BMJ Open

Variations in health-related quality of life (EQ-5D) associated with cardiovascular health: a cross-sectional study of adults with diabetes in the Korean general population

Hyejin Jung

To cite: Jung H. Variations in health-related quality of life (EQ-5D) associated with cardiovascular health: a cross-sectional study of adults with diabetes in the Korean general population. *BMJ Open* 2024;**14**:e081789. doi:10.1136/bmjopen-2023-081789

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (https://doi.org/10.1136/bmjopen-2023-081789).

Received 08 November 2023
Accepted 10 May 2024

Department of Meridian & Acupoint, College of Korean Medicine, Kyung Hee University, Seoul, Republic of Korea

Correspondence to
Dr Hyejin Jung;
junghyejin@khu.ac.kr

ABSTRACT

Objectives Previous studies on the differences in the mechanism and complications of diabetes between men and women have indicated potential sex differences in cardiovascular health, which affect health-related quality of life (HRQoL).

Design A cross-sectional cohort study.

Setting To determine how sex differences can be noticed, acknowledged and applied in clinical practice, we aimed to determine the cardiovascular (CV) health status of men and women with diabetes and its effects on HRQoL.

Participants In total, 2829 individuals with diabetes (1518 men and 1311 women) aged ≥40 years who participated in the Korean National Health and Nutrition Examination Survey from 2013 to 2018 were enrolled.

Outcome measures Individuals with diabetes were categorised into poor, intermediate and ideal groups based on CV health indicators recommended by the American Heart Association. We used EQ-5D-3L to compare HRQoL scores between the sexes. Multivariable ordinal logistic regression and analysis of covariance were used to analyse the outcome variables.

Results In the poor CV health score group, female sex was associated with mobility problems (OR 1.93, 95% CI 1.46 to 2.54), problems with usual activities (OR1.71, 95% CI 1.24 to 2.35), pain/discomfort (OR 1.69, 95% CI 1.32 to 2.16) and anxiety/depression (OR 1.66 95% CI 1.16 to 2.38). In the intermediate and ideal CV health score groups, female sex was associated with pain/discomfort (OR 1.57, 95% CI 1.15 to 2.15). Men had higher EQ-5D index scores in the poor and intermediate CV health score groups than did women.

Conclusions Although women tended to have high health-related CV health scores, HRQoL was lower in women than in men, especially in the poor CV health score group and in the pain/discomfort domain.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This study was based on reliable data from a nationally representative sample of the Korean population.
⇒ Owing to the limitations of this cross-sectional study, the cause of the significant health-related quality of life differences between men and women was unclear.
⇒ Patients with diabetes were targeted at people older than 40 years; the younger patients were excluded from this analysis.
⇒ Unadjusted socioeconomic factors, comorbidities and differences in the severity levels of diabetes might have influenced the results.

INTRODUCTION

Globally, the number of adults with diabetes increased from 108 million in 1980 to 422 million in 2014 due to population growth and ageing.[1] In Korea, the prevalence of diabetes is increasing as more people develop diabetes earlier and live longer than in previous decades.[2] In a national sample of Koreans aged ≥30 years, the prevalence of diabetes steadily increased from 10.0% to 12.7% from 2007 to 2017.[3] People with diabetes have a much higher risk of cardiovascular (CV) diseases than do those without diabetes. Additionally, CV diseases are the leading cause of comorbidity and mortality in people with diabetes.[4] In 2017, approximately 5 million people aged 20–99 years died from diabetes, accounting for 9.9% of all-cause mortality worldwide.[5] The rapid increase in the prevalence of type 2 diabetes mellitus and its complications has led to the accumulation of evidence on the sex differences in many aspects of biology, physiopathology and clinical problems in specific ways.[6–9] Differences in complications by sex have also been found in type 1 diabetes.[10] Based on this evidence, there is a growing demand for policy management to ensure that individuals with diabetes do not progress to developing additional medical complications or comorbidities. Previous research has indicated that sex differences in CV health among patients with diabetes stem from both

biological factors and sociocultural influences.[11–14] With the ageing of the population, the significance of health-related quality of life (HRQoL) has gained prominence as the duration of living with chronic diseases extends.[15] Although prior studies have investigated sex differences in HRQoL among patients with diabetes,[16 17] and studies have also been conducted on the relationship between CV health and HRQoL,[18] there is insufficient evidence on how sex differences lead to differences in cardiovascular health and HRQoL. Understanding these connections can facilitate the development of targeted health policies that consider sex-specific needs in managing patients with diabetes.

Therefore, in this study, CV health status was investigated using CV health indicators in men and women, along with other variables related to diabetes, and covariate analysis was performed to establish how HRQoL differs according to health status and sex.

MATERIALS AND METHODS

Study population

The target population for the study were Korean adult citizens, older than 40 years of age, from the Korean National Health and Nutrition Examination Survey (KNHANES), which is a cross-sectional survey of a nationally representative sample of the Korean civilian population between 2013 and 2018. The survey combined health and dietary interviews with standardised physical examination and laboratory tests.[19] The KNHANES is a nationally representative, cross-sectional survey of the South Korean population that uses a clustered, multistage, stratified and rolling sampling design to represent non-institutionalised civilian Koreans. The number of participants in the survey from 2013 to 2018 was 39 642, among whom 22 763 participants were older than 40 years. Patients with diabetes were defined as those with fasting blood glucose levels ≥126 mg/dL, those taking antidiabetic drugs such as insulin injections or those who were diagnosed by a doctor. Accordingly, there were 3266 patients with diabetes. Excluding criteria were pregnant or lactating women and individuals with missing information on seven CV health indicators and the EQ-5D. A total of 2829 patients were finally included in this study.

Data collection

Demographic and clinical characteristics

Variables, such as age, sex, marital status, education level, residential area, economic activity (currently working or unemployed), current use of hypoglycaemic drugs or insulin injections, fasting plasma glucose levels (mg/dL), current drinking habits and undiagnosed diabetes (fasting blood glucose levels ≥126 mg/dL without a diagnosis of diabetes and prescribed medications), were used to characterise the population with diabetes.

Blood pressure measurements and blood and urine sampling were performed as part of a medical examination. According to standardised protocols, all medical examination procedures were performed by trained medical personnel, and all equipment was calibrated periodically.[19] The total cholesterol and fasting plasma glucose levels were determined after 8 hours of fasting.

CV health status

CV health status was quantified using seven American Heart Association-defined indicators: smoking status, body mass index (BMI), physical activity, diet, total cholesterol, blood pressure and fasting plasma glucose.[20] The American Heart Association's proposal for a healthy lifestyle, also known as CV health metrics, has been used as a measure of CV health in many previous studies.[20–22] These indicators were used in accordance with the purpose of our study because they encompass both behavioural and biological factors that affect the predisposition to CV disease.[23] Each category was scored using 0, 1 and 2 points; patients with total scores of 0–7, 8–10 and 11–14 points were categorised into the poor, intermediate and ideal CV health score groups, respectively.[24] The scores for each category were based on the American Heart Association guidelines.

BMI was scored as 2 (<23 kg/m^2), 1 (23–24.9 kg/m^2) and 0 (≥25 kg/m^2) points based on the typical biological characteristics of Koreans.[25]

Physical activity was divided into low (no activity or some activity, not enough to meet the criteria for 'medium' or 'high'), medium (≥3 days/week of vigorous activity for at least 20 min per day; ≥5 days/week of moderate-intensity activity and/or walking of at least 30 min per day; or ≥5 days/week of a combination of walking, moderate-intensity activity, or vigorous-intensity activity achieving a minimum of at least 600 metabolic equivalents (METs)-min/week) and high (vigorous-intensity activity on at least 3 days/week achieving at least 1500 METs-min/week or ≥7 days/week of a combination of walking, moderate-intensity activity, or vigorous activity achieving least 3000 METs-min/week) based on the International Physical Activity Questionnaire-Short Form.[26]

Considering the dietary habits of Koreans, dietary scores were divided into non-adherent (>2400 mg sodium intake and being in the lower quartiles of the Korean Healthy Dietary Index (KHEI) score (Q1–Q3)), slightly adherent (sodium intake ≤2400 mg or being in the highest quartile of the KHEI score (Q4)) and highly adherent (sodium intake ≤2400 mg and being in the highest quartile of the KHEI score (Q4)).[27] The KHEI consists of eight components that evaluate the appropriate intake of recommended foods, such as fruits, vegetables and dairy products; components that evaluate the intake of foods that limit intake of saturated fatty acids, sodium and sugar; as well as the three balancing factors assessing the net energy intake.[28 29] In particular, 5–10 points are assigned to each item; thus, the total KHEI score is 100 points per individual. The distribution of each element is shown below (table 1).

Table 1 Cardiovascular health indicators recommended by the American Heart Association

	All		Men		Women		
	n	Prevalence (%, 95% CI)	n	Prevalence (%, 95% CI)	n	Prevalence (%, 95% CI)	P value
Smoking							<0.0001***
Current (0)	529	22.50 (20.58 to 24.42)	478	35.34 (32.43 to 38.25)	51	3.70 (2.32 to 5.08)	
Quit smoking <12 months (1)	59	2.35 (1.67 to 3.04)	54	3.72 (2.59 to 4.85)	5	0.36 (0.02 to 0.70)	
Never or quit smoking ≥12 months (2)	2241	75.15 (73.17 to 77.12)	986	60.94 (57.99 to 63.89)	1255	95.94 (94.54 to 97.34)	
Physical activity							<0.0001***
None (0)	746	24.09 (22.23 to 25.96)	341	20.62 (18.17 to 23.06)	405	29.19 (26.33 to 32.04)	
Intermediate (1)	1940	70.10 (68.07 to 72.13)	1081	72.45 (69.69 to 75.22)	859	66.66 (63.64 to 69.67)	
Ideal (2)	143	5.80 (4.72 to 6.89)	96	6.93 (5.37 to 8.49)	47	4.16 (2.71 to 5.60)	
Body mass index (kg/m^2)							0.0956
≥25 (0)	1355	48.44 (46.31 to 50.56)	690	46.74 (43.72 to 49.77)	665	50.91 (47.85 to 53.98)	
23–24.9 (1)	679	23.53 (21.67 to 25.38)	390	25.02 (22.37 to 27.67)	289	21.34 (18.82 to 23.85)	
<23 (2)	795	28.04 (26.05 to 30.03)	438	28.24 (25.46 to 31.02)	357	27.75 (24.97 to 30.54)	
Healthy diet score							<0.0001***
Non-adherence (0)	1205	46.31 (44.06 to 48.55)	810	56.32 (53.47 to 59.18)	395	31.64 (28.65 to 34.62)	
Slightly adherent (1)	1371	45.44 (43.23 to 47.64)	619	38.67 (35.78 to 41.56)	752	55.35 (52.23 to 58.47)	
Highly adherent (2)	253	8.26 (7.10 to 9.41)	89	5.01 (3.82 to 6.19)	164	13.01 (10.86 to 15.17)	
Total cholesterol (mg/dL)							0.2909
≥240 (0)	211	8.60 (7.27 to 9.93)	108	9.21 (7.31 to 11.12)	103	7.70 (6.02 to 9.38)	
200–239 (1)	542	20.24 (18.42 to 22.05)	281	19.33 (16.91 to 21.75)	261	21.57 (18.86 to 24.27)	
<200 (2)	2076	71.16 (69.05 to 73.28)	1129	71.46 (68.58 to 74.34)	947	70.73 (67.66 to 73.81)	
Blood pressure (mm Hg)							0.8897
≥140/≥90 (0)	665	24.12 (22.16 to 26.07)	343	24.49 (21.84–27.15)	322	23.57 (20.86 to 26.27)	
120–139/80–89 (1)	1254	43.08 (40.85 to 45.32)	665	42.86 (39.94–45.79)	589	43.41 (40.08 to 46.73)	
<120–80 (2)	910	32.80 (30.65 to 34.95)	510	32.64 (29.80–35.48)	400	33.03 (29.85 to 36.21)	
Fasting blood glucose							0.0059*
≥126 (0)	1890	69.54 (67.61 to 71.47)	1041	72.00 (69.46–74.53)	849	65.95 (62.87 to 69.02)	
100–125 (1)	702	23.38 (21.63 to 25.14)	359	21.19 (18.94–23.44)	343	26.59 (23.73 to 29.46)	
<100 (2)	237	7.08 (6.01 to 8.14)	118	6.82 (5.40–8.24)	119	7.46 (5.95 to 8.97)	

*P<0.05; ***p<0.001.

Health-related quality of life

To evaluate HRQoL, the EQ-5D-3L conducted annually by KNHANES was used. The EQ-5D is a standardised measure of HRQoL developed by the EuroQol group and is a simple, general questionnaire used in population health status surveys.[30] The EQ-5D-3L has been verified for reliability in measuring quality of life in previous studies.[31–33] In the dimensions of mobility, self-care, usual activities, pain/discomfort and anxiety/depression, respondents were required to indicate whether they experienced 'no problem', 'some problems' or 'extreme problems'. In this study, 'some problems' and 'extreme problems' were referred to as 'problems'. EQ-5D-3L responses were converted into an index form using a Korean value set based on data obtained from a national valuation study.[34] The validity and reliability of the Korean EQ-5D have been established in various diseases through previous studies.[32 35 36]

Statistical analysis

For the characterisation of persons with diabetes, values are weighted mean±SE or weighted percentage (SE) unless otherwise indicated. The characteristics between sexes were compared using Student's t-test or the Rao-Scott X^2 test. Multivariable ordinal logistic regression was used to analyse the outcome variables, CV health metrics and each EQ-5D dimension. Analysis of covariance was used to analyse EQ-5D index scores. The predictor was sex, and the covariates were age, education level and marital status. EQ-5D index scores were calculated as least square means. All analyses and tests were conducted considering the sampling design of the survey.[29] All statistical analyses were performed using the SAS PROC SURVEY procedure (SAS V.9.4; SAS Institute) for applying stratification, primary sampling units and population weights. All analyses and tests were conducted considering the sampling design of the survey. A two-tailed p value of <0.05 indicated statistical significance.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Characteristics of the study population

Of the 2829 participants, 53.6% (n=1518) were men and 46.3% (n=1311) were women. Women were significantly older than men (60.02 years; p<0.0001), averaging 63.54 years. The proportion of married individuals who received ≤12 years of education and who took hypoglycaemic drugs or insulin injections was significantly higher among women than among men (p<0.0001). The proportion of women living in urban areas was also significantly higher than that of men (p=0.0485). Economic activity, drinking rates and undiagnosed diabetes rates were significantly higher in men than in women (p<0.0001). The fasting plasma glucose level was significantly higher in men (145.74 mg/dL) than in women (140.79 mg/dL; p=0.0061; table 2).

CV health metrics in the individuals with diabetes

Age, female sex and education level >12 years were linked to CV health metrics indicating improved smoking status. Similarly, age and female sex correlated with diminished physical activity status. Education level exceeding 12 years was linked to improved physical education status. Furthermore, age was linked to improved BMI, whereas female sex correlated with diminished BMI. Moreover,

Table 2 Characteristics of patients with diabetes

	Men (n=1518)	Women (n=1311)	P value
Age (years)	60.02±0.33	63.54±0.39	<0.001****
Marital status, married (%)	1468 (95.5)	1295 (98.8)	<0.001†***
Education level			<0.001†***
≤12	1173 (73.1%)	1200 (90.2%)	
>12	342 (26.9%)	106 (9.8%)	
Residential area, urban (%)	1132 (79.3)	1004 (82.6)	0.048†*
Economic activity, yes (%)	912 (66.7)	457 (37.5)	<0.001†***
Taking hypoglycaemic drugs or insulin injections, yes (%)	1019 (62.1)	977 (72.6)	<0.001†***
Fasting plasma glucose (mg/dL)	145.74±1.18	140.79±1.31	0.006**
Current drinking, yes (%)	478 (35.3)	51 (3.7)	<0.001†
Undiagnosed DM, yes (%)	405 (31.3)	269 (22.1)	<0.001†***

*P<0.05; ***p<0.001.
†P value by Student's t-test or Rao-Scott X^2 test as appropriate.
Values are weighted mean±SE or observed N (weighted percentage) unless otherwise indicated.
*t-test.
†Rao-Scott X^2.
DM, diabetes mellitus.

Table 3 Prevalence ORs (PORs) of cardiovascular health metrics among individuals with diabetes

	Smoking	Physical activity	Body mass index (kg/m^2)	Healthy diet score	Total cholesterol (mg/dL)	Blood pressure (mm Hg)	Fasting plasma glucose (mg/dL)	Total
	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value	Common POR (95% CI), p value
Age (years)	1.05 (1.04 to 1.06), p<0.001***	0.98 (0.97 to 0.99), p<0.001***	1.02 (1.01 to 1.03) p<0.001***	1.04 (1.03 to 1.05), p<0.001***	1.04 (1.03 to 1.05), p<0.001***	1.00 (0.99 to 1.00), p=0.477	1.04 (1.03 to 1.05), p<0.001***	1.04 (1.03 to 1.05), p<0.001***
Women	15.01 (10.11 to 22.29), p<0.001***	0.70 (0.58 to 0.85), p<0.001***	0.83 (0.70 to 0.99), p=0.036*	2.85 (2.39 to 3.38), p<0.001***	0.87 (0.71 to 1.08) p=0.200	1.05 (0.88 to 1.24), p=0.608	1.19 (0.98 to 1.44), p=0.081	1.75 (1.46 to 2.10), p<0.001***
Education level >12 years	1.63 (1.19 to 2.22), p=0.002*	1.39 (1.05 to 1.82), p=0.020*	1.01 (0.80 to 1.28), p=0.941	1.88 (1.47 to 2.39), p<0.001***	0.94 (0.71 to 1.23) p=0.636	1.03 (0.81 to 1.30), p=0.827	1.24 (0.94 to 1.62), p=0.122	1.53 (1.19 to 1.97), p<0.001***
Marital status, married	1.76 (0.93 to 3.31), p=0.081	0.88 (0.41 to 1.91), p=0.750	1.00 (0.56 to 1.78), p=0.991	0.86 (0.47 to 1.56), p=0.614	1.32 (0.70 to 2.49) p=0.398	1.32 (0.79 to 2.20), p=0.293	1.28 (0.68 to 2.41), p=0.437	0.96 (0.53 to 1.75), p=0.898

*P<0.05; ***p<0.001.
Common POR and p values were calculated using multivariable ordinal logistic regression.
Ordinal shift across the range of cardiovascular health metrics scores toward a better outcome.
Outcome: cardiovascular health metrics; predictor: sex; covariates: age, education level and marital status.

age, female and education level >12 were associated with improved dietary habits. Additionally, age correlated with better scores in total cholesterol and fasting plasma glucose levels. Lastly, age, female sex and education level >12 years were associated with better overall health outcomes (table 3).

EQ-5D dimension in the individuals with diabetes

In the poor CV health score group, female sex was associated with higher prevalence of mobility problems, problems with usual activities, pain/discomfort and anxiety/depression. In the intermediate and ideal CV health score groups, female sex was associated with problems of pain/discomfort (table 4). The frequency distribution of each EQ-5D dimension (no problems, some problems, extreme problems) is given in online supplemental table 1. Prevalence ORs of having problems in each EQ-5D dimension among patients with diabetes and the general population can be found in online supplemental table 2.

Table 4 Prevalence ORs of having problems in each EQ-5D dimension among individuals with diabetes (comparison between men and women)

	Mobility		Self-care		Usual activities		Pain/discomfort		Anxiety/depression	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Poor CV health score group (0–7)										
Men	1 (ref)		1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Women	1.93 (1.46 to 2.54)	<0.001***	1.23 (0.85 to 1.77)	0.276	1.71 (1.24 to 2.35)	<0.001***	1.69 (1.32 to 2.16)	<0.001***	1.66 (1.16 to 2.38)	0.006*
Intermediate CV health score group (8–10)										
Men	1 (ref)		1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Women	1.03 (0.74 to 1.44)	0.861	0.93 (0.56 to 1.55)	0.792	1.03 (0.69 to 1.54)	0.893	1.57 (1.15 to 2.15)	0.004*	1.24 (0.85 to 1.81)	0.270
Ideal CV health score group (11–14)										
Men	1 (ref)		1 (ref)		1 (ref)		1 (ref)		1 (ref)	
Women	1.36 (0.49 to 3.80)	0.552	0.97 (0.29 to 3.27)	0.961	2.26 (0.73 to 7.05)	0.159	2.59 (0.98 to 6.83)	0.054	0.79 (0.26 to 2.37)	0.674

*P<0.05; ***p<0.001.
Adjusted for age, education level and marital status.
P value by multivariable binary logistic regression.
Ordinal shift across the range of each EQ-5D dimension toward a worse outcome.
Outcome: each EQ-5D dimension; predictor: sex; covariates: age, education level and marital status.
CV, cardiovascular.

Table 5 EQ-5D index scores among individuals with diabetes (comparison between men and women)

		Men	Women	P value
Poor CV health score (0–7 points)	LS-mean (95% CI)	0.92 (0.92 to 0.93)	0.88 (0.87 to 0.89)	<0.0001***
Intermediate CV health score (8–10 points)	LS-mean (95% CI)	0.94 (0.93 to 0.95)	0.91 (0.90 to 0.92)	0.0046*
Ideal CV health score (≥11 points)	LS-mean (95% CI)	0.95 (0.92 to 0.98)	0.92 (0.89 to 0.95)	0.1070

P values were calculated using analysis of covariance after adjustment for age, education level and marital status.
*P<0.05; ***p<0.001.
CV, cardiovascular; LS, least square.

The EQ-5D index scores of men and women were compared according to the CV health score. In the poor CV health score group, men were found to be more likely to have a poor EQ-5D index than that of women. Even in the intermediate CV health score group, men were more likely than women to have a poor EQ-5D index (table 5).

DISCUSSION

This study examined how HRQoL differs according to sex and CV health in individuals with diabetes using national sampling cross-sectional data. Based on the 2013–2018 KNHANES data, in individuals with diabetes, there were clear differences between the lifestyle habits of men and women, such as smoking, physical activity and dietary intake; however, there were no significant differences concerning biological indicators of CV health, such as total cholesterol, blood pressure and fasting plasma glucose.

Physical activity levels were significantly higher in men than in women, but diabetes management through lifestyle habits, such as drinking, smoking, diet and drug intake, was better in women than in men. However, when examining the HRQoL after scoring and dividing the CV health scale after adjustment for age, education level and marital status, HRQoL was found to be lower in women than in men. The proportion of men and women in the poor CV health score group was significantly skewed toward men. Pain/discomfort problems were more common in women in every group. EQ-5D index scores were significantly lower in women in the poor and intermediate CV health score groups.

A previous study revealed that the HRQoL of women is lower than that of men at baseline and 12-month follow-up in patients with myocardial infarction; these results were similar to those of our study.[37] Another study on patients with hypertension revealed that in a group with poor CV health, women had lower HRQoL than men.[38] This may serve as evidence to suggest that women may have lower HRQoL than men when their CV health is poor.

With the assistance of previous studies, we have attempted to explain the reason for these results. First, the risk of CV diseases is higher in men without diabetes than in women without diabetes; however, diabetes carries a greater burden of CV complications in women than in men.[39] Women with diabetes have a greater risk of incidental coronary heart disease and stroke than men with diabetes do.[40 41] Second, diabetes is often diagnosed late in women, which likely correlates with the low rate of adherence to treatment goals. The incidence of adverse drug effects and increased resistance to the action of drugs used for the prevention or treatment of CV diseases are higher in women than in men.[40] The proportion of women using diabetic drugs or insulin injections was higher than that of men in this study. However, this finding is most likely attributable to the diagnosis of diabetes at a significantly later or rapidly worsening stage or poor diabetes control after medication in women rather than compliance with treatment. Diabetes has negative psychological effects and increases the risk of depressive disorders due to diabetes-related complications, disease burden and side effects of treatment. This finding may be more prevalent among women.[41] Furthermore, the presence of mental disorders can affect glycaemic control, diabetes treatment and complications.[6]

Strengths and limitations

This study has some limitations. There may be limitations arising from categorising CV health into scores. Unadjusted socioeconomic factors, comorbidities and differences in the severity levels of diabetes might have influenced the results. Diabetes control measurement at the HbA1c level is required in future studies. Since KNHANES did not collect EQ-Visual Analogue Scale data which represent the respondent's value of their own health, HRQoL was evaluated by EQ-5D that is using non-patient, social preference weights. Owing to the limitations of this cross-sectional study, analysing the cause of the significant HRQoL differences between men and women was difficult. In the future, it will be necessary to investigate the causes through studies with larger sample sizes and well-controlled variables. This study is meaningful as it identified sex differences in the relationship between CV health status and HRQoL of patients with diabetes in Korea.

Implications of the study

This study may provide new insight into the mechanisms of sex differences in diabetes and CV health. Additionally, this study may help inform diabetes care policies to ensure that women are not disproportionately affected.

In conclusion, the management of diabetes through lifestyle adjustments, such as changes in smoking and dietary habits, showed better outcomes in women than it did in men. However, HRQoL was markedly lower in women, especially among those with lower CV health scores, than in men.

Acknowledgements I would like to thank Ji Sung Lee for helping analyse the data used in this study.

Contributors HJ conceived the study and wrote the paper.HJ is responsible for the overall content as guarantor.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval KNHANES is annually reviewed and approved by the Research Ethics Review Committee of the Centers for Disease Control and Prevention of Korea. The anonymity of the secondary data precluded the collection of informed consent; therefore, the need for obtaining informed consent was waived. This study was conducted following the 1964 Declaration of Helsinki principles and its subsequent revisions.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplemental information. All relevant materials are provided in the manuscript. Data access for the KNHANES is available from http://knhanes.cdc.go.kr.

ORCID iD

Hyejin Jung http://orcid.org/0000-0001-6996-325X

REFERENCES

1 Zhou B, Lu Y, Hajifathalian K. NCD risk factor collaboration (NCD-RISC). worldwide trends in diabetes since 1980: a pooled analysis of 751 population-based studies with 4.4 million participants. *Lancet* 2016;387:1513–30.
2 Ha KH, Kim DJ. Trends in the diabetes epidemic in Korea. *Endocrinol Metab (Seoul)* 2015;30:142–6.
3 Shin JY. Trends in the prevalence and management of diabetes in Korea: 2007-2017. *Epidemiol Health* 2019;41:e2019029.
4 Dal Canto E, Ceriello A, Rydén L, *et al*. Diabetes as a cardiovascular risk factor: an overview of global trends of macro and Micro vascular complications. *Eur J Prev Cardiol* 2019;26:25–32.
5 Cho NH, Shaw JE, Karuranga S, *et al*. IDF diabetes Atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract* 2018;138:271–81.
6 Kautzky-Willer A, Harreiter J, Pacini G. Sex and gender differences in risk, pathophysiology and complications of type 2 diabetes mellitus. *Endocr Rev* 2016;37:278–316.
7 Bhargava A, Arnold AP, Bangasser DA, *et al*. Considering sex as a biological variable in basic and clinical studies: an endocrine society scientific statement. *Endocr Rev* 2021;42:219–58.
8 Tramunt B, Smati S, Grandgeorge N, *et al*. Sex differences in metabolic regulation and diabetes susceptibility. *Diabetologia* 2020;63:453–61.
9 Mauvais-Jarvis F. Gender differences in glucose homeostasis and diabetes. *Physiol Behav* 2018;187:20–3.
10 Dei Cas A, Aldigeri R, Mantovani A, *et al*. Sex differences in cardiovascular disease and cardiovascular risk estimation in patients with type 1 diabetes. *J Clin Endocrinol Metab* 2023;108:e789–98.
11 Huebschmann AG, Huxley RR, Kohrt WM, *et al*. Sex differences in the burden of type 2 diabetes and cardiovascular risk across the life course. *Diabetologia* 2019;62:1761–72.
12 Harreiter J, Fadl H, Kautzky-Willer A, *et al*. Do women with diabetes need more intensive action for cardiovascular reduction than men with diabetes *Curr Diab Rep* 2020;20:61.
13 Baroni I, Caruso R, Dellafiore F, *et al*. Self-care and type 2 diabetes mellitus (T2Dm): a literature review in sex-related differences. *Acta Biomed* 2022;93:e2022277.
14 Connelly PJ, Azizi Z, Alipour P, *et al*. The importance of gender to understand sex differences in cardiovascular disease. *Can J Cardiol* 2021;37:699–710.
15 Krawczyk-Suszek M, Kleinrok A. Health-related quality of life (Hrqol) of people over 65 years of age. *Int J Environ Res Public Health* 2022;19:625.
16 Naughton MJ, Yi-Frazier JP, Morgan TM, *et al*. Longitudinal associations between sex, diabetes self-care, and health-related quality of life among youth with type 1 or type 2 diabetes mellitus. *J Pediatr* 2014;164:1376–83.
17 Schunk M, Reitmeir P, Schipf S, *et al*. Health-related quality of life in women and men with type 2 diabetes: a comparison across treatment groups. *J Diabetes Complications* 2015;29:203–11.
18 Odom EC, Fang J, Zack M, *et al*. Associations between cardiovascular health and health-related quality of life, behavioral risk factor surveillance system, 2013. *Prev Chronic Dis* 2016;13:E99.
19 Kweon S, Kim Y, Jang M, *et al*. Data resource profile: the Korea national health and nutrition examination survey (KNHANES). *Int J Epidemiol* 2014;43:69–77.
20 Fan H, Xu C, Li W, *et al*. Ideal cardiovascular health Metrics are associated with reduced severity of hepatic steatosis and liver fibrosis detected by transient Elastography. *Nutrients* 2022;14:5344.
21 Lee H-J, Suh B, Yoo T-G, *et al*. Trends in cardiovascular health Metrics among Korean adults. *Korean J Fam Med* 2013;34:403–12.
22 Han L, You D, Ma W, *et al*. National trends in American heart Association revised life's simple 7 Metrics associated with risk of mortality among US adults. *JAMA Netw Open* 2019;2:e1913131.
23 Lloyd-Jones DM, Hong Y, Labarthe D, *et al*. Defining and setting national goals for cardiovascular health promotion and disease reduction: the American heart Association's strategic impact goal through 2020 and beyond. *Circulation* 2010;121:586–613.
24 Allen NB, Badon S, Greenlund KJ, *et al*. The association between cardiovascular health and health-related quality of life and health status measures among U.S. adults: a cross-sectional study of the national health and nutrition examination surveys, 2001–2010. *Health Qual Life Outcomes* 2015;13:152.
25 Consultation WE. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet* 2004;363:157–63.
26 IPAQ. Guidelines for data processing and analysis of the international physical activity questionnaire, 2005. Available: https://www.researchgate.net/file.PostFileLoader.html?id=5641f4c36143250eac8b45b7&assetKey=AS%3A294237418606593%401447163075131
27 Shim JS, Jung SJ, Kim HC. Self-reported diet management, dietary quality, and blood pressure control in Korean adults with hypertension. *Clin Hypertens* 2019;25:24.
28 Yun S, Park S, Yook S-M, *et al*. Development of the Korean healthy eating index for adults, based on the Korea national health and nutrition examination survey. *Nutr Res Pract* 2022;16:233–47.
29 Yook S-M, Park S, Moon H-K, *et al*. Development of Korean healthy eating index for adults using the Korea national health and nutrition examination survey data. *J Nutr Health* 2015;48:419.
30 EuroQol Research Foundation. Euroqol. n.d. Available: https://euroqol.org
31 Zare F, Ameri H, Madadizadeh F, *et al*. Validity and reliability of the EQ-5D-3L (a generic preference-based instrument used for calculating quality-adjusted life -Years) for patients with type 2 diabetes in Iran. *Diabetes Metab Syndr* 2021;15:319–24.
32 Kim SH, Jo MW, Lee JW, *et al*. Validity and reliability of EQ-5D-3L for breast cancer patients in Korea. *Health Qual Life Outcomes* 2015;13:203.
33 Fang H, Farooq U, Wang D, *et al*. Reliability and validity of the EQ-5D-3L for Kashin-Beck disease in China. *Springerplus* 2016;5:1924.
34 Lee Y-K, Nam H-S, Chuang L-H, *et al*. South Korean time trade-off values for EQ-5D health States: modeling with observed values for 101 health States. *Value Health* 2009;12:1187–93.
35 Kim SH, Hwang JS, Kim TW, *et al*. Validity and reliability of the EQ-5D for cancer patients in Korea. *Support Care Cancer* 2012;20:3155–60.

36 Kim M-H, Cho Y-S, Uhm W-S, *et al*. Cross-cultural adaptation and validation of the Korean version of the EQ-5D in patients with rheumatic diseases. *Qual Life Res* 2005;14:1401–6.
37 Dondo TB, Munyombwe T, Hall M, *et al*. Sex differences in health-related quality of life Trajectories following myocardial infarction: national longitudinal cohort study. *BMJ Open* 2022;12:e062508.
38 Jung H. Sex differences in cardiovascular risk factors and quality of life among individuals with hypertension in Korea from 2013 to 2018: A cross-sectional cohort study. *PLoS One* 2024;19:e0296326.
39 Seghieri G, Policardo L, Anichini R, *et al*. The effect of sex and gender on diabetic complications. *Curr Diabetes Rev* 2017;13:148–60.
40 Campesi I, Franconi F, Seghieri G, *et al*. Sex-gender-related therapeutic approaches for cardiovascular complications associated with diabetes. *Pharmacol Res* 2017;119:195–207.
41 Abbate R, Mannucci E, Cioni G, *et al*. Diabetes and sex: from pathophysiology to personalized medicine. *Intern Emerg Med* 2012;7:S215–9.