Original Article

Diabetes and Depressive Symptoms in Korean Women: The Fifth Korean National Health and Nutrition Examination Survey (2010–2011)

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Background: The purpose of this study was to investigate the association between diabetes and depressive symptoms among Korean women.

Methods: We performed an analysis of data for 6,572 women aged 30 or over obtained from the Fifth Korean National Health and Nutrition Examination Survey conducted in 2010 to 2011. We examined the presence of depressive symptoms and the treatment of depression according to diabetes status.

Results: The presence of depressive symptoms was observed in 22.6% of subjects with diabetes. In the multiple logistic regression model, diabetes was associated with an increased risk of depressive symptoms (odds ratio [OR], 1.21; 95% confidence interval [CI], 1.20 to 1.21) but the treatment of depression among diabetics was less common (OR, 0.54; 95% CI, 0.54 to 0.55). Uncontrolled diabetes (glycosylated hemoglobin ≥ 7%) was associated with an increased risk of depressive symptoms (OR, 1.71; 95% CI, 1.69 to 1.73) among diabetics.

Conclusion: Physicians should manage individuals with diabetes in consideration of the presence of depressive symptoms, especially in those with uncontrolled diabetes.

Keywords: Diabetes Mellitus; Depression; Women

INTRODUCTION

Diabetes and depression are major health problems in Korea. The prevalence of diabetes was estimated to be 10.1% in 2010[1] and diabetes is the 5th cause of death in Korea with a diabetes-related mortality rate of 21.5 per 100,000 people in 2011.[2]

Reported prevalence of depressive symptoms has ranged from 12.8% to 38.9% in Korea[1,3] but the prevalence of depression that had been diagnosed by a doctor was 3.4%.[1] Depression is a common, underestimated, often chronic illness, which causes a high economic burden for society.[4]

Previous studies have shown that depression is higher in individuals with diabetes compared to those without diabetes.[5,6] The presence of depression is associated with treatment non-adherence,[7] poor glycemic control,[8] increased health care utilization,[6] increased complications,[9] impaired quality of life,[10] and increased mortality rate.[11]

Therefore, the identification and effective treatment of

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depression are considered a form of management for diabetes. Understanding the factors associated with depression in diabetics is helpful for physicians to identify depression.

A previous study in which subjects were included from a university hospital in Seoul demonstrated that the prevalence of depressive symptoms was 20.4% in individuals with diabetes.[12] Because a relatively small number of subjects with diabetes in a specific hospital were included in the study and there was no comparison with depression between subjects with diabetes and without diabetes, there was insufficient data on the relationship between diabetes and depressive symptoms in the Korean general population. As the proportion of individuals who were aware of their diabetes was about 72% among all diabetics in the general population,[1] there have been few studies including all Korean diabetics until now. Furthermore, there is a lack of data about the treatment of depression in individuals with diabetes.

In addition, women experience depression twice as often as men and women with depression more frequently experience guilt, anxiety, increased appetite and sleep, weight gain, and comorbid disorders.[13] For these reasons, we investigated the relationship between diabetes and depressive symptoms among women, who are more likely to experience depression, using a nationally representative data of Korean.

METHODS

1. Study Subjects

This study was based on data from the fifth Korean National Health and Nutrition Examination Survey (KNHANES V) conducted in 2010 and 2011 by the Korean Ministry of Health and Welfare.[1] The survey applied a stratified multistage probability sampling design for the South Korean population using a two-stage stratified systematic sampling method. KNHANES consists of four different measures: a health interview, a health behavior survey, a health examination, and a nutrition survey. In KNHANES V, 17,476 individuals aged > 1 year responded to the survey (8,958 in 2010 and 8,518 in 2011). In this study, we analyzed data from 6,572 women (3,282 in 2010 and 3,290 in 2011) aged ≥ 30.

2. Diabetes, Diabetes Related Covariates, Depressive Symptoms, and Treatment of Depression

The presence of diabetes was defined by a self-report of the physician's diagnosis. In an effort to identify undiagnosed diabetes, diabetes was defined by a fasting blood glucose (FBS) level of ≥ 126 mg/dL or glycosylated hemoglobin (HbA1c) ≥ 6.5%.[14] HbA1c was checked among those who were FBS ≥ 126 mg/dL, those who had been diagnosed with diabetes in 2010, and everyone over the age of 10 in 2011. A variable for diabetes control was divided into HbA1c < 7% and HbA1c ≥ 7%. Poor glycemic control (uncontrolled diabetes) was defined as an HbA1c level of 7% or higher.[14]

Subjects with diabetes were asked what year they had been diagnosed and what therapeutic status they had experienced (insulin, oral medications, and lifestyle modifications). We calculated the duration of diabetes using the year of diabetes diagnosed and divided subjects into groups based on that number: ≤10 years and >10 years.

Although the diagnosis of depression should be confirmed by a physician using standard criteria, screening instruments as the Patient Health Questionnaire (PHQ-2), which has been found to be up 97% sensitive and 67% specific in adults, may rule out depression.[15] Depressive symptoms were assessed by using the PHQ-2 ("Have you felt little pleasure or hopeless continuously for over the 2 weeks during the past year and does it bother your everyday life?"). Subjects who reported "yes" were regarded as having depressive symptoms because of a positive result in the depression screening. Subjects who had been diagnosed with depression by a doctor were asked about the treatment of their depression.

3. Other Covariates

Subjects were asked to report socio-demographic factors including age, household income, educational level (≤ middle school or ≥ high school), marital status, and current job status (employed or not). Household income was grouped as lower (the first, second quartile) or higher (the third, fourth quartile). Marital status was grouped as married or other (single/divorced/widowed).

Subjects were asked to report their smoking status and were grouped as currently smoking or other (never smoked/used to

smoke). High risk drinking was defined as drinking ≥ 5 drinks at least two or more times a week.[16] Regular exercise was defined as moderate-intensity aerobic (endurance) physical activity for a minimum of 30 minutes each day for five days a week or vigorous-intensity aerobic physical activity for a minimum of 20 minutes each day for three days a week.[17]

Subjects with a body mass index (calculated as weight in kilograms divided by height in meters squared) ≥ 25 were classified as obese. Subjects with a waist circumference ≥ 85 cm were classified as having abdominal obesity.[18]

Subjects also reported whether they had ever had comorbidities including hypertension, dyslipidemia, coronary artery disease (acute myocardial infarction or angina), stroke, chronic renal disease, arthritis (osteoarthritis and/or rheumatoid arthritis), and cancer (stomach, liver, lung, cervix, breast, thyroid, and colon cancer) or not. Women reported their menstrual status. We considered women who reported that their menstruation had ceased or who had undergone a hysterectomy as postmenopausal women. Although women who have undergone a hysterectomy and retain at least one ovary may have hormonal profiles that are similar to the profiles of women who are premenopausal or postmenopausal, women have been considered postmenopausal if they had a hysterectomy, even with the presence of one or more ovaries in some studies.[19]

Subjects were requested to provide information on their level of psychological stress (none, low, moderate, and extreme). Stress level was grouped as none/low or moderate/extreme.

4. Statistical Analysis

All analyses were performed by reflecting weighted values at the stratification of the samples applied to the KNHANES. The characteristics of the study subjects were compared using Pearson's chi-square test. In addition, mean values and standard deviation for age were compared using Student t-test. Multiple logistic regression analysis was used to determine the relationship between diabetes and depressive symptoms, as well as between diabetes and treatment of depression. The first model showed the crude odds ratios (ORs) and the second model included age. The third model included age, household income, education, marital status, current job status, current smoking status, high risk drinking, regular exercise, obesity, abdominal obesity, hypertension, dyslipidemia, coronary heart disease, stroke, chronic renal disease, arthritis, cancer, menstrual status and level of stress to adjust for socio-demographic, lifestyle variables, and comorbidities as the well-known risk factors of depression.[3,15] The ORs of depressive symptoms and treatment of depression according to glucose control (HbA1c < 7% or ≥ 7%) were obtained after additionally adjusting for diabetes related variables (diabetes duration and current therapeutic status), using the logistic regression analysis (model 4).

All statistical analyses were performed with IBM SPSS ver. 20.0 (IBM Co., Armonk, NY, USA). P-value < 0.05 was considered significant for all these tests.

RESULTS

1. Characteristics of Korean Women According to Diabetes Status

The prevalence of diabetes in Korean women ≥ 30 years was 10.1% in 2010 to 2011. Among Korean women with diabetes, 71.8% of subjects reported that they had been diagnosed with diabetes and 28.2% of subjects were newly diagnosed with diabetes in this study.

Women with diabetes were more likely to be older, single/divorced/widowed, have a lower education and have a lower household income than women without diabetes. The proportions of current job status (employed), current smoking status, high risk drinking, regular exercise, and pre-menopausal status were higher in women without diabetes than those with. The proportions of chronic diseases such as obesity, abdominal obesity, hypertension, dyslipidemia, coronary heart disease, stroke, chronic renal disease, arthritis, and cancer were significantly higher in women with diabetes.

The proportions of women with moderate or extreme stress and depressive symptoms were significantly higher in women with diabetes. The proportion of depressive symptoms in the diabetic women was 22.6% compared with 15.8% in the nondiabetic women. The proportion of subjects being treated for depression with or without diabetes was 1.7% (Table 1).

2. Diabetes-Related Variables of Diabetics

Because 28.2% of diabetics were diagnosed with diabetes in this study and 3.9% of diabetics did not know when they had been diagnosed with diabetes, the missing data of diabetes

Table 1. General characteristics by diabetes status among Korean women

Characteristic	Without diabetes (n = 26,353,648)	Diabetes (n = 2,919,644)	P-value*
Age (y)	49.33 ± 13.26	61.60 ± 12.48	<0.001
Household income			<0.001
Lower	12,016,207 (46.2)	1,833,428 (63.2)	
Higher	13,996,814 (53.8)	1,067,411 (36.8)	
Education level			<0.001
≤Middle school	10,232,964 (38.9)	2,165,130 (74.3)	
≥High school	16,084,194 (61.1)	749,102 (25.7)	
Marital status			<0.001
Single/divorced/widowed	4,374,644 (17.0)	1,043,827 (36.1)	
Married	21,395,277 (83.0)	1,846,247 (63.9)	
Current job status (employed)	13,722,716 (52.1)	1,109,434 (38.1)	<0.001
Current smoking	1,569,845 (6.0)	164,915 (5.7)	<0.001
High risk drinking	1,111,475 (4.2)	80,634 (2.8)	<0.001
Regular exercise	4,966,395 (18.9)	436,655 (15.1)	<0.001
Obesity†	7,263,433 (27.7)	1,586,816 (54.7)	<0.001
Abdominal obesity‡	6,144,748 (23.4)	1,644,345 (56.9)	<0.001
Hypertension	4,673,240 (17.7)	1,651,740 (56.6)	<0.001
Dyslipidemia	2,347,174 (8.9)	962,733 (33.0)	<0.001
Coronary artery disease	507,570 (1.9)	188,092 (6.4)	<0.001
Stroke	312,304 (1.2)	131,651 (4.5)	<0.001
Chronic renal disease	80,851 (0.3)	13,487 (0.5)	<0.001
Arthritis	5,349,971 (20.3)	1,214,101 (41.6)	<0.001
Cancer§	901,398 (3.4)	149,521 (5.1)	<0.001
Menstrual status			<0.001
Premenopausal	14,077,502 (53.6)	563,364 (19.4)	
Postmenopausal	12,179,818 (46.4)	2,336,740 (80.6)	
Level of stress			<0.001
None/low	18,764,609 (71.4)	1,987,265 (68.5)	
Moderate/extreme	7,513,332 (28.6)	912,839 (31.5)	
Depressive symptoms	4,151,634 (15.8)	656,176 (22.6)	<0.001
Treatment of depression	452,291 (1.7)	50,606 (1.7)	0.033

Values are presented as mean ± SD or number (%).
*Chi-square test for categorical variables and Student t-test for continuous variables comparing subjects without and with diabetes. †Defined as body mass index (calculated as weight in kilograms divided by height in meters squared) of ≥ 25. ‡Defined as waist circumference ≥ 85 cm. §Cancer: stomach, liver, lung, cervix, breast, thyroid, and colon cancers.

duration accounted for 32.1%. 23.9% of all diabetics had diabetes for over 10 years.

Among the subjects with diabetes, the proportion of those who were taking oral medication was 58.1%, which was the highest. The proportion of subjects with controlled diabetes (HbA1c < 7%) was 51.5% (Table 2).

3. The Odds Ratios for Depressive Symptoms and Treatment of Depression According to Diabetes Status

In the analysis adjusted for general characteristics, subjects with diabetes had 1.21 (95% confidence interval [CI], 1.20 to 1.21) times higher odds of depressive symptoms than subjects without diabetes. ORs for treatment of depression among subjects with diabetes compared to those without diabetes was 0.54 (95% CI, 0.54 to 0.55) (Table 3).

4. Risk Factors for Depressive Symptoms among Subjects with Diabetes

In the analysis limited to subjects with diabetes, subjects with uncontrolled diabetes (HbA1c ≥ 7%) had 1.31 (95% CI, 1.30 to 1.32) times higher odds of depressive symptoms than subjects with controlled diabetes after adjustment for general characteristics. After further adjusting for diabetes-related variables, uncontrolled diabetes had 1.71 (95% CI, 1.69 to 1.73) times higher odds of depressive symptoms. As it were, inclusion of diabetes related variables increased the strength of the association.

Subjects with uncontrolled diabetes had 3.88 (95% CI, 3.76 to 4.01) times higher odds of being treated for depression than

Table 2. Diabetes-related variables (n = 2,919,644)

Characteristic	Value
Diabetes duration (y)	
≤10	1,284,800 (44.0)
>10	696,764 (23.9)
Missing	938,079 (32.1)
Current therapeutic status	
Insulin (yes)	188,661 (6.5)
Oral medication (yes)	1,696,131 (58.1)
Lifestyle modification (yes)	241,610 (8.3)
Glycosylated hemoglobin level (%)	
<7	1,503,410 (51.5)
≥7	1,312,287 (45.0)

Values are presented as number (%).

Table 3. Odds ratios and 95% confidence interval for depressive symptoms and treatment of depression according to diabetes status

	Diabetes status	Model 1*	Model 2†	Model 3‡
Depressive symptoms	Without diabetes	1	1	1
	With diabetes	1.56 (1.55–1.56)	1.35 (1.35–1.36)	1.21 (1.20–1.21)
Treatment of depression	Without diabetes	1	1	1
	With diabetes	1.01 (1.00–1.02)	0.75 (0.74–0.75)	0.54 (0.54–0.55)

*Crude odds ratio. †Adjustment for age. ‡Adjustment for age, household income, education, marital status, current job status, current smoking, high risk drinking, regular exercise, obesity, abdominal obesity, hypertension, dyslipidemia, coronary heart disease, stroke, chronic renal disease, arthritis, cancer, menstrual status, and level of stress.

Table 4. Odds ratios and 95% Confidence interval for depressive symptoms and treatment of depression among subjects with diabetes according to glucose control

	Diabetes status	Model 1*	Model 2†	Model 3‡	Model 4§
Depressive symptoms	HbA1c < 7%	1	1	1	1
	HbA1c ≥ 7%	1.08 (1.08–1.09)	1.08 (1.07–1.08)	1.31 (1.30–1.32)	1.71 (1.69–1.73)
Treatment of depression	HbA1c < 7%	1	1	1	1
	HbA1c ≥ 7%	1.33 (1.31–1.35)	1.41 (1.38–1.44)	1.14 (1.12–1.16)	3.88 (3.76–4.01)

HbA1c: glycosylated hemoglobin.
*Crude odds ratio. †Adjustment for age. ‡Adjustment for age, household income, education, marital status, current job status, current smoking, high risk drinking, regular exercise, obesity, abdominal obesity, hypertension, dyslipidemia, coronary artery disease, stroke, chronic renal disease, arthritis, cancer, menstrual status, and level of stress. §Model 3 + diabetes duration and current therapeutic status.

subjects with controlled diabetes after adjusting for all covariates (Table 4).

Table 5 shows the risk factors for depressive symptoms among subjects with diabetes from the multiple logistic regression model. Decreasing odds of depressive symptoms were observed with subjects with lower income and lower education. Current smokers had 3.95 (95% CI, 3.89 to 4.01) times higher odds of depressive symptoms compared to others (never smoked/used to smoke).

Those with high risk drinking had 10.34 (95% CI, 10.13 to 10.55) times higher odds of depressive symptoms. Those with comorbidities including obesity, hypertension, stroke, chronic renal disease, and cancer had higher odds of depressive symptoms compared to those without these diseases. Among subjects with diabetes, postmenopausal women had significantly higher odds of depressive symptoms than premenopausal women.

Decreased odds of depressive symptoms were found in subjects who are older (≥50 years), married, employed, exercise regularly and have abdominal obesity. Subjects with moderate or extreme stress had 7.92 (95% CI, 7.85 to 7.99) times higher odds of depressive symptoms compared to those with none or low stress. Marginally decreasing odds of depressive symptoms were observed in people with a long diabetes duration (>10 years). Subjects who were being treated with insulin had 1.54 (95% CI, 1.52 to 1.56) times higher odds of depressive symptoms compared to those not being treated with insulin.

Table 5. Risk factors for depressive symptoms among subjects with diabetes

Characteristic	Odds ratio (95% confidence interval)*	P-value
Age (y)		
30–50	1	<0.001
≥50	0.58 (0.57–0.60)	
Household income		
Lower	1	<0.001
Higher	1.18 (1.16–1.19)	
Education level		
≤Middle school	1	<0.001
≥High school	2.04 (2.02–2.07)	
Marital status		
Single/divorced/widowed	1	<0.001
Married	0.57 (0.57–0.58)	
Current job status (employed)	0.96 (0.95–0.97)	<0.001
Current smoking	3.95 (3.89–4.01)	<0.001
High risk drinking	10.34 (10.13–10.55)	<0.001
Regular exercise	0.54 (0.54–0.55)	<0.001
Obesity	1.77 (1.76–1.79)	<0.001
Abdominal obesity	0.71 (0.70–0.72)	<0.001
Hypertension	1.49 (1.47–1.50)	<0.001
Dyslipidemia	0.94 (0.93–0.95)	<0.001
Coronary artery disease	0.87 (0.86–0.89)	<0.001
Stroke	3.53 (3.47–3.58)	<0.001
Chronic renal disease	35.58 (33.87–37.37)	<0.001
Arthritis	0.62 (0.61–0.62)	<0.001
Cancer	1.71 (1.69–1.74)	<0.001
Menstrual status		<0.001
Premenopausal	1	<0.001
Postmenopausal	4.35 (4.25–4.46)	<0.001
Level of stress		
None or low	1	<0.001
Moderate or extreme	7.92 (7.85–7.99)	
Diabetes duration > 10 years	0.91 (0.91–0.92)	<0.001
Current therapeutic status		
Insulin (yes)	1.54 (1.52–1.56)	<0.001
Oral medication (yes)	0.45 (0.45–0.46)	<0.001
Lifestyle modification (yes)	0.94 (0.93–0.95)	<0.001

*Adjustment for age, household income, education, marital status, current job status, current smoking, high risk drinking, regular exercise, obesity, abdominal obesity, hypertension, dyslipidemia, coronary artery disease, stroke, chronic renal disease, arthritis, cancer, menstrual status, level of stress, diabetes duration, current therapeutic status, and glycosylated hemoglobin.

DISCUSSION

Some studies suggested that the presence of diabetes increases the odds of comorbid depression.[5,8] Another study showed that depressive symptoms were associated with a higher risk of developing type 2 diabetes.[20]

In our study, 22.6% of Korean women with diabetes exhibited depressive symptoms. The proportion of individuals who were aware of their diabetes was about 71.8% among all diabetics in the general population. 28.2% of subjects were newly diagnosed with diabetes in this study. Subjects who had been diagnosed with diabetes before this study seem to feel depressive symptoms more than subjects who were diagnosed with diabetes in this study due to an additive effect of the perception of having a chronic disease.

Depressive symptoms were assessed by using the single question (PHQ-2) which has 97% sensitivity and 67% specificity for diagnosis of major depressive disorder (MDD) in adults. Despite the relatively low specificity of PHQ-2 for MDD, we used this question to screen depressive symptoms because depressive symptoms caused by other psychological disorders such as dysthymic disorder, substance abuse, bereavement, or bipolar disorder[15] were important in relation to diabetes. If the screening test is positive for depression, further evaluation is needed to confirm that symptoms meet the criteria for diagnosis.

We found that diabetes was associated with 21% increased odds of depressive symptoms among Korean women. However, diabetes was associated with 46% decreased odds of being treated for depression by a doctor. There are a few possible explanations for this. First, subjects with diabetes were not more likely to meet the criteria for MDDs than subjects without diabetes.[21] Second, depressive symptoms have been under-diagnosed by physicians.

A previous study demonstrated a significant association between depression and treatment non-adherence in patients with diabetes.[7] Treatment non-adherence may represent an important pathway between depression and worse clinical outcomes. In a meta-analysis, several authors observed that depression was significantly associated with hyperglycemia in patients with type 1 and type 2 diabetes.[21] In our study, subjects with uncontrolled diabetes had 1.71 times higher odds of depressive symptoms than subjects with controlled diabetes among Korean women. Subjects with uncontrolled diabetes had 3.88 times higher odds of being treated for depression. Subjects with uncontrolled diabetes tended to show more severe depressive symptoms, leading to treatment for their symptoms, and it is possible that the use of certain treatments of depression affects glucose homeostasis and insulin sensitivity.[22]

Socioeconomic inequality in depression is heterogeneous and varies according to the way psychiatric disorder is measured.[23] Among Korean women diabetics, increasing odds of depressive symptoms were observed according to higher income, higher education and younger age.

As previous studies have found, current smoking, obesity, and menopausal status increased the risk of depressive symptoms in our study.[24,25] A previous study showed no statistically significant association between abdominal obesity and depression among Korean women.[24] But this study showed an inverse relationship between abdominal obesity and depressive symptoms among women diabetics.

Decreasing odds of depressive symptoms were observed in patients with longer diabetes duration, but it is difficult to identify the relationship between depressive symptoms and diabetes duration because the missing value of diabetes duration is 32.1%. Similar to a previous study in Korea, subjects who were being treated with insulin had 1.54 times higher odds of depressive symptoms compared to those not being treated with insulin.[26]

The main strength of this study lies in the analysis of a nationally representative sample of Korean women concerning the public health issues of diabetes and depressive symptoms. Previous studies included patients with diabetes from a specific hospital (selection bias).[12,27] This study includes all subjects with diabetes and compares depression between subjects with diabetes and without diabetes.

This study has several limitations. First, the cross-sectional design of this study lacks the power to prove causality, and follow-up studies are needed to establish a causal relationship. A cross-sectional design did not allow us to draw causal inferences from the observed relationships. Second, we found no other covariates. We did not assess all diabetic complications because KNHANES is not a survey only for diabetes and does not provide all data related to diabetes complications. We did control for other comorbidities including diabetic complications such as neuropathy and peripheral artery disease. We did not determine whether patients with diabetes had type 1 or type 2 diabetes. However, the incidence rate of type 1 diabetes in Korea is very low, reported as 1.41 per 100,000 people.[28] Therefore, we assumed that most patients in the study population had type 2 diabetes. We did not take into account genetic factors,[29] or dietary patterns that affect glycemic control in subjects with diabetes.[30]

In conclusion, diabetes is associated with an increased risk of depressive symptoms among Korean women, yet those who are diagnosed with diabetes are treated for depression less often. In addition, depressive symptoms are more prevalent in subjects with uncontrolled diabetes. Our results show that physicians should manage individuals with diabetes in consideration of the presence of depressive symptoms, especially in those with uncontrolled diabetes.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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