Prevalence and correlates of psychological distress among diabetes mellitus adults in the Jilin province in China: a cross-sectional study

Shuang Qiu[1,*], Xuan Hong Sun[1,*], Wen Ya Liu[1], Joseph Sam Kanu[1], Ri Li[1], Qin Ya Yu[1], Feng Xu Huang[2], Bo Li[1] and Yang Xiang Zhang[3]

[1] Department of Epidemiology and Biostatistics, School of Public Health, Jilin University, Changchun, China
[2] Illawarra Health and Medical Research Institute, School of Medicine, University of Wollongong, Wollongong, Australia
[3] Psychiatry Research Center, Beijing Hui-Long-Guan Hospital, Peking University, Beijing, China
[*] These authors contributed equally to this work.

ABSTRACT

Background. Psychological disorders are common in diabetes mellitus (DM) patients, and the aim of this study was to estimate the prevalence of psychological distress and to determine the influence factors associated with psychological distress among DM patients in the Jilin province of China.

Methods and Materials. Multistage, stratified cluster sampling was used in this cross-sectional study. The 12-item General Health Questionnaire (GHQ-12) was used to assess psychological status with the total score of ≥ 4 as the threshold for psychological distress.

Results. A total of 1,956 subjects with DM were included in the study. Out of this total diabetic participants, 524 (26.8%) had psychological distress. Multiple logistic regression analysis showed that low educational level, divorce or separation from one's spouse, low family average monthly income, short sleep duration, being aware of DM status, and multiple co-morbidities are positively associated with psychological distress (all $P < 0.05$).

Conclusions. This study revealed a high rate of psychological distress among DM population in Jilin province. Low educational level, divorce or separation from one's spouse, low family average monthly income, short sleep duration, awareness of DM status, and multiple co-morbidities are all associated with psychological distress among our study subjects. Interventions to control these factors are needed to address the psychological problems among diabetics in Jilin Province.

Subjects Diabetes and Endocrinology, Epidemiology, Psychiatry and Psychology, Public Health
Keywords Psychological distress, GHQ-12, Diabetes mellitus

INTRODUCTION

Diabetes mellitus (DM) is one of the most common chronic metabolic diseases, and is a major health problem in many countries (*Fisher et al., 2012*; *Whiting et al., 2011*). In 2010, estimated 285 million people were affected by DM globally, and DM prevalence is

expected to increase to 438 million people by 2030 (*Raval et al., 2010*). Rapid economic development and the subsequent changes in lifestyle have led to the widespread occurrence of DM (*Guariguata et al., 2014*). China has the largest diabetic population worldwide, and DM prevalence is estimated to be 11.6%, representing nearly 113.9 million Chinese adults (*Xu et al., 2013*).

DM is not only associated with micro and macro vascular complications, such as increased risk of cardiovascular disease, diabetic nephropathy, retinopathy, neuropathy and lower extremity amputations, but may also influence physical functions, social interaction and mental well-being (*Jhita et al., 2014*; *Shin et al., 2014*).

Accumulating evidence suggests that psychological disorders are common in DM patients, and that DM patients are at substantial risk of heightened depression, anxiety, and stress (*Anderson et al., 2001*; *Atlantis et al., 2012*; *Raymond & Lovell, 2016*; *Roy & Lloyd, 2012*; *Yu et al., 2016*). Psychological disorders of DM patients are significantly associated with non-adherence to healthy lifestyle guidelines, thus increasing the risk for serious complications that may decrease patients' quality of life and result in premature death (*Ducat, Philipson & Anderson, 2014*; *Gonzalez et al., 2008*). Using the 12-item General Health Questionnaire (GHQ-12), *Zubair, Mansoor & Rana (2014)* reported that 68.5% of their study participants that scored more than 4 points had depressive symptoms, indicating that DM patients with psychological distress are more prone to depression. Thus, GHQ-12 as a general measure of psychological distress is a simple and useful instrument for healthcare practitioners to evaluate the overall psychological status of DM patients.

Although many studies have focused on the link between psychological disorders and DM, epidemiological data on the prevalence and correlates of psychological distress among DM population in Jilin Province are limited. The aims of the study were: (1) to estimate the prevalence of psychological distress among DM patients in Jilin Province; (2) to determine the influence factors associated with psychological distress among DM patients in Jilin Province; and (3) to provide proper references for relevant departments.

MATERIALS AND METHODS

Study population

This study was conducted using a survey of chronic disease and risk factors among adults (aged 18–79 years) in the Jilin province of China in 2012. The sample size was calculated considering the prevalence of chronic diseases investigated in this survey (varying from 0.02 to 0.99), two-tailed confidence level (α) of 95%, and absolute error varying from 0.01 to 0.10 were used. The ultimate target sample size was estimated to be 25,240, which accounts for approximately 1‰ of the total adult population of Jilin province. We used multistage stratified cluster random sampling method to select a representative sample of permanent residents who had lived in Jilin province within nine regions (Changchun, Jilin, Siping, Liaoyuan, Tonghua, Baishan, Songyuan, Baicheng and Yanbian) for at least six months. Then, we randomly selected clusters of four districts or counties from each of the nine regions using probability proportional to size (PPS) sampling. We selected 32 districts

or counties, 95 towns or communities, and 45 units. Finally, we randomly selected one adult resident from each household in the selected units. The detailed sampling process has been described previously (*Wang et al., 2014*; *Wang et al., 2015*).

All participants gave informed consents before being recruited in the study. We adhered to the bioethics principles of the Declaration of Helsinki, and our study was authorized by the Ethics Committee of the School of Public Health of Jilin University (Reference Number: 2012-R-011) and the Bureau of Public Health of Jilin Province (Reference Number: 2012-10).

Data collection and measurement
Personal health questionnaire

We used an interviewer administered questionnaire to obtain information from our study subjects. The questionnaire was designed by our project team, and primarily included demographic factors (gender, age, race, community, educational level, marital status, occupation, and family average monthly income), as well as other information such as daily sleep duration and anthropometric measurements. The Mandarin Chinese language was used to design the questionnaire, and the questionnaire was administered in Chinese by investigators who could speak Mandarin Chinese and had received uniform training on the administration of the questionnaire.

GHQ-12

The GHQ-12, a shortened version of a 60-item screening tool developed by Goldberg in 1970, is a widely-used instrument for assessing psychiatric morbidity, especially to screen for depression and anxiety disorders (*Goldberg et al., 1997*). It has recently been adapted as a screening tool for psychological distress in various populations (*Cuellar-Flores et al., 2014*; *Higuchi et al., 2016*; *Yi et al., 2016*). It has been well-validated for general Chinese populations (*Yang, Huang & Wu, 2003*; *Zhou et al., 2013*). The GHQ-12 includes 12 questions, each with two response options (Yes or No). Each item is scored as either 0 (less or no more than usual) or 1 (more or much more than usual), for a maximum total score of 12. Higher scores indicate more psychological problems. According to the total score of the GHQ-12, participants scoring 4 or more are considered to be in psychological distress (*Phillips et al., 2009*).

Baseline clinical data

Fasting plasma glucose (FPG) was measured from participants who had fasted for 10 or more hours overnight. A small drop of blood was taken from one finger, placed onto a strip of paper and the glucose level measured using a Bayer Bai Ankang fingertip blood glucose monitoring machine.

DM was defined as either a fasting plasma glucose level ≥7.0 mmol/L, according to the Chinese Guidelines on the prevention and treatment of Type 2 Diabetes (*Society, 2008*), or self-reported diagnosed DM by a medical doctor in a hospital. Those self reported patients were considered to be aware of their DM status, and those who were only diagnosed during our investigation were considered to be unaware of their DM status.

Body mass index (BMI) was categorized into two groups: underweight or normal weight (BMI < 24 kg/m^2), and overweight or obesity (BMI $\geq$ 24 kg/m^2) (*Zhou, 2002*).

Number of co-morbid diseases was defined as a count of the following chronic diseases reported simultaneously with DM by patients, including hyperlipidemia, hypertension, cerebrovascular disease, coronary heart disease and myocardial infarction, cataract, gout, and hyperthyroidism. Chronic diseases were determined by participants who self-reported having previous diagnosis of the diseases from a health professional. DM patients were categorized into four groups: without any co-morbid disease, only one kind of co-morbid disease, two, three or more co-morbid diseases.

Sociodemographics

Community was divided into two groups: urban (including those who lived in cities or towns) and rural (including the rest of the entire population).

We divided education into three levels: primary school and below (including those who never attended school and those whose highest level of education was primary school), junior high school (including those whose highest level of education was junior high school), and senior high/technical secondary school and above (including those whose highest level of education was high school, technical secondary school, or university degree).

Marital status was divided into four groups: married (including those who were married and those co-habiting), never married, divorced or separated, and widowed.

We divided occupation into three groups: manual workers (including farmers, service workers, and those who were engaged in production work), mental workers (including office and other technical staff), and others (including students, unemployed, and retirees) (*Wang et al., 2014*; *Zhang et al., 2016*).

Family average monthly income was calculated as the ratio of the total family income to the number of family members in the household, and was classified into five groups: low income group (<500 yuan/month), lower-middle group (500–1,000 yuan/month), middle group (1,000–2,000 yuan/month), higher-middle group (2,000–3,000 yuan/month), and high income group ($\geq$3,000 yuan/month) in line with the classification of the Jilin Provincial Bureau of Statistics.

Quality control

We performed a pilot study to assimilate the main study using a total of 190 participants. Issues that aroused during the pilot study were addressed before the main study. All data were processed by parallel double entry using EpiData 3.1 database.

Statistical analysis

Descriptive statistics were used to summarize the numbers and percentages for categorical variables, and mean (standard deviation—S.D) and median (IQR) for continuous variables. Univariate logistic regression analyses were used to compare the rates of psychological distress between different participants' characteristics (gender, age, race, community, educational level, marital status, occupation, family average monthly income, daily sleep duration, BMI, family history of DM, number of co-morbid diseases, and the awareness of DM). Variables that were significant in the univariate logistic analyses were included

in the final multiple logistic regression analyses. Multiple logistic regression analyses were performed to explore the association between participants' characteristics and psychological distress. The statistical tests were 2-tailed, and significance was defined as $P < 0.05$. All data were analyzed using SPSS (Version 21.0, IBM SPSS, IBM Corp, Armonk, NY, USA).

RESULTS

A total of 1,956 DM participants were recruited in this study with a mean age of 55.68 years (S.D. = 10.26). We present participants demographic characteristics and other information in Table 1. The proportions of males (49.7%) and females (50.3%) were almost the same, as well as the residence location of the participants—urban (50.8%) or rural (49.2%). Nine hundred and fifty-nine participants (49%) were 45–59 years old, which was the largest age group. More than 90% of participants were Han nationality. We also observed that 60.5% of participants attained a junior high school or higher level of education; 89.4% of participants were married; 56.3% of participants had sleep duration of ≥7 h per day; 30.7% of participants had family average monthly income of 1000–2000 yuan; 71.5% of participants had no history of DM; and 67.6% of participants were overweight or obese. More participants were engaged in manual work (47.3%) than mental labor (14.0%), with 68.9% of participants being aware of their DM status. Less than half (47.0%) of participants had no other diseases.

We further performed analysis to explore the factors associated with psychological distress of DM participants. Population characteristics according to psychological distress are shown in Table 2. Mean GHQ-12 score was 2 (IQR 0-4). Out of the 1,956 patients, 524 (26.8%) participants had psychological distress. Univariate analysis revealed that the rate of psychological distress significantly differed by gender, community, educational level, marital status, occupation, family average monthly income, daily sleep duration, number of co-morbid diseases, and the awareness of DM (all $P < 0.05$), but not by age ($P = 0.056$), race ($P = 0.472$), BMI ($P = 0.073$), and family history of DM ($P = 0.126$). Compared with male, female were more likely to have psychological distress (OR = 2.046 [1.666, 2.513]). Urban participants were less prone to psychological distress (OR = 0.628 [0.513, 0.769]), compared with rural participants. Participants whose highest level of education was primary school were associated with a higher prevalence of psychological distress than those whose highest level of education was senior high school/technical secondary school (OR = 2.472 [1.938, 3.154]). The *ORs* (95% CI) were 3.074 [1.651, 5.725] for divorce /separate DM participants, and 1.692 [1.183, 2.420] for widowed DM participants. Compared with manual workers, mental workers were less likely to be distressed (OR = 0.533 [0.380, 0.747]). The prevalence of psychological distress was higher among participants whose family average monthly income was less than 500 yuan (OR = 3.100 [1.958, 4.910]), or 500–1,000 yuan (OR = 2.214 [1.387, 3.535]) than those whose income was ≥3,000 yuan. Participants with sleep duration of <7 h per day were associated with a higher prevalence of psychological distress than participants with sleep duration of ≥7 h (OR = 1.464 [1.198, 1.790]). Participants whose co-morbid disease was 2 (OR = 1.587 [1.194, 2.110]), and ≥3 (OR = 2.993 [2.033, 4.407]) were more prone to have higher rate of psychological distress than those without any other diseases. Participants who were aware of their DM status

Table 1 Participants characteristics ($N = 1,956$).

Characteristics	n	%
Gender		
Male	972	49.7
Female	984	50.3
Age group(years)		
18–44	267	13.7
45–59	959	49.0
60–79	730	37.3
Race		
Han nationality	1,795	91.8
Non-Han minority	161	8.2
Community		
Urban	994	50.8
Rural	962	49.2
Educational level		
Primary school and below	773	39.5
Junior high school	520	26.6
Senior high/technical secondary school and above	663	33.9
Marital status		
Married	1,748	89.4
Never married	25	1.3
Divorce or separate	41	2.1
Widowed	142	7.3
Occupation		
Manual worker	925	47.3
Mental worker	274	14.0
Others	757	38.7
Family average monthly income (yuan/month)		
<500	487	24.9
500–1,000	397	20.3
1,000–2,000	600	30.7
2,000–3,000	320	16.4
≥3,000	152	7.8
Daily sleep duration (hours)		
<7	854	43.7
≥7	1,102	56.3
BMI[a] (kg/m^2)		
<24	601	30.7
≥24	1,323	67.6
Family history of DM		
No	1,398	71.5
Yes	558	28.5

Table 1 (*continued*)

Characteristics	n	%
Number of co-morbid disease		
0	920	47.0
1	601	30.7
2	312	16.0
≥3	123	6.3
Awareness of DM		
Yes	1,347	68.9
No	609	31.1

Notes.

[a]Total percentage did not equal to 100% because of missing data.

were more likely to have psychological distress than those who were unaware (OR = 1.523 [1.214, 1.911]).

Table 3 shows the results of multivariate logistic regression analysis. This analysis revealed no significant difference in psychological distress by community and occupations ($P > 0.05$). However, we found significant differences in psychological distress by educational level, marital status, family average monthly income, daily sleep duration, the number of co-morbid diseases, and the awareness of DM after considering the effect of confounding factors ($P < 0.05$).

Participants who never attended school and those whose highest level of education was primary school were associated with a higher prevalence of psychological distress than those whose highest level of education was senior high school/technical secondary school (OR = 1.474 [1.087, 1.999], $P = 0.013$). Divorced or separated participants were more likely to have psychological distress than married participants (OR = 3.434 [1.772, 6.653], $P < 0.001$). Participants whose family average monthly income was less than 500 yuan (OR = 2.282 [1.377, 3.781], $P = 0.01$), or 500–1,000 yuan (OR = 1.728 [1.045, 2.856], $P = 0.033$) were associated with a higher prevalence of psychological distress than those whose income was ≥3,000 yuan. Participants who were aware of their DM status were more likely to develop psychological distress (OR = 1.305 [1.022, 1.667], $P = 0.033$). Participants with sleep duration of <7 h per day were more likely to have psychological distress than participants with sleep duration of ≥7 h (OR = 1.522 [1.231, 1.883], $P < 0.001$). Participants who had two kinds of other diseases (OR = 1.534 [1.129 2.084], $P = 0.006$), and three or more other diseases (OR = 2.473 [1.635 3.739], $P < 0.001$) were associated with a lower prevalence of psychological distress than participants without any other diseases.

DISCUSSION

This population-based study adds to the literature that the prevalence of psychological distress (GHQ-12 total score ≥4) among DM patients in the Jilin province of China is 26.8%, higher than that the 18.9% reported for England and Scottish DM populations (*Hamer et al., 2010*), and also higher than the Quebec and Canada DM populations (22.1%) (*Smith et al., 2013*). The inconsistency may be partly due to the disparities in assessment instruments, sampling methods, and the definition of psychological distress.

Table 2 Univariate analysis of factors associated with psychological distress N = 1,956.

Characteristics	Non-distressing	Distressing	P	OR	95% CI
Gender			<0.001		
Male	779(80.1)	193(19.9)		1.000	
Female	653(66.4)	331(33.6)		2.046	1.666–2.513
Age group(years)			0.056		
18–44	195(73.0)	72(27.0)		1.000	
45–59	724(75.5)	235(24.5)		0.879	0.646–1.196
60–79	513(70.3)	217(29.7)		1.146	0.837–1.567
Race			0.472		
Han nationality	1,311(73.0)	485(27.0)		1.000	
Non-Han minority	121(75.6)	39(24.4)		0.871	0.598–1.268
Community			<0.001		
Rural	660(68.6)	302(31.4)		1.000	
Urban	772(77.7)	222(22.3)		0.628	0.513–0.769
Educational level			<0.001		
Senior school and above[a]	538(81.1)	125(18.9)		1.000	
Junior high school	403(77.5)	117(22.5)		1.250	0.941–1.659
Primary school and below	491(63.5)	282(36.5)		2.472	1.938–3.154
Marital status			<0.001		
Married	1,303(74.5)	445(25.5)		1.000	
Never married	19(76.0)	6(24.0)		0.925	0.367–2.330
Divorce or separate	20(48.8)	21(51.2)		3.074	1.651–5.725
Widowed	90(63.4)	52(36.6)		1.692	1.183–2.420
Occupation			0.001		
Manual worker	652(70.5)	273(29.5)		1.000	
Mental worker	224(81.8)	50(18.2)		0.533	0.380–0.747
Others	556(73.4)	201(26.6)		0.863	0.697–1.070
Monthly income[b]			<0.001		
≥3,000	126(82.9)	26(17.1)		1.000	
2,000–3,000	213(83.9)	41(16.1)		0.933	0.544–1.598
1,000–2,000	494(79.3)	129(20.7)		1.265	0.795–2.014
500–1,000	302(68.6)	138(31.4)		2.214	1.387–3.535
<500	297(61.0)	190(39.0)		3.100	1.958–4.910
Daily sleep duration (hours)			<0.001		
≥7	843(76.5)	259(23.5)		1.000	
<7	589(69.0)	265(31.0)		1.464	1.198–1.790
BMI[*] (kg/m^2)			0.073		
<24	424(70.5)	177(29.5)		1.000	
≥24	985(74.5)	338(25.5)		0.822	0.663–1.019
Family history of DM			0.126		
No	1,037(74.2)	361(25.8)		1.000	
Yes	395(70.8)	163(29.2)		1.185	0.953–1.475

Table 2 *(continued)*

Characteristics	Non-distressing	Distressing	P	OR	95% CI
Number of co-morbid disease			<0.001		
0	714(77.6)	206(22.4)		1.000	
1	438(72.9)	163(27.1)		1.290	1.017–1.636
2	214(68.6)	98(31.4)		1.587	1.194–2.110
≥3	66(53.7)	57(46.3)		2.993	2.033–4.407
Awareness of DM			<0.001		
No	479 (78.7)	130 (21.3)		1.000	
Yes	953 (70.7)	394 (29.3)		1.523	1.214–1.911

Notes.
*Total percentage did not equal to 100% because of missing data. Data are presented as *n*(%); OR, Odds Ratio; CI, confidence interval.
[a] Senior high/technical secondary school and above.
[b] Family average monthly income (yuan/month).

Similar to other studies (*Tellez-Zenteno & Cardiel, 2002*; *Yang, Li & Zheng, 2009*), we found that low educational levels were associated with increased risk of psychological distress. Patients with lower education levels were less knowledgeable about the association between DM and mental disorders, more difficult to understand how to moderate their mental stress, and consequently had a higher psychological well-being.

Many researchers concluded that marriage has a protective effect on mental health (*Fu & Noguchi, 2016*; *Hughes & Waite, 2009*). In our study, divorce or separation from one's spouse is the most significant factor associated with psychological distress. This is concordant with the findings of other researchers revealing that divorce or separation is associated with poor psychological well-being (*Tellez-Zenteno & Cardiel, 2002*). Divorced or separated participants may have issues of taking care of their parents, raising children alone, and trying to cope with the divorce and the burden of their disease. All these factors may have long-term negative effects on the mental health of these patients. Our results also showed no significant difference in psychological distress between widowed participants and married participants, which is inconsistent with the report by Akena and team (*Akena et al., 2014*). This may be related to the differences in widowhood duration and gender. Perkins and co-authors concluded that long-term (widowed 0 to 4 or 10+ years) widowhood predicts worse health for women, but not for men (*Perkins et al., 2016*). In our study, we adjusted the confounding influence of gender using multiple logistic regression, but we did not obtained information about widowhood duration which need further research.

Our study demonstrated that participants with low family average monthly income were more prone to psychological distress. This accords with a study in central China by Yang and team (*Yang, Li & Zheng, 2009*). Management of DM is associated with long term financial burden (*Arnold et al., 2016*). Failure to cope with this heavy financial burden might be associated with psychological disturbances. It is not surprising in our study that participants with low family average monthly income had a great likelihood of developing psychological distress. In a study among low and middle income countries, Leone et al.

Qiu et al. (2017), *PeerJ*, DOI 10.7717/peerj.2869

9/17

Table 3 Multivariate analysis of factors associated with psychological distress.

Variables	β	S.E.	Wald	P	OR	95% CI	
						Lower	Upper
Educational level							
Senior high school and above[a]					1.000		
Junior high school	−0.008	0.156	0.003	0.958	0.992	0.731	1.346
Primary school and below	0.388	0.156	6.217	0.013	1.474	1.087	1.999
Marital status							
Married					1.000		
Never married	0.178	0.496	0.129	0.720	1.194	0.452	3.155
Divorce or separate	1.234	0.337	13.365	<0.001	3.434	1.772	6.653
Widowed	0.132	0.199	0.441	0.507	1.141	0.773	1.686
Monthly income[b]							
≥3,000					1.000		
2,000–3,000	−0.112	0.282	0.157	0.692	0.894	0.515	1.554
1,000–2,000	0.086	0.248	0.120	0.729	1.090	0.671	1.771
500–1,000	0.547	0.256	4.545	0.033	1.728	1.045	2.856
<500	0.825	0.258	10.259	0.001	2.282	1.377	3.781
Awareness of DM							
No					1.000		
Yes	0.266	0.125	4.540	0.033	1.305	1.022	1.667
Daily sleep duration (hours)							
≥7					1.000		
<7	0.420	0.108	15.030	<0.001	1.522	1.231	1.883
Number of co-morbid disease							
0					1.000		
1	0.152	0.129	1.397	0.237	1.164	0.905	1.498
2	0.428	0.156	7.488	0.006	1.534	1.129	2.084
≥3	0.905	0.211	18.416	<0.001	2.473	1.635	3.739

Notes.

Adjusted age and gender, Method: Backward: Conditional, β represents the logistic regression coefficient, S.E. represents the standard error, OR, Odds Ratio; CI, confidence interval.

[a] Senior high/technical secondary school and above.

[b] Family average monthly income (yuan/month).

noted that the occurrence of depression among diabetic patients seems to be associated with lower socioeconomic status (*Leone et al., 2012*).

Participants who were aware of their DM status were more likely to have psychological distress. A meta-analysis of 13 studies by Nouwen and colleagues concluded that patients who were aware of DM had increased risk of depression relative to patients that were unaware (*Nouwen et al., 2011*). Our finding is consistent with the findings of other studies (*Domingo et al., 2015*; *Knol et al., 2007*; *Olvera et al., 2016*). These psychological problems in people with DM might be related to the consequences of the burden of DM. Participants who were aware of their DM status have to change their poor health behaviors (e.g., smoking, high fat diet, and low physical activity), or take their anti-diabetic medications.

The need for monitoring their blood glucose and medical complications or related diseases may induce psychological problems.

Poor sleep is an important etiology of depression (*Chang et al., 2012*; *Paunio et al., 2014*). This observation is in agreement with our finding that participants with short sleep durations had higher likelihood of developing psychological distress. Yu and team investigated the prevalence of depression among rural residents with DM patients in China, and reported that shorter sleep duration increases the risk of depressive symptoms (*Yu et al., 2016*). In addition, frequent urination that is a major symptom of DM may cause discomfort to diabetic patients and reduce their quality of sleep. Sleep quality can be a potential mediator between psychological distress and diabetes quality of life. In a study on veterans, Seligowski and co-authors found that sleep quality has a partial indirect effect on the relationships between the symptoms of depression and the quality of life of diabetic patients, and between the symptoms of anxiety and diabetes quality of life (*Seligowski et al., 2013*).

Participants who co-morbid more than or equal to two kinds of other diseases were associated with a higher prevalence of psychological distress. Similarly, a study from Palestine by *Sweileh et al. (2014)* showed that DM participants with combined multiple additional illnesses were more prone to develop depressive symptoms. Chronic pain, somatic discomfort, and restrictions on one's social life are common consequences of chronic medical illnesses which lower quality of life and increase the risk for psychological disorders (*Agborsangaya et al., 2013*).

Our study involved a large and representative sample of DM participants and a good response rate from these participants in Jilin province. We considered not only demographic factors but also baseline clinical factors possibly associated with psychological distress. Our study revealed a high rate of psychological distress among DM population in the Jilin province in China and some correlates of psychological distress. Prevention and treatment are urgently needed to address the public health problem of psychological distress among DM population and to prevent them from developing more serious psychological disorders. The Chinese government should pay attention to DM-related mental diseases, increase investment for health education and promotion, inform patients about the harm of DM-related mental diseases and formulate methods to reduce psychological distress, strengthen the primary mental health care system, increase financial subsidies for low income families, and put in place DM and other chronic diseases prevention and treatment measures.

However, our results may be biased by the method used to confirm DM. We only used FPG levels to confirm DM, as we did not perform postprandial glucose tolerance test or measure glycosylated hemoglobin levels. In addition, other unmeasured variables such as time since diagnosis, social support, and diabetes self-efficacy, might have been important to adjust for in our study. Third, because of the cross-sectional design, the interpretation of causal relationships between risk factors and the development of psychological distress is limited. Longitudinal studies are also needed to investigate the predictors of psychological distress in the Chinese DM population in the future.

CONCLUSIONS

Psychological distress is highly prevalent among DM population in Jilin province, China. Several factors are associated with psychological distress among diabetic patients in Jilin Province (low educational level, divorce or separation from one's spouse, low family average monthly income, short sleep duration, being aware of DM status, and multiple co-morbidities). In order to effectively improve the quality of life of diabetics in this part of China, relevant health authorities should adequately address these factors.

ACKNOWLEDGEMENTS

ADDITIONAL INFORMATION AND DECLARATIONS

Funding

Grant Disclosures

Competing Interests

The authors declare there are no competing interests.

Author Contributions

- Shuang Qiu conceived and designed the experiments, performed the experiments, analyzed the data, contributed reagents/materials/analysis tools, wrote the paper, prepared figures and/or tables, reviewed drafts of the paper.
- Xuan Hong Sun conceived and designed the experiments, performed the experiments, analyzed the data, contributed reagents/materials/analysis tools, prepared figures and/or tables, reviewed drafts of the paper.
- Wen Ya Liu and Qin Ya Yu conceived and designed the experiments, performed the experiments, reviewed drafts of the paper.
- Joseph Sam Kanu performed the experiments, reviewed drafts of the paper.
- Ri Li analyzed the data, contributed reagents/materials/analysis tools, reviewed drafts of the paper.
- Feng Xu Huang and Yang Xiang Zhang reviewed drafts of the paper.
- Bo Li conceived and designed the experiments, performed the experiments, contributed reagents/materials/analysis tools, reviewed drafts of the paper.

Human Ethics

The following information was supplied relating to ethical approvals (i.e., approving body and any reference numbers):

All participants gave their informed consent for inclusion before they participated in the study. We adhered to the bioethics principles of the Declaration of Helsinki, and our study was authorized by the Ethics Committee of Jilin University School of Public Health (Reference Number: 2012-R-011) and the Bureau of Public Health of Jilin Province (Reference Number: 2012-10).

Data Availability

The following information was supplied regarding data availability:

The raw data has been supplied as a Supplementary File.

Supplemental Information

Supplemental information for this article can be found online at http://dx.doi.org/10.7717/peerj.2869#supplemental-information.

REFERENCES

Agborsangaya CB, Lau D, Lahtinen M, Cooke T, Johnson JA. 2013. Health-related quality of life and healthcare utilization in multimorbidity: results of a cross-sectional survey. *Quality of Life Research* **22(4)**:791–799 DOI 10.1007/s11136-012-0214-7.

Akena D, Kadama P, Ashaba S, Akello C, Kwesiga B, Rejani L, Okello J, Mwesiga EK, Obuku EA. 2014. The association between depression, quality of life, and the health care expenditure of patients with diabetes mellitus in Uganda. *Journal of Affective Disorders* **174c**:7–12 DOI 10.1016/j.jad.2014.11.019.

Anderson RJ, Freedland KE, Clouse RE, Lustman PJ. 2001. The prevalence of comorbid depression in adults with diabetes: a meta-analysis. *Diabetes Care* **24(6)**:1069–1078 DOI 10.2337/diacare.24.6.1069.

Arnold M, Beran D, Haghparast-Bidgoli H, Batura N, Akkazieva B, Abdraimova A, Skordis-Worrall J. 2016. Coping with the economic burden of Diabetes, TB and co-prevalence: evidence from Bishkek, Kyrgyzstan. *BMC Health Services Research* **16**:118 DOI 10.1186/s12913-016-1369-7.

Atlantis E, Vogelzangs N, Cashman K, Peninx BJWH. 2012. Common mental disorders associated with 2-year diabetes incidence: the Netherlands Study of Depression and Anxiety (NESDA). *Journal of Affective Disorders* **142**:S30–S35 DOI 10.1016/S0165-0327(12)70006-X.

Chang JJ, Salas J, Habicht K, Pien GW, Stamatakis KA, Brownson RC. 2012. The association of sleep duration and depressive symptoms in rural communities of Missouri, Tennessee, and Arkansas. *Journal of Rural Health* **28(3)**:268–276 DOI 10.1111/j.1748-0361.2011.00398.x.

Chinese Diabetes Society. 2008. China Guideline for Type 2 Diabetes (2007 edition). *National Medical Journal of China* **88**:1227–1245.

Cuellar-Flores I, Sanchez-Lopez MP, Liminana-Gras RM, Colodro-Conde L. 2014. The GHQ-12 for the assessment of psychological distress of family caregivers. *Behavioral Medicine* **40(2)**:65–70 DOI 10.1080/08964289.2013.847815.

Domingo AK, Asmal L, Seedat S, Esterhuizen TM, Laurence C, Volmink J. 2015. Investigating the association between diabetes mellitus, depression and psychological distress in a cohort of South African teachers. *South African Medical Journal* **105(12)**:1057–1060 DOI 10.7196/SAMJ.2015.v105i12.9843.

Ducat L, Philipson LH, Anderson BJ. 2014. The mental health comorbidities of diabetes. *Jama* **312(7)**:691–692 DOI 10.1001/jama.2014.8040.

Fisher EB, Chan JC, Nan H, Sartorius N, Oldenburg B. 2012. Co-occurrence of diabetes and depression: conceptual considerations for an emerging global health challenge. *Journal of Affective Disorders* **142(Suppl)**:S56–S66 DOI 10.1016/s0165-0327(12)70009-5.

Fu R, Noguchi H. 2016. Does marriage make us healthier? Inter-country comparative evidence from China, Japan, and Korea. *PLOS ONE* **11**:e0148990 DOI 10.1371/journal.pone.0148990.

Goldberg DP, Gater R, Sartorius N, Ustun TB, Piccinelli M, Gureje O, Rutter C. 1997. The validity of two versions of the GHQ in the WHO study of mental illness in general health care. *Psychological Medicine* **27(1)**:191–197 DOI 10.1017/S0033291796004242.

Gonzalez JS, Peyrot M, McCarl LA, Collins EM, Serpa L, Mimiaga MJ, Safren SA. 2008. Depression and diabetes treatment nonadherence: a meta-analysis. *Diabetes Care* **31(12)**:2398–2403 DOI 10.2337/dc08-1341.

Guariguata L, Whiting DR, Hambleton I, Beagley J, Linnenkamp U, Shaw JE. 2014. Global estimates of diabetes prevalence for 2013 and projections for 2035. *Diabetes Research and Clinical Practice* **103(2)**:137–149 DOI 10.1016/j.diabres.2013.11.002.

Hamer M, Stamatakis E, Kivimaki M, Pascal Kengne A, Batty GD. 2010. Psychological distress, glycated hemoglobin, and mortality in adults with and without diabetes. *Psychosomatic Medicine* **72**:882–886 DOI 10.1097/PSY.0b013e3181f6696e.

Higuchi Y, Inagaki M, Koyama T, Kitamura Y, Sendo T, Fujimori M, Uchitomi Y, Yamada N. 2016. A cross-sectional study of psychological distress, burnout, and the associated risk factors in hospital pharmacists in Japan. *BMC Public Health* **16**:534 DOI 10.1186/s12889-016-3208-5.

Hughes ME, Waite LJ. 2009. Marital biography and health at mid-life. *Journal of Health and Social Behavior* **50**:344–358 DOI 10.1177/002214650905000307.

Jhita T, Petrou S, Gumber A, Szczepura A, Raymond NT, Bellary S. 2014. Ethnic differences in health related quality of life for patients with type 2 diabetes. *Health and Quality of Life Outcomes* **12**:Article 83 DOI 10.1186/1477-7525-12-83.

Knol MJ, Heerdink ER, Egberts AC, Geerlings MI, Gorter KJ, Numans ME, Grobbee DE, Klungel OH, Burger H. 2007. Depressive symptoms in subjects with diagnosed and undiagnosed type 2 diabetes. *Psychosomatic Medicine* **69**:300–305 DOI 10.1097/PSY.0b013e31805f48b9.

Leone T, Coast E, Narayanan S, De Graft Aikins A. 2012. Diabetes and depression co-morbidity and socio-economic status in low and middle income countries (LMICs): a mapping of the evidence. *Global Health* **8**:Article 39 DOI 10.1186/1744-8603-8-39.

Nouwen A, Nefs G, Caramlau I, Connock M, Winkley K, Lloyd CE, Peyrot M, Pouwer F. 2011. Prevalence of depression in individuals with impaired glucose metabolism or undiagnosed diabetes: a systematic review and meta-analysis of the European Depression in Diabetes (EDID) Research Consortium. *Diabetes Care* **34(4)**:752–762 DOI 10.2337/dc10-1414.

Olvera RL, Fisher-Hoch SP, Williamson DE, Vatcheva KP, McCormick JB. 2016. Depression in Mexican Americans with diagnosed and undiagnosed diabetes. *Psychological Medicine* **46(3)**:637–646 DOI 10.1017/S0033291715002160.

Paunio T, Korhonen T, Hublin C, Partinen M, Koskenvuo K, Koskenvuo M, Kaprio J. 2014. Poor sleep predicts symptoms of depression and disability retirement due to depression. *Journal of Affective Disorders* **172c**:381–389 DOI 10.1016/j.jad.2014.10.002.

Perkins JM, Lee HY, James KS, Oh J, Krishna A, Heo J, Lee JK, Subramanian SV. 2016. Marital status, widowhood duration, gender and health outcomes: a cross-sectional study among older adults in India. *BMC Public Health* **16**:1032 DOI 10.1186/s12889-016-3682-9.

Phillips MR, Zhang J, Shi Q, Song Z, Ding Z, Pang S, Li X, Zhang Y, Wang Z. 2009. Prevalence, treatment, and associated disability of mental disorders in four provinces in China during 2001-05: an epidemiological survey. *Lancet* **373(9680)**:2041–2053 DOI 10.1016/S0140-6736(09)60660-7.

Raval A, Dhanaraj E, Bhansali A, Grover S, Tiwari P. 2010. Prevalence & determinants of depression in type 2 diabetes patients in a tertiary care centre. *Indian Journal of Medical Research* **132**:195–200.

Raymond KL, Lovell GP. 2016. Food addiction associations with psychological distress among people with type 2 diabetes. *Journal of Diabetes and its Complications* **30(4)**:651–656 DOI 10.1016/j.jdiacomp.2016.01.020.

Roy T, Lloyd CE. 2012. Epidemiology of depression and diabetes: a systematic review. *Journal of Affective Disorders* **142(Suppl)**:S8–S21 DOI 10.1016/s0165-0327(12)70004-6.

Seligowski AV, Pless Kaiser AP, Niles BL, Mori DL, King LA, King DW. 2013. Sleep quality as a potential mediator between psychological distress and diabetes quality of life in veterans with type 2 diabetes. *Journal of Clinical Psychology* **69(10)**:1121–1131 DOI 10.1002/jclp.21866.

Shin JK, Shortridge-Baggett LM, Sachmechi I, Barron C, Chiu YL, Bajracharya B, Bang H. 2014. Screening for type 2 diabetes mellitus in patients with mental illness: application of a self-assessment score for diabetes mellitus risk. *Psychiatry Research* **220(3)**:1037–1042 DOI 10.1016/j.psychres.2014.08.047.

Smith KJ, Gariepy G, Pedneault M, Beland M, Clyde M, Schmitz N. 2013. Exploring the association of psychological status with self-rated diabetes control: results from

the Montreal evaluation of diabetes treatment study. *Psychosomatics* **54(1)**:35–43 DOI 10.1016/j.psym.2012.08.002.

Sweileh WM, Abu-Hadeed HM, Al-Jabi SW, Zyoud SH. 2014. Prevalence of depression among people with type 2 diabetes mellitus: a cross sectional study in Palestine. *BMC Public Health* **14**:163 DOI 10.1186/1471-2458-14-163.

Tellez-Zenteno JF, Cardiel MH. 2002. Risk factors associated with depression in patients with type 2 diabetes mellitus. *Archives of Medical Research* **33(1)**:53–60 DOI 10.1016/S0188-4409(01)00349-6.

Wang SB, D'Arcy C, Yu YQ, Li B, Liu YW, Tao YC, Wu YH, Zhang QQ, Xu ZQ, Fu YL, Kou CG. 2015. Prevalence and patterns of multimorbidity in northeastern China: a cross-sectional study. *Public Health* **129(11)**:1539–1546 DOI 10.1016/j.puhe.2015.06.013.

Wang C, Yu Y, Zhang X, Li Y, Kou C, Li B, Tao Y, Zhen Q, He H, Kanu JS, Huang X, Han M, Liu Y. 2014. Awareness, treatment, control of diabetes mellitus and the risk factors: survey results from northeast China. *PLOS ONE* **9**:e103594 DOI 10.1371/journal.pone.0103594.

Whiting DR, Guariguata L, Weil C, Shaw J. 2011. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Research and Clinical Practice* **94(3)**:311–321 DOI 10.1016/j.diabres.2011.10.029.

Xu Y, Wang L, He J, Bi Y, Li M, Wang T, Wang L, Jiang Y, Dai M, Lu J, Xu M, Li Y, Hu N, Li J, Mi S, Chen CS, Li G, Mu Y, Zhao J, Kong L, Chen J, Lai S, Wang W, Zhao W, Ning G. 2013. Prevalence and control of diabetes in Chinese adults. *Jama* **310**:948–959 DOI 10.1001/jama.2013.168118.

Yang Y, Huang L, Wu Z. 2003. Study on the appropriateness of the Chinese version of the General Health Questionnaire as a screening instrument for psychological disorders in mainland China. *Chinese Journal of Epidemiology* **24**:769–773.

Yang J, Li S, Zheng Y. 2009. Predictors of depression in Chinese community-dwelling people with type 2 diabetes. *Journal of Clinical Nursing* **18(9)**:1295–1304 DOI 10.1111/j.1365-2702.2008.02703.x.

Yi S, Tuot S, Chhoun P, Pal K, Choub SC, Mburu G. 2016. Prevalence and correlates of psychological distress among drug users in Phnom Penh, Cambodia. *International Journal of Drug Policy* **36**:25–32 DOI 10.1016/j.drugpo.2016.06.002.

Yu S, Yang H, Guo X, Zheng L, Sun Y. 2016. Prevalence of depression among rural residents with diabetes mellitus: a cross-sectional study from northeast China. *International Journal of Environmental Research and Public Health* **13(6)**:Article 542 DOI 10.3390/ijerph13060542.

Zhang P, Wang R, Gao C, Song Y, Lv X, Jiang L, Yu Y, Wang Y, Li B. 2016. Types of obesity and its association with the clustering of cardiovascular disease risk factors in Jilin Province of China. *International Journal of Environmental Research and Public Health* **13(7)**:Article 685 DOI 10.3390/ijerph13070685.

Zhou BF. 2002. Predictive values of body mass index and waist circumference for risk factors of certain related diseases in Chinese adults–study on optimal cut-off points

of body mass index and waist circumference in Chinese adults. *Biomedical and Environmental Sciences* **15**:83–96.

Zhou X, Kang L, Sun X, Song H, Mao W, Huang X, Zhang Y, Li J. 2013. Prevalence and risk factors of post-traumatic stress disorder among adult survivors six months after the Wenchuan earthquake. *Comprehensive Psychiatry* **54**:493–499 DOI 10.1016/j.comppsych.2012.12.010.

Zubair UB, Mansoor S, Rana MH. 2014. Prevalence of depressive symptoms and associated socio-demographic factors among recruits during military training. *Journal of the Royal Army Medical Corps* **161**:127–131 DOI 10.1136/jramc-2014-000253.