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Original Article

Depression, Diabetes, and Healthcare Utilization: Results from the Korean Longitudinal Study of Aging (KLoSA)

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Abstract

Background: The aim of this study was to explore the relationship between diabetes and depression and investigate the effects of comorbid diabetes and depression on healthcare utilization.

Methods: The study sample included 10,179 Korean adults aged ≥45 years. The presence of diabetes was assessed by asking participants if the participants had ever been diagnosed with diabetes. Depression was measured using the 10-item Center for Epidemiological Studies–Depression scale. Healthcare utilization was assessed by self-report. Multiple logistic regression analyses were performed.

Results: Diabetes was positively associated with depression after controlling socioeconomic and health variables. Diabetic patients who had low socioeconomic status, who were obese, who were smokers, and who had higher numbers of chronic diseases had a higher depression risk. Diabetes and depression was associated with increased healthcare utilization. People with both diabetes and depression had significantly increased odds of multiple physician visits, multiple hospital admissions, and prolonged hospitalization compared with individuals with neither diabetes nor depression. Patients with both diabetes and depression had greater odds of multiple hospital admissions than patients with diabetes alone.

Conclusions: We found a positive association between diabetes and depression. Depression in persons with diabetes is associated with increased multiple hospital admissions. More research is warranted to clarify an association between co-occurring depression with diabetes and increased healthcare utilization.

Keywords: Depression, Diabetes, Healthcare utilization, Korea

Introduction

Depression is a widespread condition (1, 2) that can cause significant worsening of comorbid medical conditions, socioeconomic burden resulting from functional disability, and reduced quality of life (3-5). The World Health Organization has predicted that by the year 2030, depression will be among the top three causes of disability-adjusted life years lost, both globally and regionally (6). Diabetes, a common chronic disease in older populations, is another major worldwide public health problem, particularly in some Asian countries (7, 8). Almost 346million people currently have diabetes worldwide (9), and one person in ten is expected to have diabetes by 2030 (10). Korea has one of the highest rates of diabetes among Asian countries; the prevalence in Korea's general population is 10.1% (11.3% in male and 9.0% in female individuals) (11). Both diabetes and depression increase morbidity and mortality, and their co-occurrence increases the risks of complications and their related costs (4, 12-15). Several studies have shown an association between depression

and diabetes and their effects on healthcare utilization. However, most of these previous findings came from Western populations (13, 15-17). Few studies have examined depression among people with diabetes in Asian countries (18, 19). To our knowledge, little has been reported about the relationship between diabetes and depression and their effects on healthcare utilization in Korea.

The current study aimed to explore the relationship between diabetes and depression and their related factors using data from the 2006 Korean Longitudinal Study of Ageing (KLoSA). In addition, this article aimed to investigate the effects of comorbid diabetes and depression on healthcare utilization.

Materials and Methods

Study design and study population

The data used for the following analyses were derived from the KLoSA, which was a cross-sectional survey that enrolled a large, nationally representative sample of community-dwelling Koreans aged ≥45 years. The survey was conducted by the Ministry of Labor of Korea from August 1 to December 22, 2006 and examined mental and physical health status, healthcare utilization, and socioeconomic data. Detailed descriptions of the study design and methods of KLoSA have been presented elsewhere (20, 21). Participants were selected randomly by a multistage, stratified probability sampling design to select household units according to geographical area including both urban and rural areas. In case of refusal to participate, another subject was selected from an additional, similar sample from the same district. The survey was conducted by skilled interviewers in the participants' homes using a structured questionnaire. The response rate was 70.7% for households and 75.4% for individuals within households. The final survey sample included 10,254-persons, who represented 0.07% of Koreans aged ≥45 years and had representative age and gender distributions and geographic localization (16 major metropolitan cities and provinces). In the current study, we analyzed 10,179 subjects aged ≥45 years after excluding 75people (1non-responder regarding diabetes status and 74 non-responders on the short-form [10-item] Center for Epidemiological Studies Depression Scale [CES-D10]). Missingness was not related to any other characteristics considered in this study. Furthermore, any non-response bias in estimates should be very small, because the percentage of non-respondents was only 0.7%. The final sample included 4,436 men and 5,743 women aged 45–105 years (M = 61.7, SD = 0.1). Weights were assigned for reducing design effect caused by stratified sampling. Computation of weight employed three steps including the design weight based on two-staged sampling probability, the non-response-adjusted weight, and the benchmark weight reflecting population distribution changes using demographic changes in other large-scale surveys. Details of KLoSA weight can be found elsewhere (20).

Measures

Socioeconomic and health variables

Socioeconomic variables assessed during the interviews included age, gender, marital status, education, and household income. Marital status was self-reported as married, divorced/separated, widowed, or single. Education level was classified into elementary school or less, middle school, high school, and college or above. Adjusted monthly household income was calculated as the total household income divided by the square root of the number of household members. These scores were then divided into quartiles (eg, <250,000 South Korean won [KRW], 250,000 KRW–1,000,000 KRW, 1,000,000 KRW–2,500,000 KRW, and >2,500,000 KRW). BMI was computed from self-reported weight and height as weight in kg divided by the square of the height in metre square; participants were categorized as normal, overweight, or obese (≤24.9 kg/m^2,25.0–29.9 kg/m^2, and ≥30 kg/m^2, respectively), following WHO definitions (22). Smoking was self-reported as never, past use, or current use. Alcohol drinking was self-reported as yes or no. The presence of diabetes was exclusively assessed based on self-reports and not base upon clinical screenings or medical records. Participants were asked whether they had ever been diagnosed by a physi-

cian with diabetes. The specific type of diabetes (type 1/type 2) was not assessed. Participants were also asked whether they had ever been diagnosed by a physician with chronic diseases, including hypertension, heart disease (congestive heart failure or myocardial infarction), stroke, lung disease, and arthritis. Responses were coded 'yes' or 'no'. The number of chronic diseases was calculated by counting the number of disease diagnosed by a physician.

Depression

Depressive symptoms were measured using the CES-D10, which is commonly used to assess depressive symptoms in non-psychiatric community settings (23-25). The CES-D10 assesses the frequency or duration of depressed mood, feeling tired or low in energy, feeling lonely, trouble concentrating, and sleep disturbances during the preceding week (20, 25). The CES-D10 is a 10-item scale; each item can be scored 0–3, total scores range 0–30,and higher scores indicate the presence of more depressive symptoms. The cutoff between moderately severe and severe depression has been identified as 10 points (26). Therefore, this study uses the standard cutoff score of 10 to categorize individuals with depression. The CES-D10 has good internal consistency, acceptable test-retest reliability (20, 21, 26, 27), and has shown a statistically significant correlation with self-rated health (28). The internal consistency of the CES-D10 in the current sample was Cronbach's $\alpha = .82$.

Healthcare utilization

Healthcare utilization was assessed using the structured questionnaire. Three types of healthcare utilization during the previous year were examined:1) physician visits—the number of visits to a physician in the last 12 months; 2) hospital admissions—the number of hospital admissions due to medical problems during the last12 months; and 3) length of hospital stay—the number of inpatient hospital days during the last 12 months. In the multiple logistic regression models, increased healthcare utilization was defined as multiple physician visits (above average: ≥6 physician visits), multiple hospital admissions (≥2), and prolonged length of hospital stay (above median: ≥11 days). Median is preferred to mean values when parameters are not normally distributed (29). As length of hospital stay was not normally distributed, median was used as the cutoff of prolonged length of hospital stay.

Statistical analyses

Descriptive statistics, chi-squared (χ^2) tests, t-tests, analyses of variance (ANOVAs), Scheffe's tests, and multiple logistic regression analyses were conducted to assess the association between diabetes and depression in people with diabetes. Data were checked for distribution. The normality of the variables was acceptable except length of hospital stay, based on kurtosis and skewness analysis. These multivariate models were adjusted for several potential covariates, including socioeconomic characteristics (age, gender, marital status, education, and income) and health-related factors (BMI, smoking, alcohol drinking and number of chronic diseases). These covariates were selected from earlier literature reporting that increasing age, female gender, being unmarried, low socioeconomic status, high BMI, smoking, alcohol consumption, and comorbidities are associated with the presence of depression in people with diabetes (15, 30-33). Finally, both simple logistic regression and adjusted multivariate logistic regression analyses were conducted to determine whether diabetes and depression independently predict healthcare utilization across the three groups (neither diabetes nor depression, diabetes alone, and diabetes plus depression). Adjusted multivariate models were controlled for related variables, including socioeconomic characteristics and health-related factors. Odds ratios (ORs) and 95% confidence intervals were calculated. Statistical analyses were performed with SPSS version19.0. All analyses are reported as two-tailed with an α level of .05.

Results

Among the 10,179 subjects included in the analysis, 1826(17.9%) had depression alone, 838 (8.2%) had diabetes alone, and 375 (3.7%) had both dia-

betes and depression. The subjects' characteristics and levels of healthcare utilization are summarized in Table 1.

Table 1: Characteristics of the subjects by diabetes and depression (*n* =10,179)

Variables (unit or range)	Neither diabetes nor depression (n = 7,140)	Diabetes Alone (n = 838)	Depression and Diabetes (n = 375)	*P*-value	post hoc
Age (yr), mean±SD	59.83±10.73	64.53±9.28	67.52±9.32	.000	a<b and a<c and b<c
Gender, *n* (%)					
Males	3286(46.0)	419(50.0)	134(35.7)	.000	
Females	3854(54.0)	419(50.0)	241(64.3)		
Body mass index, mean±SD	23.17±2.74	23.95±3.19	23.94±3.40	.000	a<b and a<c
Normal (≤24.9)	5471(78.0)	570(69.3)	227(63.4)		
Overweight (25.0-29.9)	1461(20.8)	219(26.6)	133(31.6)		
Obese (≥30.0)	86(1.2)	33(4.0)	18(5.0)		
Marital status				.000	
Married	5982(83.8)	634(75.3)	230(61.3)		
Divorced, separated	147(2.1)	15(1.8)	19(5.1)		
Widowed	959(13.4)	182(21.7)	123(32.8)		
Single	51(0.7)	7(0.8)	3(0.8)		
Education				.000	
≤Elementary school	2805(39.3)	433(51.7)	270(72.0)		
Middle school	1231(17.3)	141(16.8)	50(13.3)		
High school	2204(30.9)	191(22.8)	42(11.2)		
College or above	894(12.5)	72(8.6)	13(3.5)		
Monthly household income (won) †				.000	
1Q (<250,000)	1486(23.9)	185(27.5)	140(48.4)		
2Q (250,000-1,000,000)	1462(23.5)	180(26.7)	73(25.3)		
3Q (1,000,000-2,500,000)	1852(29.8)	194(28.8)	55(19.0)		
4Q (>2,500,000)	1419(22.8)	114(16.9)	21(7.3)		
Smoking				.007	
Never	5060(70.9)	558(66.6)	262(69.9)		
Past	671(9.4)	111(13.2)	42(11.2)		
Current	1408(19.7)	169(20.2)	71(18.9)		
Drinking				.000	
Yes	2904(40.7)	287(34.2)	92(24.5)		
No	4236(59.3)	551(65.8)	283(75.5)		
Number of chronic disease, mean±SD	0.45 ± 0.69	0.90 ± 0.89	1.39 ± 0.97	.000	a<b and a<c and b<c
Number of physician visit, mean±SD	4.60 ±11.21	8.99 ± 15.38	12.43 ± 20.74	.000	a<b and a<c and b<c
Number of hospital admission, mean±SD	0.12 ± 0.54	0.22 ± 0.74	0.47 ± 1.18	.000	a<b and a<c and b<c
Length of hospital stay (days), mean±SD	19.24 ± 32.18	21.93 ± 31.70	34.87 ± 53.68	.000	a<c and b<c
median	10.00	10.50	16.00		

* Monthly household income was categorized into quartiles.

Persons with neither diabetes nor depression were significantly younger, more likely to be married, more educated, and had higher household incomes and lower numbers of chronic diseases than those with diabetes or diabetes and depression. There were statistically significant differences in the number of physician visits (F = 112.02, $P < .001$), hospital admissions (F = 65.42, $P < .001$), and length of hospital stay (F = 8.13, $P < .001$) between the three groups. Individuals with diabetes and depression had significantly higher mean scores for physician visits, hospital admissions, and length of hospital stay compared with the other groups.

In this sample, diabetes was significantly associated with depressive symptoms (Table 2). First, individuals with diabetes had significantly higher mean scores for depressive symptoms compared with those without diabetes (CES-D scores: 7.95 and 6.48, respectively [$P < .001$]). Second, persons with diabetes exhibited a higher prevalence of depression compared with those without diabetes (30.9% vs. 20.4% [$P < .001$]). These associations remained significant even after adjustment for covariates (age, gender, BMI, marital status, education, household income, smoking, drinking, and number of chronic diseases). After adjusting for those covariates, Korean adults with diabetes were 1.3 times as likely to have depression as individuals without diabetes. A multivariate model was built to explore the factors associated with depression in persons with diabetes. In this model, elementary school education (OR =1.91 vs. >elementary school, 95% CI = 1.06–3.44, P =.002), being more than 25.0 in BMI (OR =1.39 vs. less than 24.9, 95% CI = 1.01–1.90, P = .041), being in the lowest quartile of household income (OR =1.94 vs. other quartiles, 95% CI = 1.42–2.66, $P < .001$), being smoker (OR =1.60 vs. non-smoker, 95% CI = 1.04–2.46, P = .031), and having ≥2 chronic diseases (OR =2.34 vs. ≤1, 95% CI = 1.69–3.24, $P < .001$) were significantly associated with the presence of depression among those with diabetes, independent of age, gender, marital status, and alcohol drinking (Table 3).

Table 2: Level of depressive symptoms in subjects with and without diabetes (n = 10,179)

	Without diabetes (n = 1,211)	**With diabetes (n = 8,968)**	**X^2or *t*-value**	***P*-value**
Mean CES-D score (mean, SD)	6.48(5.05)	7.95(5.56)	8.733	.000
Percent of depression (CESD ≥ 10)	20.4	30.9	70.161	.000

Table 4 shows the unadjusted and adjusted ORs of diabetes and depression in binary regression analyses with healthcare utilization measures as dependent variables. After controlling for the above-mentioned covariates, those with diabetes had significantly greater ORs of multiple physician visits (≥6, OR=3.02, 95% CI = 2.54–3.58, $P < .001$) compared with those with neither diabetes nor depression, and those with both diabetes and depression had increased odds of multiple physician visits (≥6, OR=2.62, 95% CI=2.01–3.42, $P < .001$), multiple hospital admissions (≥2, OR=3.71, 95% CI=2.17–6.34, $P < .001$) and prolonged hospitalization (≥11 days, OR=2.33, 95% CI=1.32–4.13, P = .004) compared with those with neither diabetes nor depression. We also analyzed the association between healthcare utilization and depression in those with diabetes. After adjusting for potential confounding factors, there was a significant difference between depressed and non-depressed persons with diabetes in terms of multiple hospital admissions (≥2, OR =2.75, 95% CI = 1.40–5.40, P = .003). However, there were no significant differences between depressed and non-depressed persons with diabetes in terms of multiple physician visits (≥6, OR =1.01, 95% CI = 0.75–1.36, P = .960) and prolonged hospitalization (≥11 days, OR =1.82, 95% CI = 0.91–3.66, P = .091).

Table 3: Univariate and multivariate analyses for factors associated with depression in subjects with diabetes

Variables	Without Depression (n = 838) n (%)	With Depression (n = 375) n (%)	OR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Age (yr)				.000		.767
≤ 60	256(30.5)	72(19.2)	1.0		1.0	
>60	582(69.5)	303(80.8)	1.85(1.38-2.49)		1.06(0.73-1.54)	
Gender				.000		.714
Males	419(50.0)	134(35.7)	1.0		1.0	
Females	419(50.0)	241(64.3)	1.80(1.40-2.31)		1.08(0.73-1.59)	
Body mass index				.046		.041
≤ 24.9	570(69.3)	227(63.4)	1.0		1.0	
≥ 25.0	252(30.7)	131(36.6)	1.31(1.01-1.70)		1.39(1.01-1.90)	
Marital status				.000		.098
Married	634(75.7)	230(61.3)	1.0		1.0	
Divorced, separated, widowed, single	204(24.3)	145(38.7)	1.96(1.51-2.54)		1.34(0.95-1.91)	
Education				.000		.002
≤ Elementary school	433(51.7)	270(72.0)	2.40(1.84-3.12)		1.75(1.23-2.49)	
> Elementary school	404(48.3)	105(28.0)	1.0		1.0	
Monthly household income†				.000		.000
≤ 1Q (Lowest)	185(27.5)	140(48.4)	2.48(1.86-3.30)		1.94(1.42-2.66)**	
≥ 2Q	488(72.5)	149(51.6)	1.0		1.0	
Smoking				.618		.031
Yes	169(20.2)	71(18.9)	0.93(0.68-1.26)		1.60(1.04-2.46)	
No	669(79.8)	304(81.1)	1.0		1.0	
Drinking				.001		.184
Yes	287(34.2)	92(24.5)	1.0		1.0	
No	551(65.8)	283(75.5)	1.60(1.22-2.11)		1.29(0.88-1.89)	
Number of chronic disease				.000		.000
≤ 1	656(78.3)	210(56.0)	1.0		1.0	
≥ 2	182(21.7)	165(44.0)	2.83(1.69-3.24)		2.34(1.89-3.24)	

Table 4: Unadjusted and adjusted odds of diabetes and depression in binary regression analyses with healthcare utilization measures as dependent variables

Variables	Diabetes Alone† (*n* = 838)				Depression and Diabetes† (*n* = 375)			
	OR (95% CI)	*P*-value	AOR (95% CI)	*P*-value	OR (95% CI)	*P*-value	AOR (95% CI)	*P*-value
Multiple physician visits (≥ 6)	3.30(2.85-3.82)	.000	3.02(2.54-3.58)	.000	3.79(3.07-4.68)	.000	2.62(2.01-3.42)	.000
Multiple hospital admissions (≥ 2)	2.03(1.32-3.13)	.001	1.30(0.76-2.22)	.346	6.33(4.25-9.44)	.000	3.71(2.17-6.34)	.000
Prolonged length of hospital stay (≥ 11days)	1.29(0.88-1.89)	.194	1.82(0.75-1.83)	.483	2.79(1.76-4.42)	.000	2.33(1.32-4.13)	.004

* Models are adjusted for age, gender, body mass index, marital status, education, monthly household income, smoking, drinking, and number of chronic diseases with subjects without diabetes and depression as a reference group.

Discussion

The aim of this study was to examine the relationship between diabetes and depression and their related factors, and investigate the effects of comorbid diabetes and depression on healthcare utilization in Koreans aged ≥45 years. We found a significant, positive association between diabetes and depression. Individuals with diabetes experienced elevated symptoms of depression, and the prevalence of depression was higher in diabetics than non-diabetics. This effect persisted after adjustment for confounding factors, showing that Korean adults with diabetes were 1.3 times as likely to have depression as individuals without diabetes. This finding is in the line with previous research reporting an increased prevalence of depression among those with diabetes (13, 15-17, 34).

Low socioeconomic status is known to be associated with depression (31, 33). There is also an independent relationship between comorbid depression and low socioeconomic status in individuals with diabetes (15, 17). Our study confirmed this association in people with diabetes. Researchers (1, 32) have previously determined the relationship between depressive symptoms and obesity. Consistent with previous studies, we observed that obese people had greater odds of having depression among those with diabetes. Previous studies (30, 32) have indicated the relationship between depressive symptoms and smoking. We also found that smokers had greater odds of having depression among those with diabetes. Earlier studies have shown a positive association between depression and the number of chronic diseases in individuals with diabetes (4, 15, 17, 32). The present study also demonstrated that the number of chronic diseases is an independent risk factor for depression. Therefore, it is necessary to assess depression in diabetic patients who have low socioeconomic status, who are obese, who are smokers, and who have higher numbers of chronic diseases. Simple measures, such as the CES-D10 used in the present study, can be used to screen for depression.

People with depression have reported higher rates of alcohol drinking compared with those without depression (30, 35). In the current study, we found no differences between depressed and non-depressed patients with diabetes in terms of alcohol consumption. At the univariate level, people with both diabetes and depression showed a lower rate of alcohol drinking compared with people with diabetes but no depression. However, this association was no longer significant after controlling for covariates. The lower alcohol-drinking rate in people with both diabetes and depression might be partly attributed to the plurality of women (who show a lower alcohol-drinking rate than men) in that group.

Compared with individuals with neither diabetes nor depression, those with diabetes and depression had greater odds of multiple physician visits, multiple hospital admissions, and prolonged hospitalization. These results are consistent with findings showing that persons with chronic medical conditions, such as diabetes and depression, have higher healthcare utilization (4, 15). Previous research has also indicated that comorbid depression is associated with multiple hospital admissions and prolonged length of hospital stay in persons with diabetes (12, 13, 15, 17). Consistent with previous studies, we found that patients with both diabetes and depression were 2.8 times more likely to report multiple hospital admissions compared with non-depressed diabetic patients. We did not observe a significant difference between depressed and non-depressed patients with diabetes in terms of prolonged hospitalization. A possible interpretation of this might be attributed to the low statistical power to detect the relationship due to the low number of persons with diabetes and depression. More research is needed to clarify the underlying mechanisms of association between co-occurring depression with diabetes and increased healthcare utilization; further, it would also be useful to test various clinical practices intended to reduce the risk of comorbid depression in individuals with diabetes. This study contributes to the current literature by providing a better understanding of the associations between depression, diabetes, and healthcare utilization in an un-

derstudied population, namely community-dwelling Korean adults.

Several limitations should be taken into account. First, this study was based on a cross-sectional survey, which cannot generate inferences regarding causality; this makes it difficult to conclude that the increased healthcare use among depressed persons with diabetes can be attributed solely to depression/diabetes. Second, because the diabetes was measured by self-report, the prevalence of diabetes may be underestimated (15). Some people with unknown diabetes would likely have reported as not having diabetes. The use of a self-reported single-item global assessment rather than medical confirmation of diagnoses for diabetes may be incomplete and prone to errors with regard to recall. Third, our study did not obtain specific information on diabetes subtypes. Earlier studies have indicated that the prevalence rates of type 1 diabetes are substantially lower in Asian countries, including Korea, than in Caucasian countries (36, 37). Therefore, we believe that most participants with diabetes in this study had type 2 diabetes. Finally, even though diabetes complications were closely related to the level of healthcare utilization (17), the present study did not include data on diabetic complications experienced by the participants.

The strength of our study is its use of a large, nationally representative sample of the Korean non-institutionalized population. An additional strength is the fact that the KLoSA was a household survey conducted via face-to-face interview. Many researchers have indicated that the response rate of face-to-face interviews is higher than those of mail surveys and telephone interviews (38, 39).

Conclusion

After controlling socioeconomic and health variables, diabetes is associated with depression in this Korean adults aged ≥45 years. We also observed that depression is related with BMI, smoking, socioeconomic status and number of chronic diseases among diabetic patients. These findings indicate that diabetic patients who are obese, smoker, who have low socioeconomic status, and who have higher numbers of chronic diseases may derive an advantage from screening, because they seem to be at the highest risk for depression. Our study showed that diabetes and depression is associated with increased healthcare utilization. People those with diabetes and depression had significantly increased odds of multiple physician visits, multiple hospital admissions, and prolonged hospitalization compared with individuals with neither diabetes nor depression. Patients with both diabetes and depression had greater odds of multiple hospital admissions than patients with diabetes alone.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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