Original Article

J Prev Med Public Health 2015;48:287-300 • http://dx.doi.org/10.3961/jpmph.15.048

pISSN 1975-8375 eISSN 2233-4521

Journal of Preventive Medicine & Public Health

Determinants of Poor Self-rated Health in Korean Adults With Diabetes

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Objectives: Self-rated health is a measure of perceived health widely used in epidemiological studies. Our study investigated the determinants of poor self-rated health in middle-aged Korean adults with diabetes.

Methods: A cross-sectional study was conducted based on the Health Examinees Study. A total of 9759 adults aged 40 to 69 years who reported having physician-diagnosed diabetes were analyzed with regard to a range of health determinants, including sociodemographic, lifestyle, psychosocial, and physical variables, in association with self-rated health status using multivariate logistic regression models. A p-value <0.05 was considered to indicate statistical significance.

Results: We found that negative psychosocial conditions, including frequent stress events and severe distress according to the psychosocial well-being index, were most strongly associated with poor self-rated health (odds ratio [OR]$_{\text{Frequent stress events}}$, 5.40; 95% confidence interval [CI], 4.63 to 6.29; OR$_{\text{Severe distress}}$, 11.08; 95% CI, 8.77 to 14.00). Moreover, younger age and being underweight or obese were shown to be associated with poor self-rated health. Physical factors relating to participants' medical history of diabetes, such as a younger age at diagnosis, a longer duration of diabetes, insulin therapy, hemoglobin A_{1c} levels of 6.5% or more, and comorbidities, were other correlates of poor reported health.

Conclusions: Our findings suggest that, in addition to medical variables, unfavorable socioeconomic factors, and adverse lifestyle behaviors, younger age, being underweight or obese, and psychosocial stress could be distinc factors in predicting negative perceived health status in Korean adults with diabetes.

Key words: Epidemiology, Self-rated health, Diabetes mellitus, Cohort studies, Health Examinees, Korea

INTRODUCTION

Perceptions of health are currently considered to encompass both physical and psychological dimensions. Self-rated health (SRH) is a self-reported health measure that is valid and widely used in epidemiological studies to assess an individual's integrated perception of health, which may be inaccessible to an external observer [1-3]. Despite the subjective nature of this concept, it can aid in the global assessment of health in terms of biological, psychological, and social dimensions, which may be more sensitive than external measures of health

Received: July 31, 2015 Accepted: October 21, 2015

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for monitoring overall health [1]. In fact, SRH has been shown to predict a range of health outcomes, spanning from morbidity and mortality to future health care use [4,5].

According to a report by the Organization for Economic Cooperation and Development (OECD), Korea ranked 33rd out of 34 OECD member states in perceived health status of the population [6]. Less than half of the total population (36.8%) reported being in good health, far below the OECD average of 69.0%. A wide range of factors may have influenced those results, and it is imperative that greater emphasis be placed on public health and disease prevention in order to improve population health. Such efforts can begin with specific populations at the local level.

Diabetes has emerged as a new epidemic, with approximately 382 million people living with diabetes globally [7]. In recent years, the proportion of type 2 diabetes has increased, especially in Asia, making this region the epicenter of the diabetes epidemic [7]. Korea is not free from this global phenomenon, with 12.4% of adults 30 years and older diagnosed with diabetes. This trend continues, with a twofold growth of the diabetic population expected over the next 40 years [8].

So far, only a handful of studies has investigated the association between perceived health status and chronic diseases, such as diabetes, within the Korean population. Some studies have found independent associations between diseases such as hypertension and non-fatal musculoskeletal disorders and poor SRH [9,10]. Most studies regarding SRH, however, have been conducted in the general Korean population, rendering it unfeasible to identify factors representative of people with chronic conditions [11,12]. It is necessary to determine the factors associated with negative perceived health among specific subgroups. This study thus aimed to identify the factors associated with poor SRH in diabetic middle-aged Korean adults.

METHODS

This study was based on a large-scale genomic cohort study, the Health Examinees (HEXA) Study. Described elsewhere in detail, the HEXA Study was launched to investigate the risk factors for major chronic diseases, ranging from epidemiological characteristics and genomic features to gene-environment interactions [13].

Study Population

A total of 162 142 subjects aged 40 to 69 years participated in the HEXA Study between 2004 and 2012. In addition to respondents who answered 'yes' to a question about physician-diagnosed diabetes in the self-reported survey, only those who were 30 years or older at the time of diabetes diagnosis were included in order to limit the possibility of including cases of type 1 diabetes (n=10 112) [3,14]. Subjects were also excluded due to missing information about SRH (n=84) or a his-

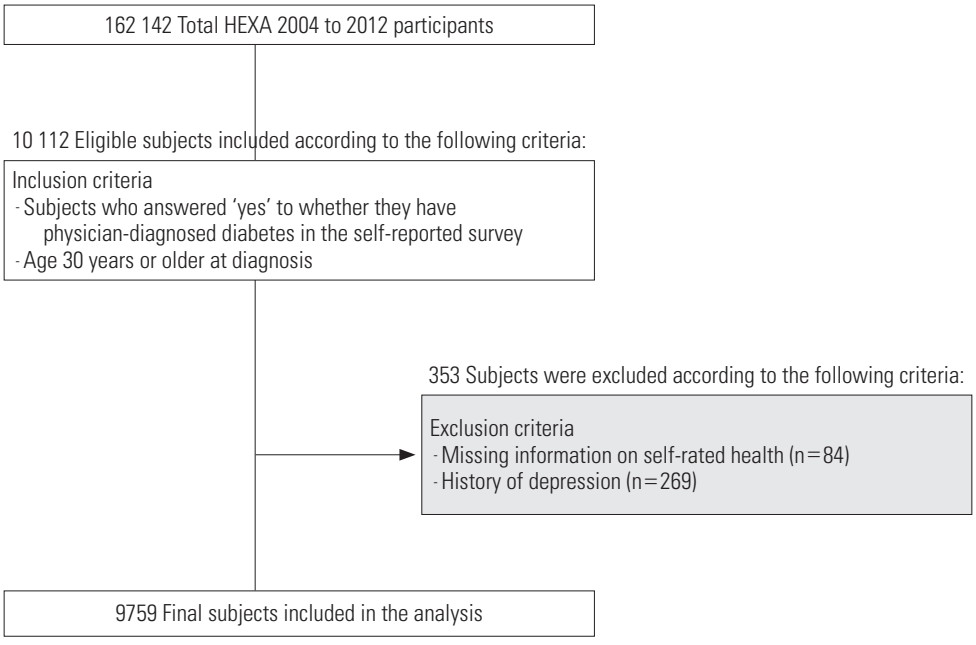

Figure 1. Flow diagram showing selection of study subjects. HEXA, Health Examinees.

tory of depression (n=269). Since a number of studies has argued that depression is closely correlated with poor SRH, we excluded respondents with depression in order to eliminate the potential influence on the evaluation of SRH by depressed individuals in relation to variables of interest [3,15]. A total of 9759 respondents comprised the final subjects of our analysis (Figure 1).

Self-rated Health

SRH was assessed with a single question: 'How do you evaluate your current health status?' Participants were asked to choose a response from a five-category Likert scale (very healthy, healthy, normal, unhealthy, or very unhealthy). Following common procedure, we grouped the answers into a dichotomous variable of 'good' (very healthy, healthy, and normal) and 'poor' (unhealthy and very unhealthy) [16].

Domains of Health Determinants

The factors presumed to be correlated with SRH were grouped into different domains: sociodemographic factors, lifestyle factors, psychosocial conditions, anthropometric indices, and physical conditions (Supplemental Table 1). The physical domain of health focused on diabetes history and status as well as comorbid conditions.

The sociodemographic factors included sex and age. Age was divided into intervals of 40 to 49 years, 50 to 59 years, and 60 to 69 years. Marital status was defined as married or not married. Educational attainment was classified as less than a high school diploma, a high school diploma to some college, or a bachelor's degree and higher. Occupation types were classified as non-manual labor, manual labor, and not in the work force. Income was categorized based on the monthly salary in units of 1000 Korean won (<2000, 2000 to 4000 or ≥4000), which is approximately equivalent to units of 1 US dollar.

Lifestyle factors included smoking, alcohol consumption, and physical activity. Smoking status and alcohol consumption were classified as never, past, or current. The physical activity variable was defined by classifying participants as either regular exercisers or non-exercisers, where regular exercisers referred to those who engaged in regular, sweat-inducing exercise.

The psychosocial variables included the frequency of mental and/or physical stress experienced during the past month (not at all, sometimes, or frequent). The psychosocial well-being index (PWI), a measure of mental health focusing on the psychosocial aspect of stress [17,18], was used to define three groups: positive well-being, moderate distress, and severe distress. Sleep duration was categorized as <6, 6 to 8, 8 to 10 or ≥10 h/d.

The anthropometric indices included body mass index (BMI) and waist circumference (WC). Respondents were classified into five BMI groups based on the weight range associated with a minimal risk of death in Asian populations: underweight (<22.5 kg/m^2), normal weight (22.6 to 25.0 kg/m^2), overweight (25.1 to 27.1 kg/m^2), pre-obese (27.6 to 30.0 kg/m^2), or obese (>30.0 kg/m^2) [19]. Central obesity was defined as a WC ≥90 cm in men and ≥80 cm in women, as suggested by global organizations such as the International Diabetes Federation [20,21].

In the physical domain, subjects' diabetes history and status were queried and the following variables were extracted: age of diagnosis, duration of the disease, current treatment status, treatment type, fasting blood sugar (FBS) level, and hemoglobin A1c (HbA1c) level. The age of diagnosis was presented as a mean (±standard deviation [SD]) value and was also divided into dichotomous groups of <50 vs. ≥50 years [8]. The duration of diabetes was classified as <5, 5 to 10, or ≥10 years. The current treatment status included no treatment necessary, currently under treatment, or treatment neglected or never treated. The treatment types were divided into lifestyle modification, oral medication, or insulin therapy. As an indicator of diabetes control, FBS was categorized into <126 mg/dL vs. ≥126 mg/dL. A subgroup analysis was conducted on subjects who provided information about their HbA1c levels (n=3689). As an indicator of long-term diabetes control status, HbA1c was categorized as <6.5% vs. ≥6.5%.

The HEXA Study surveyed information on participants' personal medical histories and medication usage. Based on self-reports, nine diseases and conditions were evaluated in our study: hypertension, hyperlipidemia, stroke, myocardial infarction, gastrointestinal diseases, liver diseases, diseases of the joints and bones, respiratory diseases, and cancer.

Statistical Analysis

Selected characteristics for the two SRH groups (good vs. poor) were compared using the Student's *t*-test for continuous variables and the chi-square test for categorical variables. All results were considered statistically significant at a *p*-value <0.05. Logistic regression analyses were performed to identify factors that were significantly associated with poor SRH. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. Three models were included in the overall analysis. Model 1 was adjusted for sex and age. Model 2 was adjusted for so-

Table 1. Basic characteristics of the study population[1] (n=9759)

	n	(%)
Sociodemographic factors		
Sex		
Male	4721	48.4
Female	5038	51.6
Age (y)		
40-49	1339	13.7
50-59	3892	39.9
60-69	4528	46.4
Marital status[2]		
Married	8523	87.3
Not married	1212	12.4
Educational attainment		
Bachelor's degree or higher	1768	18.1
High school diploma to college[3]	3414	35.0
Less than high school diploma	4467	45.8
Occupation type		
Non-manual labor	1496	15.3
Manual labor	3109	31.9
Not in work force[4]	4974	51.0
Income[5]		
≥4000	1500	15.4
2000-4000	3020	31.0
<2000	3766	38.6
Lifestyle factors		
Current smokers	1532	15.7
Current drinkers	4083	41.8
Regular exercisers	5774	59.2
Psychosocial conditions		
Stress events		
Not at all	5217	53.5
Often	3505	35.9
Frequent	936	9.6
PWI score (mean±SD, points)[6]	17	8.3
PWI status		
Positive well-being	1043	10.7
Moderate distress	7121	73.0
Severe distress	1274	13.1
Sleep duration (h/d)		
<6	1307	13.4
6-8	5603	57.4
8-10	2560	26.2
≥10	248	2.5
Anthropometry		
BMI (mean±SD, kg/m^2)	24.9	3.1
WC (mean±SD, cm)	85.6	8.4
Indicators of DM control		
FBS (mean±SD, mg/dL)	134.1	44.7
HbA1c (mean±SD, %)	7.3	1.4

SD, standard deviation; SRH, self-rated health; PWI, psychosocial well-being; BMI, body mass index; WC, waist circumference; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; DM, diabetes mellitus; SD, standard deviation.
[1]Unknown values are not shown, but were included in statistical models.
[2]Married includes married or living with a partner; not married includes single, divorced, separated, or widowed.
[3]College includes a vocational certificate, associate's degree, or some years of college-level education without completion of a degree.
[4]Not in work force refers to housewives, students, or the unemployed.
[5]Income refers to monthly salary in Korean won (unit: 1000 won).
[6]PWI scores: ≤8, positive well-being; 9-26, moderate distress; ≥27, severe distress.

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ciodemographic factors (sex, age, marital status, education level, employment status, and income level) and lifestyle factors (smoking status, alcohol consumption, and physical activity). Model 3 was adjusted for the covariates in model 2 as well as psychosocial conditions (stress events, PWI score, and sleep duration) and anthropometry (BMI and WC). All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA).

RESULTS

The basic characteristics of the study subjects are presented in Table 1. Our study included more women (51.6%) than men, and the older age group (60 to 69 years) comprised almost half of the diabetic population (46.4%). Most of the subjects were married (87.3%) and were not in the work force (51.0%). The plurality of respondents were current drinkers (41.8%), more than half (59.2%) were regular exercisers, and 15.7% were smokers. Most of the subjects reported experiencing moderate distress (73.0%), but more than half (53.5%) of the subjects did not report mental and/or physical stress during the past month. Approximately 57% of the respondents slept six to eight hours per day on average. The mean±SD values of BMI and WC were 24.9±3.1 kg/m^2 and 85.6±8.4 cm, respectively. The mean±SD FBS value was 134.1±44.7 mg/dL and the mean HbA1c level was 7.3±1.4%.

The ORs of poor SRH according to multiple domains of health determinants are presented in Table 2. Sociodemographic factors had a significant impact in the fully adjusted model, with the exception of income level. Poor SRH was significantly asso-

Table 2. ORs (95% CIs) of poor SRH according to selected correlates of the study population[1] (n=9759)

	SRH				Model 1[2]	Model 2[3]	Model 3[4]
	Good (n=6530)		Poor (n=3229)				
Sociodemographic factors							
Sex							
Male	3472	53.2	1249	38.7	1.00 (reference)	1.00 (reference)	1.00 (reference)
Female	3058	46.8	1980	61.3	1.80 (1.65, 1.96)*	1.41 (1.22, 1.63)*	1.26 (1.09, 1.46)*
Age (y)							
40-49	884	13.5	455	14.1	1.00 (reference)	1.00 (reference)	1.00 (reference)
50-59	2607	39.9	1285	39.8	0.94 (0.82, 1.07)	0.84 (0.73, 0.97)*	0.84 (0.73, 0.97)*
60-69	3039	46.5	1489	46.1	0.94 (0.83, 1.07)	0.74 (0.64, 0.85)*	0.73 (0.63, 0.85)*
p for trend					0.48	<0.01	0.01
Marital status[5]							
Married	5823	89.2	2700	83.6	1.00 (reference)	1.00 (reference)	1.00 (reference)
Not married	692	10.6	520	16.1	1.39 (1.23, 1.58)*	1.26 (1.11, 1.44)*	1.17 (1.02, 1.34)*
Educational attainment							
Bachelor's degree or higher	1376	21.1	392	12.1	1.00 (reference)	1.00 (reference)	1.00 (reference)
High school diploma to college[6]	2376	36.4	1038	32.2	1.39 (1.21, 1.60)*	1.31 (1.14, 1.51)*	1.29 (1.12, 1.50)*
Less than high school diploma	2703	41.4	1764	54.6	1.94 (1.69, 2.23)*	1.65 (1.43, 1.92)*	1.58 (1.36, 1.84)*
p for trend					<0.01	<0.01	<0.01
Occupation type							
Non-manual labor	1146	17.6	350	10.8	1.00 (reference)	1.00 (reference)	1.00 (reference)
Manual labor	2138	32.7	971	30.1	1.37 (1.18, 1.58)*	1.05 (0.89, 1.23)	1.02 (0.87, 1.21)
Not in work force[7]	3118	47.8	1856	57.5	1.55 (1.34, 1.80)*	1.34 (1.14, 1.58)*	1.36 (1.15, 1.61)*
Income[8]							
≥4000	1103	16.9	397	12.3	1.00 (reference)	1.00 (reference)	1.00 (reference)
2000-4000	2161	33.1	859	26.6	1.05 (0.91, 1.21)	0.91 (0.79, 1.05)	0.93 (0.80, 1.08)
<2000	2355	36.1	1411	43.7	1.55 (1.35, 1.78)*	1.14 (0.98, 1.33)	1.14 (0.98, 1.33)
p for trend					0.05	0.02	0.64
Lifestyle factors							
Smoking							
Never smokers	3919	60.0	2207	68.4	1.00 (reference)	1.00 (reference)	1.00 (reference)
Past smokers	1528	23.4	544	16.9	1.08 (0.93, 1.26)	1.09 (0.93, 1.27)	1.13 (0.97, 1.33)
Current smokers	1068	16.4	464	14.4	1.25 (1.07, 1.46)*	1.19 (1.01, 1.39)*	1.19 (1.01, 1.40)*
Alcohol drinking							
Never drinkers	3118	47.8	1876	58.1	1.00 (reference)	1.00 (reference)	1.00 (reference)
Past drinkers	420	6.4	247	7.7	1.35 (1.13, 1.62)*	1.27 (1.06, 1.53)*	1.18 (0.97, 1.43)*
Current drinkers	2984	45.7	1099	34.0	0.82 (0.73, 0.91)*	0.79 (0.70, 0.88)*	0.76 (0.68, 0.85)*
Physical activity							
Regular exercisers	4100	62.8	1674	51.8	1.00 (reference)	1.00 (reference)	1.00 (reference)
Non-exercisers	2425	37.1	1552	48.1	1.51 (1.39, 1.65)*	1.40 (1.28, 1.53)*	1.28 (1.17, 1.41)*
Psychosocial conditions							
Stress events							
Not at all	4029	61.7	1188	36.8	1.00 (reference)	1.00 (reference)	1.00 (reference)
Sometimes	2118	32.4	1387	43.0	2.12 (1.93, 2.33)*	2.07 (1.88, 2.27)*	2.07 (1.88, 2.28)*
Frequent	326	5.0	610	18.9	5.88 (5.05, 6.83)*	5.44 (4.67, 6.34)*	5.40 (4.63, 6.29)*
p for trend					<0.01	<0.01	<0.01

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Table 2. Continued from the previous page

	SRH				Model 1[2]	Model 2[3]	Model 3[4]
	Good (n=6530)		Poor (n=3229)				
PWI status[9]							
Positive well-being	922	14.1	121	3.8	1.00 (reference)	1.00 (reference)	1.00 (reference)
Moderate distress	5042	77.2	2079	64.4	2.98 (2.45, 3.63)*	2.91 (2.39, 3.55)*	2.58 (2.11, 3.15)*
Severe distress	357	5.5	917	28.4	17.92 (14.29, 22.48)*	15.95 (12.69, 20.04)*	11.08 (8.77, 14.00)*
p for trend					<0.01	<0.01	<0.01
Sleep duration (h/d)							
<6	802	12.3	505	15.6	1.37 (1.21, 1.56)*	1.31 (1.15, 1.48)*	1.17(1.03, 1.34)*
6-8	3886	59.5	1717	53.2	1.00 (reference)	1.00 (reference)	1.00 (reference)
8-10	1681	25.7	879	27.2	1.17 (1.06, 1.30)*	1.11 (1.00, 1.22)*	1.14 (1.03, 1.27)*
≥10	138	2.1	110	3.4	1.79 (1.38, 2.32)*	1.59 (1.22, 2.07)*	1.58 (1.20, 2.08)*
p for trend					0.18	0.34	0.26
Anthropometry							
Body mass index (kg/m^2)							
Underweight (≤22.5)	1355	20.8	730	22.6	1.16 (1.04, 1.31)*	1.16 (1.03, 1.30)*	1.13 (1.00, 1.28)*
Normal (22.6-25.0)	2267	34.7	1013	31.4	1.00 (reference)	1.00 (reference)	1.00 (reference)
Overweight (25.1-27.5)	1813	27.8	899	27.8	1.13 (1.01, 1.26)*	1.10 (0.99, 1.23)*	1.09 (0.97, 1.22)*
Pre-obese (27.5-30.0)	757	11.6	359	11.1	1.05 (0.90, 1.21)	1.01 (0.87, 1.18)	0.98 (0.84, 1.15)
Obese (>30.0)	326	5	219	6.8	1.38 (1.14, 1.67)*	1.29 (1.06, 1.56)*	1.22 (1.00, 1.49)*
WC							
No central obesity	3090	47.3	1367	42.3	1.00 (reference)	1.00 (reference)	1.00 (reference)
Central obesity[10]	3309	50.7	1774	54.9	1.07 (0.98, 1.17)	1.00 (0.91,1.09)	1.02 (0.91, 1.15)

Values are presented as number (%) or OR (95% CI).
SRH, self-rated health; PWI, psychosocial well-being; BMI, body mass index; WC, waist circumference; OR, odds ratio; CI, confidence interval.
[1]Unknown values are not shown, but were included in statistical models.
[2]Model 1, adjusted for sex and age.
[3]Model 2, adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level) and lifestyle factors (smoking status, alcohol consumption, and physical activity).
[4]Model 3, fully adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level), lifestyle factors (smoking status, alcohol consumption, and physical activity), psychosocial conditions (stress events, PWI score, and sleep duration), and anthropometry (BMI and WC).
[5]Married includes married or living with a partner; not married includes single, divorced, separated, or widowed.
[6]College includes a vocational certificate, associate's degree, or some years of college-level education without completion of a degree.
[7]Not in work force refers to housewives, students, or the unemployed.
[8]Income refers to monthly salary in Korean won (unit: 1000 won).
[9]PWI scores: ≤8, positive well-being; 9-26, moderate distress; ≥27, severe distress.
[10]Central obesity refers to a waist circumference of ≥90 cm in men and ≥80 cm in women.
*$p<0.05$.

ciated with female gender (OR, 1.26; 95% CI, 1.09 to 1.46), not being married or living with a partner (OR, 1.17; 95% CI, 1.02 to 1.34), and unemployment (OR, 1.36; 95% CI, 1.15 to 1.61). The most prominent association was observed with educational attainment, as the likelihood of reporting poor SRH increased with a lower level of education (*p* for trend <0.01). The lifestyle factors of smoking and lack of regular physical activity were also significantly associated with increased odds of poor SRH. Age and alcohol, however, were inversely associated with poor SRH, with the odds of poor SRH gradually decreasing in older age groups (*p* for trend=0.01). Psychosocial conditions such as frequent stress events and severe distress, based on PWI scores, showed the strongest associations with poor SRH, with frequent stress events accounting for a 5.40-fold increase in the odds of poor SRH (95% CI, 4.63 to 6.29) and severe distress being associated with an 11.08-fold increase in the odds of poor SRH (95% CI, 8.77 to 14.00), even after full adjustment for covariates. While stress events and PWI status were associated with higher odds of poor SRH (*p* for trend <0.01), sleep duration showed a J-shaped association with poor SRH. BMI presented a U-shaped association, in which subjects at both ends of the BMI spectrum (underweight and obese) were marginally

Table 3. ORs (95% CIs) for poor SRH according to diabetes history, diabetes status, and comorbidity status[1] (n=9759)

	SRH				Model 1[2]	Model 2[3]	Model 3[4]
	Good (n=6530)		Poor (n=3229)				
Diabetes history and status							
DM diagnosis age (y)							
≥50	4123	63.1	1875	58.1	1.00 (reference)	1.00 (reference)	1.00 (reference)
<50	2407	36.9	1354	41.9	1.38 (1.24, 1.54)*	1.42 (1.27, 1.58)*	1.46 (1.30, 1.63)*
DM duration (y)							
<5	2593	39.7	1083	33.5	1.00 (reference)	1.00 (reference)	1.00 (reference)
5-10	1632	25.0	821	25.4	1.21 (1.08, 1.35)*	1.23 (1.10, 1.38)*	1.27 (1.14, 1.44)*
≥10	1564	24.0	950	29.4	1.52 (1.36, 1.70)*	1.55 (1.39, 1.74)*	1.62 (1.44, 1.82)*
Unknown	741	11.4	375	11.6			
Current treatment status							
No treatment necessary	174	2.7	48	1.5	1.00 (reference)	1.00 (reference)	1.00 (reference)
Currently under treatment	5523	84.6	2827	87.6	1.91 (1.38, 2.64)*	2.03 (1.46, 2.82)*	2.03 (1.44, 2.85)*
Treatment neglected/never treated	833	12.8	354	11.0	1.61 (1.14, 2.28)*	1.66 (1.17, 2.35)*	1.58 (1.10, 2.27)*
Treatment type[5]							
Lifestyle modification only[6]	157	2.8	57	2.0	1.00 (reference)	1.00 (reference)	1.00 (reference)
Oral meds±lifestyle	4009	72.6	1798	63.6	1.22 (0.89, 1.66)	1.17 (0.85, 1.60)	1.26 (0.91, 1.76)
Insulin±oral meds±lifestyle	234	4.2	228	8.1	2.65 (1.86, 3.79)*	2.43 (1.69, 3.50)*	2.62 (1.79, 3.82)*
Unknown	1123	20.3	744	26.3			
Fasting blood sugar (mg/dL)							
<126	3353	51.4	1628	50.4	1.00 (reference)	1.00 (reference)	1.00 (reference)
≥126	3025	46.3	1539	47.7	1.07 (0.98, 1.17)	1.08 (0.99, 1.18)	1.08 (0.99, 1.18)
Unknown	152	2.3	62	1.9			
Comorbidity status							
Comorbid diseases[7]							
Hypertension	2560	39.2	1508	46.7	1.37 (1.26, 1.50)*	1.41 (1.29, 1.54)*	1.46 (1.33, 1.61)*
Hyperlipidemia	786	12.0	561	17.4	1.45 (1.29, 1.64)*	1.57 (1.39, 1.78)*	1.57 (1.38, 1.78)*
Stroke	77	1.2	90	2.8	2.76 (2.02, 3.77)*	2.57 (1.87, 3.52)*	2.57 (1.85, 3.57)*
Myocardial infarction	247	3.8	220	6.8	2.10 (1.73, 2.54)*	2.10 (1.73, 2.55)*	2.03 (1.65, 2.48)*
Gastrointestinal diseases	94	1.4	115	3.6	2.50 (1.89, 3.31)*	2.48 (1.87, 3.29)*	2.25 (1.68, 3.02)*
Liver diseases	147	1.5	124	1.3	1.87 (1.46, 2.39)*	1.87 (1.46, 2.40)*	1.78 (1.37, 2.31)*
Diseases of the joints and bones	279	4.3	330	10.2	2.18 (1.84, 2.59)*	2.11 (1.77, 2.50)*	1.98 (1.66, 2.37)*
Respiratory diseases	40	0.6	38	1.2	2.22 (1.41, 3.48)*	1.89 (1.19, 2.98)*	1.69 (1.06, 2.71)*
Cancer	61	0.9	58	1.8	1.93 (1.34, 2.78)*	1.83 (1.26, 2.65)*	1.85 (1.26, 2.71)*
No. of diseases							
None (DM only)	3263	50.0	1208	37.4	1.00 (reference)	1.00 (reference)	1.00 (reference)
DM+one condition	2416	37.0	1225	37.9	1.39 (1.26, 1.53)*	1.42 (1.29, 1.57)*	1.48 (1.33, 1.64)*
DM+two or more conditions	851	13.0	796	24.7	2.54 (2.25, 2.86)*	2.65 (2.34, 3.00)*	2.69 (2.36, 3.07)*
p for trend					<0.01	<0.01	<0.01

Values are presented as number (%) or OR (95% CI).
SRH, self-rated health; DM, diabetes mellitus; OR, odds ratio; CI, confidence interval.
[1]Unless the values comprised a significant percentage of the total, unknown values are not shown, but were included in the statistical models.
[2]Model 1, adjusted for sex and age.
[3]Model 2, adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level) and lifestyle factors (smoking status, alcohol consumption, and physical activity).
[4]Model 3, fully adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level), lifestyle factors (smoking status, alcohol consumption, and physical activity), psychosocial conditions (stress events, PWI score, and sleep duration), and anthropometry (body mass index and waist circumference).
[5]Treatment type refers to those categorized as 'currently under treatment'.
[6]Lifestyle modification only refers to diet and/or exercise regimens.
[7]Gastrointestinal diseases include ulcer diseases and chronic gastritis; liver diseases include acute, chronic, and fatty liver disease; diseases of the joints and bones include arthritis and osteoporosis; respiratory diseases include asthma and pulmonary tuberculosis.
*$p<0.05$.

Table 4. ORs (95% CIs) for poor SRH according to HbA1c as an indicator of long-term DM control (n=3689)

	SRH				Model 1[1]	Model 2[2]	Model 3[3]
	Good (n=2576)		Poor (n=1113)				
Indicator of long-term DM control							
HbA1c (mean±SD)	7.2	1.3	7.4	1.5	1.13 (1.08, 1.19)*	1.11 (1.05, 1.17)*	1.11 (1.06, 1.17)*
HbA1c (%)							
<6.5	812	31.5	294	26.4	1.00 (reference)	1.00 (reference)	1.00 (reference)
≥6.5	1764	68.5	819	73.6	1.24 (1.06, 1.45)*	1.21 (1.04, 1.43)*	1.21 (1.02, 1.43)*

Values are presented as number (%) or odds ratio (95% CI).
SRH, self-rated health; DM, diabetes mellitus; HbA1c, hemoglobin A1c; OR, odds ratio; CI, confidence interval; SD, standard deviation.
[1]Model 1, adjusted for sex and age.
[2]Model 2, adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level) and lifestyle factors (smoking status, alcohol consumption, and physical activity).
[3]Model 3, fully adjusted for sociodemographic factors (sex, age, marital status, education level, employment status, and income level), lifestyle factors (smoking status, alcohol consumption, and physical activity), psychosocial conditions (stress events, PWI score, and sleep duration), and anthropometry (body mass index and waist circumference).
*$p<0.05$.

more likely to report poor SRH ($OR_{Underweight}$, 1.13; 95% CI, 1.00 to 1.28, OR_{Obese}, 1.22; 95% CI, 1.00 to 1.49).

The details of the associations between poor SRH and physical health variables dealing with participants' medical history of diabetes and comorbidities are shown in Table 3. FBS did not show a significant association with poor SRH, but a younger age at the time of diagnosis, a diabetes duration of 5 to 10 years and ≥10 years, current treatment, and receiving insulin therapy were all variables found to be significantly associated with increased odds of poor SRH. In fact, a 1.46-fold increased likelihood of poor SRH was found in subjects who were diagnosed at a younger age (95% CI, 1.30 to 1.63), and ORs of 1.27 (95% CI, 1.14 to 1.44) and 1.62 (95% CI, 1.44 to 1.82) were found in respondents with diabetes durations of 5 to 10 years and ≥10 years, respectively. Compared to subjects for whom treatment was unnecessary, respondents currently undergoing treatment (OR, 2.03; 95% CI, 1.44 to 2.85) and having never received treatment or having neglected their treatment (OR, 1.58; 95% CI, 1.10 to 2.27) had higher odds of poor SRH. Respondents who received insulin therapy in addition to oral medication and/or lifestyle modification had a higher likelihood of poor SRH (OR, 2.62; 95% CI, 1.79 to 3.82) compared to those who engaged in lifestyle modification only.

A significant association was found between each comorbid condition and poor SRH (Table 3). Diseases associated with a higher likelihood of poor health were stroke (OR, 2.57; 95% CI, 1.85 to 3.57), gastrointestinal diseases (OR, 2.25; 95% CI, 1.68 to 3.02), and myocardial infarction (OR, 2.03; 95% CI, 1.65 to 2.48). Additionally, the odds of poor SRH increased as the number of comorbid conditions increased (p for trend <0.01).

A subgroup analysis was conducted on 3689 subjects who provided information about their HbA1c levels (Table 4). Compared to the reference group with an HbA1c level <6.5%, those with higher HbA1c levels had increased odds of poor SRH (OR, 1.21; 95% CI, 1.02 to 1.43).

DISCUSSION

The present study was conducted to explore various domains of health determinants possibly associated with poor SRH among diabetic adults in Korea. After adjusting for sociodemographic, lifestyle, psychosocial factors, and anthropometric indices, the associations between poor SRH and a number of characteristics remained statistically significant. Specifically, the psychosocial domain of health, including stress events and PWI scores, were observed to have greater impact on SRH than other types of health determinants. Factors such as low sociodemographic status, adverse lifestyle behaviors, and disease history were also significantly associated with poor SRH.

In our study of the Korean diabetic population, variables representative of psychosocial distress were found to be strongly associated with an increased likelihood of poor SRH. These results are consistent with prior studies of diabetic populations in other nations demonstrating SRH to be strongly related to emotional well-being [15,22]. The strong association between poor SRH and psychological measures may be due to reasons specific to the diabetic population, since emotional distress occurs as a result of the severity of diabetes and the resulting burden of self-care [23]. When dealing with the demands of the disease, many people with diabetes may become emotionally

overwhelmed, frustrated, and discouraged—an emotional reaction now understood as diabetes-related distress [24]. In a study by Jones et al. [25] of people with diabetes, approximately half of the study subjects (50.1%) reported that living with diabetes took up too much mental and physical energy every day. In a study conducted by de Groot et al. [26], reduced well-being and mental health problems were found to be more prevalent among people with type 2 diabetes than in the general population.

Certain sociodemographic factors, such as younger age, female gender, and low educational attainment, were also associated with poor SRH, echoing the findings of prior studies on diabetic populations [23,27-29]. The positive association between poor SRH and younger age deserves particular attention because the opposite association is observed in the general population [12]. This phenomenon may be explained in several ways. First, the notion of social comparison explains that older people are more likely to normalize physical discomfort by attributing it to aging rather than poor health [30]. Second, experiences and perceptions of diabetes differ by age, and the physical and psychological burdens appear to be generally greater in middle-aged subjects, even though older diabetic patients tend to have poorer control of the disease [31]. Our subgroup analyses (data not shown) showed that the oldest age group (60 to 69 years) had the greatest number of comorbidities. The middle-aged group (40 to 49 years) had the least overall prevalence of disease, but the highest odds of poor SRH.

Another finding in our diabetic population was that past drinkers had higher odds of poor SRH. Badawi et al. [3] proposed that never or past drinkers who are diabetic abstain from alcohol due to health reasons. In fact, we found in a separate analysis (data not shown) that never or past drinkers were more likely than current drinkers to have been undergoing current treatment, receiving insulin therapy, to have had diabetes for more than 10 years, and to have had more than one comorbid condition ($p<0.01$). They also had significantly higher mean HbA1c levels, which reflect the severity of diabetes.

The physical domain of health was strongly associated with SRH. Of a range of variables addressing participants' medical history and diabetes status, all except FBS were significantly associated with SRH. Our findings are supported by those of a prior study of diabetic patients, in which disease severity, including insulin use (OR, 2.0; 95% CI, 1.7 to 2.3) and a duration of diabetes of ≥20 years (OR, 1.3; 95% CI, 1.1 to 1.6), was associated with an increased likelihood of fair or poor health [29]. Likewise, another study reported that one in five people with diabetes responded that taking diabetes medication interfered with their ability to live a normal life, resulting in a greater distress or a negative evaluation of their emotional well-being [25]. Moreover, Delahanty et al. [23] showed that compared to those who received diet or oral medication therapy, patients who underwent insulin therapy scored the highest in the assessment of diabetes-related emotional distress (Problem Areas in Diabetes scale (points±SD): 14.6±1.7 [diet] vs. 18.6±1.3 [oral medication] vs. 23.6±1.7 [insulin]).

Comorbid conditions were also found to be positively associated with poor SRH to varying extents. Moreover, this association strengthened as the number of comorbidities increased. An association between comorbidities and the odds of poor SRH has also been found in another diabetic population (OR, 4.3; 95% CI, not shown) [28].

Since a limited number of studies have been published evaluating SRH in diabetic populations, we could not contextualize some of our results, including the role of sleep duration and marital status as health determinants of poor SRH specific to people with diabetes. We found that our results regarding sleep duration were not significantly different from studies based on the general population in Korea [12] and Australia [32], which found positive associations between poor SRH and short and long sleep durations. Not being married is also a significant correlate of poor SRH that may not be specific to the diabetic population [33,34]. However, Zheng and Thomas [35] pointed out the possibility of married people misestimating their health status in the positive direction; caution is thus warranted when interpreting SRH according to marital status. Further studies are needed to clarify the association between marital status and poor SRH. The adverse lifestyle behaviors of smoking and being physically inactive were also significantly associated with poor SRH, which is consistent both with studies on diabetic populations and with studies of the general population [2,3,28,29].

Marginally significant associations were found between poor SRH and both underweight and obese status. Studies of non-Asian populations have failed to find an association between poor SRH and low BMI; in those studies, fair or poor health was only found to be related to obesity [3,28,29]. A possible explanation for this discrepancy is that insulin resistance in Asian populations occurs at a BMI level considered to be within the normal range for Western populations (23.0 to 24.0 kg/m^2) [36].

Japanese researchers showed that underweight (BMI <18.5 kg/m^2) was associated with a 1.32-fold increased risk of diabetes in older males (95% CI, 1.12 to 1.56) and a 1.31-fold increase in older females (95% CI, 1.07 to 1.60) [37]. Moreover, weight loss is a symptom of diabetes [38]. The question of whether low BMI is associated with poor SRH as a symptom reflecting disease severity remains unresolved.

All of our variables—dependent and independent—were obtained from self-reported data, which may have compromised the validity due to recall bias. It is also important to keep in mind that the direction of causality could not be determined due to the cross-sectional nature of the present study.

Despite these limitations, our study has the strength of including a large sample of diabetic subjects. Using the HEXA questionnaire, we were able to conduct a comprehensive analysis of SRH by assessing a broad range of factors, from sociodemographic variables to physical health. Moreover, as this is one of the few studies of SRH and diabetes in the Korean population, the findings of this study add to our understanding of the association between low SRH and diabetes in a developed, non-Western society. Lastly, we limited our subjects to type 2 diabetic patients in order to identify the factors associated with negative perceptions of health among people with a specific health condition.

SRH is a widely used tool that is a strong predictor for mortality and morbidity, even in relation to diabetes [27,39]. In the present study, we identified factors with a significant relationship to poor SRH among the adult diabetic population in Korea. Although caution is warranted in interpreting the results, we found that multiple domains of health determinants were associated with poor SRH, most notably the psychosocial domain. Further studies are needed to investigate the underlying mechanisms connecting the psychosocial conditions, known variables, and unmeasured residual variables with SRH.

Negative perceived health status itself elicits adverse health outcomes in conditions such as diabetes. In our study, several domains of health determinants, ranging from sociodemographic to psychosocial and physical, were associated with poor SRH. Our findings suggest that younger age, underweight or obesity, and adverse psychosocial conditions could be factors that distinctively predict negative perceived health status in Korean adults with diabetes. As these factors may contribute both directly and indirectly to the exacerbation of diabetes via SRH, further studies are needed to explore the underlying mechanism. Meanwhile, strategies such as focusing attention on specific groups (middle-aged and/or underweight and obese adults) or routinely screening for stress may be suggested to improve the SRH—and eventually the overall prognosis—of people with diabetes.

ACKNOWLEDGEMENTS

This study was supported by the National Genome Research Institute, Korea Centers for Disease Control and Prevention. The authors would like to thank all participants and members of the HEXA Study Group.

CONFLICT OF INTEREST

The authors have no conflicts of interest associated with the material presented in this paper.

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Supplemental Table 1. List and description of variables[1]

Domain	Variable	Category	Variable description
Sociodemographic factors	Sex	Male vs. female	-
	Age (y)	40-49 vs. 50-59 vs. 60-69	-
	Marital status	Married	Includes living with a partner
		Not married	Includes single, separated, divorced, or widowed
	Educational attainment	Less than high school diploma	-
		High school diploma to college	Includes those who completed a high school education and/or received a vocational certificate, associate's degree, or attended some years of college-level education without completion of a degree
		Bachelor's degree or higher	-
	Occupation type	Based on the Korean Standard Classification of Occupations, originally derived from the International Standard Classification of Occupations	
		Non-manual labor	Includes high ranking officer and executives, professionals, engineers, or office workers
		Manual labor	Includes service workers, salespersons, people in agriculture, forest and fishing industry, skilled operators, mechanics, or labor workers
		Not in work force	Includes housewives, students, or the unemployed
	Income (unit: 1000 won)	<2000 vs. 2000-4000 vs. ≥4000	Based on the monthly salary in Korean won
Lifestyle factors	Smoking status	Never	Refers to those who have smoked less than 20 packs of cigarettes
		Past	Refers to those who smoked a minimum of 20 packs of cigarettes (or 400 cigarettes) in their lifetime, but no longer smoke
		Current	Refers to those who smoked a minimum of 20 packs of cigarettes (or 400 cigarettes) in their lifetime, and continue to smoke
	Alcohol consumption	Never vs. past vs. current	Based on the questions "Are you unable to consume alcohol or refuse to do so (for religious reasons, etc.)? and "Do you still drink?"
	Physical activity	Regular vs. non-exercisers	"Regular" exercisers refer to those who answered "yes" to the question "Do you engage in regular exercise that induces sweating?"
Psychosocial conditions	Stress events	Not at all vs. sometimes vs. frequent	Based on the experience of mental and/or physical stress during the past month
	PWI (point)	Modified from the General Health Questionnaire score for Koreans, composed of 18 items with a score range of 0-54 points	
		Positive well-being	≤8
		Moderate distress	9-26
		Severe distress	≥27
	Sleep duration (h/d)	<6 vs. 6-8 vs. 8-10 vs. ≥10	Average number of hours per day spent sleeping (including naps) during the past year

(Continued to the next page)

Supplemental Table 1. Continued from the previous page

Domain	Variable	Category	Variable description
Anthropometry	BMI (kg/m^2)	BMI as Quetelet's index using measured height and weight	
		Underweight	≤22.5
		Normal weight	22.6-25.0
		Overweight	25.1-27.5
		Pre-obese	27.6-30.0
		Obese	≥30.0
	WC (cm)	Based on the cut-off values for high-risk internal fat store according to sex and ethnicity	
		No central obesity	-
		Central obesity	"Central obesity" defined as ≥90 cm in males and ≥80 cm in females
Physical condition: DM history and status	DM diagnosis age (y)	<50 vs. ≥50	-
	DM duration (y)	<5 vs. 5-10 vs. ≥10	-
	Current treatment status	No treatment necessary	-
		Currently under treatment	-
		Treatment neglected/never treated	-
	Treatment type	Refers to subjects categorized as "Currently under treatment" in Current treatment status	
		Lifestyle modification only	Includes diet and/or exercise regimens
		Oral medication	Oral medication alone or in addition to lifestyle modification
		Insulin therapy	Insulin therapy alone or in addition to oral medication and/or lifestyle modification
	FBS (mg/dL)	<126 vs. ≥126	-
	HbAlc (%)	<6.5 vs. ≥6.5	-
Physical condition: Comorbidity status	Comorbid diseases	Nine diseases and conditions:	According to self-reports on physician-diagnosed state and current treatment status
		Hypertension	-
		Hyperlipidemia	-
		Stroke	-
		Myocardial infarction	-
		Gastrointestinal diseases	Include ulcer diseases and chronic gastritis
		Liver diseases	Include acute, chronic, and fatty liver disease
		Diseases of the joints and bones	Include osteoporosis and arthritis
		Respiratory diseases	Include asthma and pulmonary tuberculosis
		Cancer	Any cancer

All variables and their data were acquired through Health Examinees questionnaires, 2004-2012.
PWI, psychosocial well-being; BMI, body mass index; WC, waist circumference; FBS, fasting blood sugar; HbA1c, hemoglobin A1c; DM, diabetes mellitus.