Negative emotions in community-dwelling adults with prediabetes and hypertension

Qianling Zhuang[1] (iD)**, Lirong Wu[1], Wang Ting[1], Lin Jie[1], Jingying Zou[1] and Jiangang Du[2]**

Abstract

Objective: The purpose of this study was to investigate negative emotions and factors related to the risk of mental disorders in individuals with prediabetes and hypertension.

Methods: A total of 504 community-dwelling adult men and women in Suzhou, China, were enrolled and questionnaires used to obtain sociodemographic data, anxiety and depression scores, and current status of common metabolic indicators, including blood glucose level and blood pressure.

Results: Anxiety and depression scores in participants with prediabetes and hypertension were significantly higher than those in participants with normal blood glucose levels and normal blood pressure. Correlation analysis revealed that age, sex, smoking, duration of disease, physical activity, blood pressure and fasting plasma glucose levels were key factors accelerating the progression to both anxiety and depression in all participants.

Conclusions: More attention should be paid to negative emotions in individuals with prediabetes and hypertension. These findings could help to inform health providers in developing interventions for this population.

Keywords

Prediabetes, hypertension, negative emotions, China, community, anxiety, depression, blood glucose, blood pressure

[1]Nursing Department, Suzhou Vocational Health College, Suzhou, Jiangsu Province, P. R. China
[2]Suzhou Municipal Hospital, Suzhou, Jiangsu Province, P. R. China

Corresponding author:
Qianling Zhuang, Nursing Department, Suzhou Vocational Health College, No 28 Kehua Road, Gaoxin, Suzhou, Jiangsu Province, P. R. China.
Email: zhuangqianlinglu@163.com

Introduction

The prevalence of prediabetes is increasing worldwide. It has been estimated that over 470 million people will have prediabetes by 2030,[1] and most people with prediabetes go on to develop type 2 diabetes within 6 years.[2,3] The situation is more serious in China; the prevalence of diabetes is 10.4% (about 1.5 billion people) and half the adult population is prediabetic.[4] Moreover, individuals with prediabetes, also known as intermediate hyperglycemia, are at high risk for developing cardiovascular disease, cancer and neuropathy.[5,6] The prevalence of hypertension in China has increased sharply from 5.1% (1959) to 27.9% (2015).[7] More importantly, even slightly elevated blood pressure is associated with an increased risk of myocardial infarction, heart failure, stroke and chronic renal failure.[8] Therefore, prevention is important in reducing the burden associated with diabetes and hypertension.[9,10]

Many studies indicate an increased likelihood of negative emotions such as anxiety and depression in people with prediabetes and hypertension.[11–14] Negative emotions can affect the endocrine system through the hypothalamus–pituitary–adrenal axis (the sympathetic nervous system) by increasing blood sugar and blood pressure, aggravating disease conditions and leading to complications.[15] Research has shown that prediabetes and hypertension lead to physiological dysfunction and mental disorders.[16,17] One previous study found that prediabetes combined with negative emotions (mainly anxiety and depression) may facilitate the progression to diabetes and negatively influence the efficacy of lifestyle interventions for high-risk adults.[18] Negative emotions not only directly affect patients' quality of life, but may also have a negative effect on self-management ability, medication compliance and blood sugar control in diabetic patients, and increase the risk of cardiovascular events and mortality[19,20] However, there is no information on the frequency of negative emotions in patients with prediabetes and hypertension in the Chinese community. Therefore, this observational study aimed to investigate the prevalence of negative emotions and identify possible factors influencing the risk of mental disorders in individuals with or without prediabetes and hypertension from communities in Suzhou, China.

Methods

Study design and participants

Adults were recruited from two communities in Suzhou, China. Convenience sampling was used to select participants. Individuals were excluded if they were pregnant or had a history of diabetes, congestive heart failure, coronary heart disease, angina, heart attack, stroke, prescribed psychiatric medication or psychiatric disorders. A total of 504 adults with no previous history of diabetes were recruited sequentially from Jul 2016 to Dec 2018. All enrolled participants were 18 to 79 years old. Written informed consent was obtained from all participants.

The experimental protocol was approved by the human research ethics committee of Suzhou Vocational Health College.

Prediabetes and hypertension screening

Glucose metabolism status was determined for all participants using an oral glucose tolerance test (OGTT). Multiple blood pressure measurements were also taken. Briefly, participants were instructed to maintain their physical activity and diet as usual for at least 3 days prior to laboratory examinations. After 12 hours of overnight fasting, fasting blood samples were obtained to measure plasma glucose. After participants had taken a standard 75-g

glucose solution, their plasma glucose was measured at 30 minutes, 1 hour and 2 hours post-glucose challenge. On the same day, right brachial artery blood pressure was measured using an electronic sphygmomanometer (Omron, Dalian, China) when the participant was sitting calmly.

Fifty-four participants were diagnosed with new-onset diabetes and excluded from the study. Fifty-six participants were diagnosed as prediabetic according to the Diabetes Prevention and Cure Guideline of China (DPCGC) 2017 criteria.[4] These participants were divided into three subgroups: (1). Impaired fasting glucose group with fasting plasma glucose $\geq$6.1 mmol/L (110 mg/dL) but <7.0 mmol/L (126 mg/dL), and plasma glucose at 2 hours post-OGTT <7.8 mmol/L (140 mg/dL); (2) Impaired glucose tolerance group with plasma glucose at 2 hours post-OGTT $\geq$7.8 mmol/L (140 mg/dL) but <11.1 mmol/L (199 mg/dL), and fasting plasma glucose <6.1 mmol/L (110 mg/dL); (3) IFG combined with IGT group.

Eighty-four participants were diagnosed with hypertension according to a 2015 China hypertension grassroots administration guide[21]; 23 participants were diagnosed with both prediabetes and hypertension. Thus, the remaining 287 participants had normal levels of both blood glucose and blood pressure.

Assessment of anxiety and depression

Anxious and depressive symptoms were assessed using the Zung Self-Rating Anxiety Scale (SAS)[22] and the Zung Self-Rating Depression Scale (SDS),[13] respectively. Both scales consist of 20 items that assess the degree and frequency of anxious and depressive symptoms during the past 2 weeks. For each item, symptom severity is rated as 1 = never/very rarely/rarely; 2 = once in a while/some of the time/occasionally; 3 = relatively often/very often/often;

4 = most of the time/always/almost always. The final SAS/SDS scores for individual participants were calculated by summing scores on all 20 items. Anxiety and depression status was evaluated as normal range (<53 points); presence of minimal to mild anxiety/depression (53–62 points); presence of moderate to marked anxiety/depression (63–72 points); and presence of severe to extreme anxiety/depression ($\geq$73 points).

Data collection

All participants were asked to complete a self-report questionnaire with instructions from trained staff. The questionnaire assessed age, height, body weight, smoking, drinking, family history of diabetes and/or hypertension, body mass index (BMI), education level, disease duration and family income. Smoking and drinking history was defined as having smoked at least 100 cigarettes and consumed >5 g of alcohol per day over the lifetime, respectively. BMI was calculated as weight in kilograms divided by height in square meters. Educational levels were categorized as primary school or below, high school, and college or above.

All investigators and staff members were trained according to the research protocol to be familiar with the study aim, the collection of anthropometric data, the tools and methods used for measurement of blood pressure and blood glucose, and the detailed instructions on completing the study questionnaires.

Statistical analysis

Data are expressed as the mean $\pm$ standard deviation or percentage values as appropriate. The difference between groups was analyzed using the chi-square test or one-way analysis of variance. The potential associations between variables were analyzed using Pearson linear correlation

analysis or Spearman linear correlation analysis. The potential influencing factors were determined using multinomial linear regression analysis using SPSS for Windows 15 (SPSS Inc., Chicago, IL, USA). A two-tailed P-value of <0.05 was considered statistically significant.

Results

Participant demographic and clinical characteristics

A total of 450 participants were included in the study and they were classified into four subgroups: G1 (participants with hypertension, $n = 84$), G2 (participants with prediabetes, $n = 56$), G3 (participants with hypertension combined with prediabetes, $n = 23$) and G4 (participants without hypertension or prediabetes, $n = 287$). Their demographics and characteristics are shown in Table 1. There were no significant differences in drinking, family income, or disease duration among the four subgroups. However, there were significant differences among the four subgroups in sex, age, educational levels, smoking, BMI, waist circumference (WC), physical activity, and family history of diabetes and hypertension (all $P < 0.05$).

The hypertension or prediabetes groups ranked first and second, respectively, for the percentage of participants aged >60 years. There were significantly more participants living a physically active life in the normal participant group than in the hypertension and/or prediabetes groups (G4: 75.5% *vs* G1: 41.7%, G2: 44.6%, G3: 34.7%, respectively, all $P < 0.05$). Of the four subgroups, the normal participant group contained the lowest percentage of participants who smoked (G4: 39.4% *vs* G1: 66.7%, G2: 60.7%, and G3: 65.2%, all $P < 0.05$). These data indicate that some important factors, such as age, smoking habit and lifestyle, are associated with the risk of developing non-communicable diseases.

Anxiety and depression scores by health status

Anxiety and depression scores in the different groups are shown in Table 2. The mean anxiety and depression scores for participants with hypertension and/or prediabetes were significantly higher than for participants with normal blood glucose levels and normal blood pressure (all $P < 0.05$). Anxiety severity in participants with both prediabetes and hypertension was significantly higher than in those with hypertension alone (all $P < 0.05$). These results demonstrate that participants with prediabetes and/or hypertension are more likely to experience negative emotional states than normal participants.

Possible factors influencing the risk of developing negative emotions

To further determine potential high-risk factors for developing negative emotion in Chinese adults, we analyzed the correlations between anxiety/depression scores and several factors (Table 3). Notably, the severity of both anxiety and depression was positively correlated with levels of fasting plasma glucose, blood pressure, and WC. Moreover, there were positive correlations between anxiety and depression, respectively, and age (both $P < 0.05$), duration of disease (both $P < 0.05$), and smoking habit ($P = 0.10$, $P < 0.05$). Physical activity was negatively correlated with the severity of anxiety ($P = 0.010$) and depression ($P < 0.05$) for all participants.

Regression models predicting the risk of developing negative emotions

To explore which factors predicted the risk of developing anxiety and depression, we

Table 1. Demographic and clinical characteristics of participants.

General Data	G1 (n = 84)	G2 (n = 56)	G3 (n = 23)	G4 (n = 287)	P	P_1 G1 vs G2	P_2 G1 vs G3	P_3 G1 vs G4	P_4 G2 vs G3	P_5 G2 vs G4	P_6 G3 vs G4
Sex					0.045	0.085	0.059	0.012	0.617	0.518	0.520
Male	35 (41.7)	24 (42.9)	8 (34.8)	120 (40.8)							
Female	49 (58.3)	32 (57.1)	15 (65.2)	167 (58.2)							
Age (years)					0.000	0.007	0.016	0.000	0.000	0.000	0.587
18–39	17 (20.2)	19 (33.9)	13 (56.2)	157 (54.7)							
40–59	33 (39.3)	28 (50)	8 (34.8)	126 (43.9)							
>60	34 (40.5)	9 (16.1)	2 (9.0)	4 (1.4)							
Duration of disease					0.902	1.000	0.799	–	0.790	–	–
≤5 years	58 (69.0)	39 (69.6)	17 (73.9)	0 (100.0)							
>5 years	26 (31.0)	17 (30.4)	6 (26.1)	0 (100.0)							
Education					0.000	0.660	0.061	0.000	0.195	0.000	0.912
College or above	27 (32.1)	14 (25.0)	12 (52.2)	160 (55.7)							
High school	35 (41.7)	26 (46.4)	6 (26.1)	64 (22.3)							
Primary school or below	22 (26.2)	16 (28.6)	5 (21.7)	63 (22.0)							
Diabetes history					0.001	0.705	0.114	0.032	0.245	0.017	0.004
Yes	58 (69.0)	32 (57.1)	20 (87.0)	159 (55.4)							
No	26 (31.0)	24 (42.9)	3 (13.0)	128 (44.6)							
Hypertension					0.002	0.599	0.142	0.036	0.292	0.019	0.004
Yes	50 (59.2)	36 (64.3)	18 (78.3)	133 (46.3)							
No	34 (40.5)	20 (35.7)	5 (21.7)	154 (44.6)							
WC	82.4 ± 4.5	78.5 ± 5.9	83.1 ± 5.1	79.6 ± 4.1	0.000	0.000	0.000	0.112	0.478	0.000	0.000
BMI					0.001	0.529	0.057	0.165	0.145	0.001	0.005
Normal	37 (44.0)	30 (53.6)	6 (26.1)	173 (60.3)							
Overweight	32 (38.1)	17 (30.4)	9 (39.1)	56 (19.5)							
Obesity	15 (17.9)	9 (16.1)	8 (34.8)	58 (20.2)							
Physical activity					0.000	0.716	0.778	0.000	0.641	0.000	0.000
Not working	19 (22.6)	13 (23.2)	5 (21.7)	34 (11.8)							
Sedentary	30 (35.7)	18 (32.1)	10 (43.5)	36 (12.5)							
Light	23 (27.4)	12 (21.4)	5 (21.7)	135 (47.0)							
Moderate	11 (13.1)	12 (21.4)	2 (8.7)	73 (25.4)							
Heavy	1 (1.2)	1 (1.8)	1 (4.3)	9 (3.1)							
Smoking					0.000	0.478	1.000	0.000	0.802	0.005	0.026
Yes	56 (66.7)	34 (60.7)	15 (65.2)	113 (39.4)							
No	28 (33.3)	22 (39.3)	8 (34.8)	174 (60.6)							

(continued)

Table 1. Continued.

General Data	G1 (n=84)	G2 (n=56)	G3 (n=23)	G4 (n=287)	P	P_1 G1 vs G2	P_2 G1 vs G3	P_3 G1 vs G4	P_4 G2 vs G3	P_5 G2 vs G4	P_6 G3 vs G4
Drinking					0.418	0.587	0.807	0.128	1.000	0.656	0.661
Yes	57 (67.9)	35 (62.5)	13 (56.2)	167 (58.2)							
No	27 (32.1)	21 (37.5)	10 (43.8)	120 (41.8)							
Family Income (CNY, unit: 10,000)					0.275	0.094	0.545	0.036	0.661	0.889	0.667
<5	29 (34.5)	22 (39.3)	7 (30.4)	91 (31.7)							
5–10	28 (33.3)	25 (44.6)	10 (43.5)	100 (34.8)							
>10	27 (32.1)	9 (16.1)	6 (26.1)	96 (33.4)							

Data in columns G1 to G4 are numbers (percentages) or means (standard deviations). G1: participants with hypertension; G2: participants with prediabetes; G3: participants with both prediabetes and hypertension; G4: participants without prediabetes or hypertension; WC: waist circumstance; BMI: body mass index.

further generated multinomial linear regression prediction models. The mean SAS and SDS scores in the different subgroups were the dependent variables. The results showed that the risk of developing anxiety was positively predicted by sex, duration of disease, fasting plasma glucose and diastolic blood pressure (all $P < 0.05$), and depression was positively predicted by duration of disease, fasting plasma glucose and diastolic blood pressure (all $P < 0.05$) (Table 4). Based on the results of the linear regression analysis, two regression equation prediction models for anxiety and depression were established, as follows (FPG: fasting plasma glucose; DBP: diastolic blood pressure):

$$\text{Anxiety} = 0.155 * \text{Sex} + 0.446 \\ * \text{duration of disease} \\ + 0.135 * \text{FPG} + 0.142 * \text{DBP}$$

$$\text{Depression} = 17.556 + 0.408 \\ * \text{duration of disease} \\ + 0.133 * \text{FPG} + 0.187 * \text{DBP}$$

Discussion

In this study, we first examined the distribution of anxiety, depression, prediabetes and hypertension in Chinese community-dwelling adults in Suzhou, China. Data analysis indicated that symptoms of anxiety and depression in participants with prediabetes were much more severe than those in participants with hypertension. Moreover, participants with both prediabetes and hypertension exhibited the highest severities of anxiety and depression. An increasing body of evidence suggests that prediabetes can lead to substantial health problems, such as chronic cardiovascular diseases, kidney damage and diabetic retinopathy, which are attributed to insulin resistance, multiple

Table 2. Anxiety and depression scores (means ± standard deviations).

Group	n	Anxiety	Depression
Control group	287	39.54 ± 9.686	37.83 ± 8.049
Prediabetes	56	53.04 ± 7.639*	51.88 ± 6.48*
Hypertension	84	51.51 ± 6.785*	50.24 ± 7.703*
Hypertension and prediabetes	23	55.87 ± 8.996*#	53.13 ± 8.002*#

Comparison with control group: *P < 0.05; comparison with hypertension group: #P < 0.05.

Table 3. Spearman correlation analysis of relationships between risk factors and negative emotion scores.

	Anxiety		Depression	
	r	P-value	r	P-value
Sex	0.081	0.085	−0.073	0.124
Age	0.185	0.000	0.157	0.001
Family income	−0.072	0.125	−0.039	0.412
Duration of disease	0.575	0.000	0.653	0.000
Education	0.056	0.238	0.072	0.128
Physical activity	−0.122	0.010	−0.170	0.000
BMI	0.090	0.057	0.037	0.433
Drinking	0.014	0.774	−0.096	0.041
Smoking	−0.121	0.010	−0.218	0.000

BMI: body mass index.

Table 4. Regression analyses of predictors of the risk for developing anxiety and depression.

	B	β	P	R2
Anxiety				
(Constant)	3.801		0.705	0.356
Sex	3.416	0.155	0.000	
Duration of disease	7.161	0.446	0.000	
FPG	2.109	0.135	0.002	
DBP	0.134	0.142	0.046	
Depression				
(Constant)	17.556		0.045	0.429
Duration of disease	6.056	0.408	0.000	
FPG	1.922	0.133	0.001	
DBP	0.163	0.187	0.005	

FPG: fasting plasma glucose; DBP: diastolic blood pressure.

metabolic disorders and even genetic susceptibilities[5,6,8]. There are few satisfactory treatment strategies to prevent or mitigate the harmful consequences of prediabetes. As a result, prediabetic patients in most countries tend to be more anxious and depressed, as they are confused about how to manage this disease.[23,24]

A previous study by Yang[25] has shown that in China the prevalence of prediabetes is much higher than that of diabetes (35.7% vs 10.4%). Furthermore, the prevalence of hypertension in China is gradually increasing year by year. When an individual is told that he or she has prediabetes and/or hypertension, they will experience substantial negative emotions. Interestingly, it has been confirmed that disease-related knowledge about lifestyle changes provided by clinicians and nutritionists can help to alleviate depression and anxiety and improve cognitive scores[13,22] in patients with prediabetes and/or hypertension. Indeed, Li et al.[26] reported that an emphasis on the importance of screening depressive prediabetic patients could help to identify susceptible individuals and improve their future health outcomes. Hence, robust measures are needed to increase disease awareness in the prediabetic population, which would help to reduce negative emotions and delay the occurrence of type 2 diabetes.

De Mello[27] found that people who did not engage in sufficient physical activity had a higher chance of exhibiting symptoms of depression and anxiety when compared with those who regularly engaged in physical activity. Several randomized controlled trials have demonstrated that physical activity and dietary changes can prevent or delay the progress of prediabetes to diabetes.[28,29] A recent study has also shown that dietary habits, occupational stress and WC are the main influencing factors of prediabetes.[30] Our data demonstrated that participants older than 60 years who smoked or had a physically inactive lifestyle were more prone to developing prediabetes and hypertension, which may further increase the risk of developing negative emotions. More importantly, physical activity negatively correlated with anxiety and depression scores in all participants with prediabetes and/or hypertension. These data suggest that more emphasis should be placed on lifestyle improvements, such as quitting smoking and increasing the amount of exercise, especially for older people.

Patients with diabetes and hypertension are at high risk of experiencing negative emotions such as pessimism owing to the occurrence of life-threatening chronic complications and reduced quality of life. Our findings showed that both age and duration of disease were positively related to anxiety and depression levels. Patients with prediabetes and/or hypertension who have longer disease duration are particularly likely to experience more anxiety symptoms. Moreover, we found that higher blood pressure and poorer blood glucose control are more likely to accelerate the development of subclinical cognitive and mood disorders during the progression of the disease, which is consistent with previous study findings.[31,32] All the data indicate that more psychological care should be provided for patients with prediabetes and/or hypertension, especially for older patients with longer disease duration.

Additional multiple linear regression analyses revealed that females had higher anxiety severity than males. Indeed, Blümel showed that women are more inclined to develop anxiety or depression than men, which is consistent with our data.[33] Similarly, one previous study indicated that women are more vulnerable to psychological stress when facing life stress events because of hormonal differences.[34,35] These findings emphasize the importance of psychological counseling for women, as they are more likely to feel hopeless when confronted with prediabetes and/or hypertension.

It is worth noting that two prediction equation models for anxiety and depression risk were established, which mainly included potential factors associated with the susceptibility to negative emotions. On the basis of the findings, we conclude that for

patients with longer duration of prediabetes and/or hypertension, better glycemic and blood pressure control could more effectively prevent the development of negative emotions.

Study strengths and limitations

To our knowledge, this is the first report on the prevalence of negative emotions in Chinese community-dwelling patients with prediabetes and/or hypertension. More importantly, our data indicate several possible risk factors for the development of anxiety and depression in individuals susceptible to diabetes. Identification of these factors may be very useful in developing effective and feasible measures to prevent disease-related chronic complications, such as cardiovascular diseases and kidney disease. However, there were some study limitations. First, the sample contained more women because women retire 5 years earlier than men in China. Second, the number of participants may be insufficient owing to the shortage of research funding. Finally, a number of important variables were not measured, such as hemoglobin A1c, total cholesterol, high density lipoprotein and low density lipoprotein.

Conclusion

Overall, we found that participants with prediabetes or hypertension exhibited significantly higher levels of anxiety and depression than those without prediabetes or hypertension. Participants with both prediabetes and hypertension experienced more anxious and depressive symptoms than those with prediabetes or hypertension alone. Aging, being female, longer disease duration, smoking, inactive physical lifestyle, and high levels of blood glucose and blood pressure were risk factors for developing anxiety and depression in individuals with prediabetes or hypertension. These findings will be of great value in helping both clinicians and nutritionists develop more effective interventions to delay or prevent the progress from prediabetes to diabetes in susceptible individuals.

ORCID iD

Qianling Zhuang 🆔 https://orcid.org/0000-0002-8308-3539

References

1. Tabák AG, Herder C, Rathmann W, et al. Prediabetes: a high-risk state for developing diabetes. *Lancet* 2012; 379: 2279–2290.
2. Shaw JE, Sicree RA and Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. *Diabetes Res Clin Pract* 2010; 87: 4–14.
3. Hamman RF, Wing RR, Edelstein SL, et al. Effect of weight loss with lifestyle intervention on risk of diabetes. *Diabetes Care* 2013; 29: 2102–2107.
4. DPCGC. "Diabetes Prevention and Cure Guideline of China". 2017.

5. Nwatu CB, Ofoegbu EN, Unachukwu CN, et al. Prevalence of prediabetes and associated risk factors in a rural Nigerian community. *International Journal of Diabetes in Developing Countries* 2015; 36: 1–7.

6. Mirghani HO, Mohammed OS and Alyoussuf AA. Outcomes of prediabetes and undiscovered diabetes among patients with acute coronary syndrome. *Journal of Taibah University Medical Sciences* 2015; 11: 359–363.

7. Wang Z, Chen Z, Zhang L, et al. Status of hypertension in China: results from the China hypertension survey, 2012–2015. *Circulation* 2018; 137: 2344–2356.

8. Cannon CP. Cardiovascular disease and modifiable cardiometabolic risk factors. *Clin Cornerstone* 2008; 9: 24–38; discussion 39-41.

9. Association A D. 5. Prevention or delay of type 2 diabetes: standards of medical care in diabetes—2018. *Diabetes Care* 2018; 41: S51.

10. Leung AA, Nerenberg K, Daskalopoulou SS, et al. Hypertension Canada's 2016 Canadian hypertension education program guidelines for blood pressure measurement, diagnosis, assessment of risk, prevention, and treatment of hypertension. *Can J Cardiol* 2016; 32: 589–597.

11. Mendis S. The contribution of the Framingham Heart Study to the prevention of cardiovascular disease: a global perspective. *Prog Cardiovasc Dis* 2010; 53: 10–14.

12. Suzuki T, Hirata K, Elkind MS, et al. Metabolic syndrome, endothelial dysfunction, and risk of cardiovascular events: the Northern Manhattan Study (NOMAS). *Am Heart J* 2008; 156: 405–410.

13. Eriksson AK, Ekbom A, Granath F, et al. Psychological distress and risk of prediabetes and type 2 diabetes in a prospective study of Swedish middle-aged men and women. *Diabet Med* 2008; 25: 834–842.

14. Derakhshanpour F, Vakili MA, Farsinia M, et al. Depression and quality of life in patients with type 2 diabetes. *Iran Red Crescent Med J* 2015; 17: e27676.

15. International Diabetes Federation Guideline Development Group. Global guideline for type 2 diabetes. *Diabetes Res Clin Pract* 2014; 104: 1–52.

16. Wu EL, Chien IC and Lin CH. Increased risk of hypertension in patients with anxiety disorders: a population-based study. *J Psychosom Res* 2014; 77: 522–527.

17. Bajko Z, Szekeres CC, Kovacs KR, et al. Anxiety, depression and autonomic nervous system dysfunction in hypertension. *J Neurol Sci* 2012; 317: 112–116.

18. Rosas LG, Vasquez JJ, Naderi R, et al. Development and evaluation of an enhanced diabetes prevention program with psychosocial support for urban American Indians and Alaska natives: a randomized controlled trial. *Contemp Clin Trials* 2016; 50: 28–36.

19. Van Son J, Nyklicek I, Pop V J, et al. The effects of a mindfulness-based intervention on emotional distress, quality of life, and HbA1c in outpatients with diabetes (DiaMind): a randomized controlled trial. *Diabetes Care* 2013; 36: 823–830.

20. Park M, Katon WJ and Wolf FM. Depression and risk of mortality in individuals with diabetes: a meta-analysis and systematic review. *Gen Hosp Psychiatry* 2013; 35: 217–225.

21. Revision committee of Chinese guidelines for primary management of hypertension in China. 2015 China hypertension grassroots adminstration guide. *Chin J Hypertens* 2015; 23: 24–44.

22. Kyrios M, Moore SM, Hackworth N, et al. The influence of depression and anxiety on outcomes after an intervention for prediabetes. *Med J Aust* 2009; 190: S81–S85.

23. Tabák AG, Akbaraly TN, Batty GD, et al. Depression and type 2 diabetes: a causal association? *Lancet Diabetes Endocrinol* 2014; 2: 236–245.

24. Zhu SQ, Zhang LX, Zhao JN, et al. Study on correlation between anxiety and depression and quality of life among patients with patients with impaired glucose regulation. *Chin Nurs Res* 2015; 29: 2364–2366.

25. Yang WY. Epidemiology and trends in diabetes in China (in Chinese). *Sci Sin Vitae* 2018; 48: 812–819.

26. Li L, Shelton RC, Chassan RA, et al. Impact of major depressive disorder on prediabetes by impairing insulin sensitivity. *J Diabetes Metab* 2016; 7: 664–670.

27. De Mello MT, Lemos Vde A, Antunes HK, et al. Relationship between physical activity and depression and anxiety symptoms: a population study. *J Affect Disord* 2013; 149: 241–246.

28. Lipska KJ, Inzucchi SE, Van Ness PH, et al. Elevated HbA1c and fasting plasma glucose in predicting diabetes incidence among older adults: are two better than one? *Diabetes Care* 2013; 36: 3923–3929.

29. Matfin G and Pratley RE. Advances in the treatment of prediabetes. *Ther Adv Endocrinol Metab* 2010; 1: 5–14.

30. Ryu H, Moon J and Jung J. Influence of health behaviors and occupational stress on prediabetic state among male office workers. *Int J Environ Res* 2018; 15: 1264–1277.

31. Piotrowicz K, Prejbisz A, Klocek M, et al. Subclinical mood and cognition impairments and blood pressure control in a large cohort of elderly hypertensives. *J Am Med Dir Assoc* 2016; 17: 864.e17–22.

32. Mann DM, Palmisano J and Lin JJ. A pilot randomized trial of technology-assisted goal setting to improve physical activity among primary care patients with prediabetes. *Prev Med Rep* 2016; 4: 107–112.

33. Blümel JE, Chedraui P, Aedo S, et al. Obesity and its relation to depressive symptoms and sedentary lifestyle in middle-aged women. *Maturitas* 2015; 80: 100–105.

34. Rantanen AT, Korkeila JJA, Loyttyniemi ES, et al. Awareness of hypertension and depressive symptoms: a cross-sectional study in a primary care population. *Scand J Prim Health Care* 2018; 36: 323–328.

35. Krysiak R, Drosdzol-Cop A, Skrzypulec-Plinta V, et al. Sexual functioning and depressive symptoms in women with various types of prediabetes – a pilot study. *Endokrynol Pol* 2018; 69: 175–181.