5D-3L User Guide. Accessed 07/31/2014.
- Zhang, X., Kuchinke, L., Woud, M. L., Velten, J., & Margraf, J. (2017). Survey Method Matters: Online/Offline Questionnaires and Face-to-Face or Telephone Interviews Differ. *Computers in Human Behavior*, *71*, 172–180.
- Zvolensky, M. J., & Bernstein, A. (2005). Cigarette smoking and panic psychopathology. *Current Directions in Psychological Science*, *14*(6), 301–305. <https://doi.org/10.1111/j.0963-7214.2005.00386.x>.
- Zvolensky, M. J., Bernstein, A., Marshall, E. C., & Feldner, M. T. (2006). Panic attacks, panic disorder, and agoraphobia: Associations with substance use, abuse, and dependence. *Current Psychiatry Reports*, *8*(4), 279–285.
- Zvolensky, M. J., Bernstein, A., Sachs-Ericsson, N., Schmidt, N. B., Buckner, J. D., & Bonn-Miller, M. O. (2006). Lifetime associations between cannabis use, abuse, and dependence and panic attacks in a representative sample. *Journal of Psychiatric Research*, *40*(6), 477–486. <https://doi.org/10.1016/j.jpsychires.2005.09.005>.
- Zvolensky, M. J., Feldner, M. T., Eifert, G. H., & Brown, R. A. (2001). Affective style among smokers - Understanding anxiety sensitivity, emotional reactivity, and distress tolerance using biological challenge. *Addictive Behaviors*, *26*(6), 901–915. [https://doi.org/10.1016/S0306-4603\(01\)00242-8](https://doi.org/10.1016/S0306-4603(01)00242-8).
- Zvolensky, M. J., Feldner, M. T., Leen-Feldner, E. W., & McLeish, A. C. (2005). Smoking and panic attacks, panic disorder, and agoraphobia: A review of the empirical literature. *Clinical Psychology Review*, *25*(6), 761–789. <https://doi.org/10.1016/j.cpr.2005.05.001>.
- Zvolensky, M. J., Kotov, R., Antipova, A. V., & Schmidt, N. B. (2003). Cross cultural evaluation of smokers risk for panic and anxiety pathology: A test in a Russian epidemiological sample. *Behaviour Research and Therapy*, *41*(10), 1199–1215. [https://doi.org/10.1016/S0005-7967\(03\)00031-7](https://doi.org/10.1016/S0005-7967(03)00031-7).
- Zvolensky, M. J., Lejuez, C. W., Kahler, C. W., & Brown, R. A. (2004). Nonclinical panic attack history and smoking cessation: An initial examination. *Addictive Behaviors*, *29* (4), 825–830. <https://doi.org/10.1016/j.addbeh.2004.02.017>.
- Zvolensky, M. J., Schmidt, N. B., & Stewart, S. H. (2003). Panic disorder and smoking. *Clinical Psychology-Science and Practice*, *10*(1), 29–51. <https://doi.org/10.1093/clipsy/10.1.29>.