Correlates of Quality of Life in Older Adults With Diabetes

The Diabetes & Aging Study

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OBJECTIVE—To evaluate associations between health-related quality of life (HRQL) and geriatric syndromes, diabetes complications, and hypoglycemia in older adults with diabetes.

RESEARCH DESIGN AND METHODS—A race-stratified random sample of 6,317 adults with type 2 or type 1 diabetes, aged 60 to 75 years, enrolled in Kaiser Permanente Northern California, who completed a survey that included a HRQL instrument based on the Short Form 8-item health survey. Administrative records were used to ascertain diagnoses of geriatric syndromes, diabetes complications, and hypoglycemia. Associations were estimated between HRQL and exposures in exposure-specific and combined exposure models (any syndrome, any complication, or hypoglycemia). Conservatively, differences of ≥3 points were considered the minimally important difference in HRQL scores.

RESULTS—HRQL was lower with nearly all exposures of interest. The lowest physical HRQL was associated with amputation. In combined exposure models, geriatric syndromes (−5.3 [95% CI −5.8 to −4.8], $P < 0.001$) and diabetes complications (−3.5 [−4.0 to −2.9], $P < 0.001$) were associated with lower physical HRQL. The lowest mental HRQL was associated with depression, underweight (BMI <18 kg/m^2), amputation, and hypoglycemia. In combined exposure models, only hypoglycemia was associated with lower mental HRQL (−4.0 [−7.0 to −1.1], $P = 0.008$).

CONCLUSIONS—Geriatric syndromes and hypoglycemia are associated with lower HRQL to a comparable degree as diabetes complications. Addressing geriatric syndromes and avoiding hypoglycemia should be given as high a priority as preventing diabetes complications in older adults with diabetes.

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Diabetes care guidelines traditionally have focused on blood pressure, cholesterol, and glycemic control to reduce diabetes complications. These guidelines are based on studies performed in middle-aged adults, and the applicability of these studies to the care of older adults with diabetes is unclear (1). The care of older adults is more complicated than younger adults because they are at an elevated risk for geriatric syndromes (i.e., depression and falls), pharmacotherapy-related hypoglycemia, and diabetes complications (2). Care planning is complicated even further by this population's limited life expectancy and high rates of comorbidity and functional disability (1).

Geriatric and general diabetes care guidelines recognize the importance of maximizing health-related quality of life (HRQL) for older adults with diabetes (1,2). However, little research exists on the correlates of HRQL in older adults with diabetes. Nearly all studies have compared HRQL in older adults with diabetes with HRQL in those without diabetes (3–5). Specifically, only one study of older adults has evaluated associations between HRQL and diabetes complications (6).

In this study, we compared the associations between HRQL and geriatric syndromes, diabetes complications, and hypoglycemia in older adults with diabetes.

RESEARCH DESIGN AND METHODS

Study design, setting, and population

Since 1993, Kaiser Permanente Northern California has maintained a registry of all its patients with diabetes defined by laboratory results, pharmacy use, and outpatient diagnoses. In 2005, a race-stratified random sample of registry members, aged 30 to 75 years, was invited to participate in the Diabetes Study of Northern California (DISTANCE) survey ($N = 40,735$). The response rate was 62% ($n = 20,188$) based on a standard algorithm from the Council of American Survey Research Organization (7). Details about the survey and its methods have been published previously (8).

The DISTANCE survey was administered in four different versions, three of which included a HRQL instrument. Respondents were excluded from this study if they completed a survey version that did not have a HRQL instrument ($n = 6,421$) or if they were aged <60 years ($n = 7,125$). There were 6,642 respondents who received a survey that included a HRQL instrument and were aged 60 to 75 years, and 6,317 (95%) completed the HRQL instrument. Respondents who completed the HRQL instrument were significantly younger, more physically active, and less depressed, and reported a higher income compared with respondents who did not complete the instrument.

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Outcome of interest

HRQL was assessed using an instrument based on the Short Form 8-item (SF-8) health survey, which includes one question for each domain of the Medical Outcomes Short Form-36 (SF-36) health survey (physical functioning, role limitations due to physical health, bodily pain, general health perceptions, vitality, social functioning, role limitations due to emotional problems, and mental health). Validated methods were used to transform responses to each question to the SF-36 equivalent scores, and overall physical and mental HRQL scores were calculated (9,10). HRQL scores can range from 0 (worst) to 100 (best) and have a mean of 50 (SD, 10) points. Studies on the meaningful difference in HRQL scores have suggested that differences between 0.3 to 0.5 SDs could be considered a minimally important difference in HRQL (11). Previous studies using the SF-36 have recommended not using less than a 1-point difference when interpreting results (12). We chose a cutoff of 3 points a priori to be conservative in describing conditions that were associated with meaningful differences in HRQL.

Exposures of interest

Administrative records were used to ascertain the presence versus absence of geriatric syndromes, diabetes complications, and hypoglycemia for the 1-year period before each subject's survey date. Multiple sources of administrative records were used, including diagnostic codes from outpatient and inpatient records and the Kaiser End-Stage Renal Disease (ESRD) database used for reporting to the Health Care Financing Administration. We included diagnostic codes for each condition according to the clinical location in which the exposure typically occurred (outpatient, inpatient, or outpatient/inpatient). Details about the diagnostic codes and clinical locations are available in the Supplementary Table A1.

The geriatric syndromes were determined by a review of the geriatrics literature (13–15) and geriatric diabetes guidelines (2) and included chronic pain, depression, urinary incontinence, being underweight, and falls. The diabetes complications included amputation, blindness, congestive heart failure (CHF), ESRD, foot ulcer, myocardial infarction (MI), peripheral neuropathy, and stroke. Outpatient diagnoses were used to identify depression, incontinence, blindness, and peripheral neuropathy. Chronic pain was defined by outpatient diagnoses of arthritis, back/neck/musculoskeletal pain, headache, fibromyalgia, or reflex sympathetic dystrophy (16,17). Inpatient diagnoses were used to identify CHF, MI, and stroke. Outpatient and inpatient diagnoses were used to identify fall history, foot ulcer, and hypoglycemia. Amputation was identified by outpatient diagnoses and procedure codes. Being underweight was defined by a BMI <18.5 kg/m^2 calculated from outpatient records or survey data. ESRD was defined by an active record in the Kaiser ESRD database. In addition, two pooled exposure variables were created to specify if any geriatric syndrome or if any diabetes complication was present.

Potential confounders

We included a range of factors that may confound the relationship between HRQL and geriatric syndromes, diabetes complications, and hypoglycemia. We obtained self-reported data on *1*) sociodemographics (age, sex, race/ethnicity, education, income, marital status); *2*) health behaviors (smoking history, alcohol use, physical activity [18]); and *3*) diabetes-related factors (duration, treatment, self-monitoring of blood glucose). We included obesity (BMI $\geq$ 30 kg/m^2) calculated from outpatient records or survey data.

Statistical analysis

We specified two types of linear regression models to examine associations between HRQL and geriatric syndromes, diabetes complications, and hypoglycemia: *1*) exposure-specific models and *2*) combined exposure models. Because conditions may co-occur and interact, each exposure was modeled individually as a predictor of HRQL in exposure-specific models. Also, we modeled pooled exposure variables and hypoglycemia simultaneously in combined exposure models to compare associations between HRQL and geriatric syndromes, diabetes complications, and hypoglycemia. All exposures were specified a priori as binary variables to indicate if the condition was present or absent. All covariates were modeled categorically, except for age and diabetes duration, and were included in all models. Expansion weights were applied to all models to account for the complex sampling design (race-stratified random sampling). We report β-values, which indicate differences in HRQL scores based on the presence versus absence of each exposure. *P* values were based on two-sided tests and considered significant at $P < 0.05$. Analyses were performed using SAS 9.0 software (SAS Institute Inc, Cary, NC).

Symptom-based conditions may be under-reported in administrative data; therefore, sensitivity analyses were conducted that respecified models using survey data instead of administrative data. Chronic pain was assessed by asking if bodily pain was present most of the time during the last 6 months (19). Depression was assessed using the 8-item Personal Health Questionnaire depression scale,

Table 1—*Characteristics of older adults with diabetes completing the HRQL questionnaire in the DISTANCE survey* (n = *6,317*)*

Age (years)	67.1 ± 4.7
Female	3,079 (49)
Race/ethnicity	
White	1,811 (29)
Black	1,196 (19)
Hispanic	937 (15)
Asian	1,453 (23)
Multiracial	699 (11)
Other	161 (3)
Married or partnered	4,333 (69)
Some college education or more	1,874 (30)
Income ≥$100,000	699 (11)
No smoking history	3,198 (51)
No alcohol history	1,771 (28)
High physical activity	2,382 (38)
Diabetes duration (years)	11.7 ± 9.6
Type 2 diabetes	6,088 (96)
Self-monitoring of blood glucose	5,235 (83)
Insulin use	1,397 (22)
Obesity	2,523 (40)
Any geriatric syndrome	2,855 (45)
Chronic pain	2,593 (41)
Depression	464 (7)
Fall	84 (1)
Underweight	36 (1)
Urinary incontinence	97 (2)
Any diabetes complication	1,874 (30)
Amputation	14 (0.2)
Blindness	23 (0.4)
CHF	196 (3)
ESRD	130 (2)
Foot ulcer	271 (4)
MI	135 (2)
Peripheral neuropathy	1,593 (25)
Stroke	40 (1)
Hypoglycemia	42 (1)
HRQL	
Physical	45.1 ± 10.4
Mental	51.0 ± 8.7

*Data are reported as mean ± SD or *n* (%).

and scores ≥15 were considered diagnostic (20). Peripheral neuropathy was defined by symptoms occurring ≥3 days/week. Hypoglycemia was defined by a history of "a severe low blood sugar reaction" in the past year. Urinary incontinence was asked only in women and included if it affected daily activities "quite a bit" or "extremely."

RESULTS—Respondents were a mean age of 67.1 years (Table 1), 49% were female, 71% were nonwhite, and 69% were married or partnered. The average duration of diabetes was 11.7 years, and 96% had type 2 diabetes. Most respondents performed self-monitoring of blood glucose, and 22% were prescribed insulin. In the past year, 45% of the population had been diagnosed with at least one geriatric syndrome, 30% were diagnosed with at least one diabetes complication, and 1% had a hypoglycemic event. Chronic pain (41%), obesity (40%), peripheral neuropathy (25%), and depression (7%) were prevalent.

The mean physical and mental HRQL scores were 45.1 and 51.0. Of the covariates, income <$15,000 vs. ≥$100,000 was associated with lower physical (−4.2 [95% CI −5.4 to −3.0], $P < 0.001$) and mental HRQL (−4.6 [−5.7 to −3.4], $P < 0.001$). Also, insufficient physical activity versus highly active (−4.4, 95% CI, −5.0 to −3.9, $P < 0.001$) and obesity versus not (−3.4 [−3.9 to −2.8], $P < 0.001$) were associated with lower physical HRQL. All other covariates, including age, race, duration of diabetes, and insulin use, were associated with differences in HRQL of <3 points.

Physical HRQL

In exposure-specific models, any geriatric syndrome (−5.9 [95% CI −6.5 to −5.4], $P < 0.001$), any diabetes complication (−4.5 [−5.1 to −4.0], $P < 0.001$), and hypoglycemia (−4.7 [−8.2 to −1.3], $P < 0.001$) were associated with lower physical HRQL (Table 2). The lowest physical HRQL was associated with amputation (−9.8 [−13.9 to −5.8], $P < 0.001$), CHF (−7.2 [−8.7 to −5.8], $P < 0.001$), falls (−6.3 [−8.6 to −4.1], $P < 0.001$), chronic pain (−5.6 [−6.1 to −5.0], $P < 0.001$), and MI (−5.3 [−7.0 to −3.5], $P < 0.001$). In combined exposure models, the association between physical HRQL and geriatric syndromes (−5.3 [−5.8 to −4.8], $P < 0.001$) and diabetes complications (−3.5 [−4.0 to −2.9], $P < 0.001$) were still clinically significant but attenuated. The association with hypoglycemia was no longer significant (Table 3).

Mental HRQL

Overall, geriatric syndromes and diabetes complications were not associated with clinically significant lower mental HRQL in exposure-specific models (Table 2). However, lower mental HRQL was associated with several individual geriatric syndromes and diabetes complications: depression (−7.9 [95% CI −8.7 to −7.2], $P < 0.001$), underweight (−5.6 [−9.7 to −1.4], $P = 0.008$), amputation (−5.5 [−9.0 to −2.0], $P = 0.002$), hypoglycemia (−5.0 [−8.0 to −2.0], $P = 0.001$), CHF (−4.0 [−5.3 to −2.7], $P < 0.001$), and falls (−3.6 [−5.5 to −1.6], $P < 0.001$). In combined exposure models, only hypoglycemia (−4.0 [−7.0 to −1.1], $P = 0.008$) remained associated with lower mental HRQL (Table 3).

Sensitivity analyses

The use of survey data instead of administrative data showed that fewer respondents had geriatric syndromes and diabetes complications (Table 4). Chronic pain, depression, and peripheral neuropathy occurred less frequently, whereas urinary incontinence and hypoglycemia occurred more frequently. In exposure-specific models, associations were larger between physical HRQL and any geriatric syndrome (survey vs. administrative data, −10.1 vs. −5.9 points) and any diabetes complication (−5.8 vs. −4.5 points). Specifically, larger differences in physical HRQL were associated with chronic pain (survey vs. administrative data, −10.3 vs. −5.6 points), depression (−10.3 vs. −4.9 points), and urinary incontinence (−7.3 vs. −3.1 points). Also, larger differences in mental HRQL were associated with depression (survey vs. administrative data, −17.3 vs. −7.9 points)

Table 2—*Differences in HRQL scores associated with the presence versus absence of individual geriatric syndromes, diabetes complications, and hypoglycemia* (n = 6,317)*

	Physical HRQL		Mental HRQL	
Variable	β-Coefficient (95% CI)	*P*	β-Coefficient (95% CI)	*P*
Any geriatric syndrome	−5.9 (−6.5 to −5.4)	<0.001	−2.4 (−2.8 to −1.9)	<0.001
Chronic pain	−5.6 (−6.1 to −5.0)	<0.001	−1.4 (−1.9 to −0.9)	<0.001
Depression	−4.9 (−5.8 to −4.0)	<0.001	−7.9 (−8.7 to −7.2)	<0.001
Fall	−6.3 (−8.6 to −4.1)	<0.001	−3.6 (−5.5 to −1.6)	<0.001
Underweight	−5.0 (−9.8 to −0.2)	0.04	−5.6 (−9.7 to −1.4)	0.008
Urinary incontinence	−3.1 (−5.1 to −1.1)	0.002	−0.7 (−2.4 to 1.0)	0.43
Any diabetes complication	−4.5 (−5.1 to −4.0)	<0.001	−1.5 (−2.0 to −1.0)	<0.001
Amputation	−9.8 (−13.9 to −5.8)	<0.001	−5.5 (−9.0 to −2.0)	0.002
Blindness	1.4 (−3.6 to 6.3)	0.59	0.3 (−3.9 to 4.6)	0.87
CHF	−7.2 (−8.7 to −5.8)	<0.001	−4.0 (−5.3 to −2.7)	<0.001
ESRD	−4.6 (−7.2 to −2.1)	<0.001	−1.2 (−3.4 to 1.1)	0.31
Foot ulcer	−4.8 (−6.1 to −3.6)	<0.001	−2.8 (−3.9 to −1.7)	<0.001
MI	−5.3 (−7.0 to −3.5)	<0.001	−1.4 (−2.9 to 0.1)	0.08
Peripheral neuropathy	−4.4 (−5.0 to −3.8)	<0.001	−1.3 (−1.8 to −0.7)	<0.001
Stroke	−4.7 (−7.6 to −1.8)	0.002	−1.4 (−4.0 to 1.1)	0.27
Hypoglycemia	−4.7 (−8.2 to −1.3)	<0.001	−5.0 (−8.0 to −2.0)	0.001

*Exposures of interest were modeled in exposure-specific models. All models were adjusted for sex, age, race/ethnicity, marital status, education, income, smoking/alcohol history, physical activity, diabetes duration, diabetes treatment, self-monitoring of glucose, and obesity.

Table 3—*Differences in HRQL associated with the presence vs. the absence of the pooled exposures of geriatric syndromes and diabetes complications and hypoglycemia in older adults with diabetes* (n = 6,317)*†

	Physical HRQL		Mental HRQL	
Variable	β-Coefficient (95% CI)	*P*	β-Coefficient (95% CI)	*P*
Any geriatric syndrome	−5.3 (−5.8 to −4.8)	<0.001	−2.1 (−2.6 to −1.6)	<0.001
Any diabetes complication	−3.5 (−4.0 to −2.9)	<0.001	−1.0 (−1.5 to −0.5)	<0.001
Hypoglycemia	−2.5 (−5.7 to 0.8)	0.14	−4.0 (−7.0 to −1.1)	0.008

*Two pooled exposure variables (one for any geriatric syndrome, one for any diabetes complication) and hypoglycemia were modeled simultaneously. All models were adjusted for sex, age, race/ethnicity, marital status, education, income, smoking/alcohol history, physical activity, diabetes duration, diabetes treatment, self-monitoring of glucose, and obesity. †Among sociodemographics, health behaviors, and diabetes–related factors, income category <$15,000 vs. ≥$100,000 was associated with lower physical (−4.2 [95% CI −5.4 to −3.0], $P < 0.001$) and mental HRQL (−4.6 [−5.7 to −3.4], $P < 0.001$). Insufficient physical activity vs. highly active (−4.4 [−5.0 to −3.9], $P < 0.001$) and obesity vs. not (−3.4 [−3.9 to −2.8], $P < 0.001$) were associated with lower physical HRQL. All other covariates were associated with differences in HRQL <3 points.

and incontinence (−4.6 vs. −0.7 points). Associations with HRQL were slightly smaller for hypoglycemia.

In the combined exposure models, the association between physical HRQL and any geriatric syndromes was larger (survey vs. administrative data, −9.4 vs. −5.3 points), whereas associations with diabetes complications and hypoglycemia changed minimally. Associations between mental HRQL and any geriatric syndrome, any diabetes complication, and hypoglycemia did not change substantially.

CONCLUSIONS—Our study found that geriatric syndromes and hypoglycemia affect HRQL as much as, or more so, than diabetes complications in older adults with diabetes. Nearly all geriatric syndromes, diabetes complications, and hypoglycemia were associated with lower HRQL, suggesting that all of these conditions should be addressed in the care of older adults with diabetes. Many of these conditions were uniquely associated with lower HRQL; specifically, amputation, CHF, falls, chronic pain, MI, depression, underweight, and hypoglycemia were most strongly associated with lower HRQL. These conditions were more strongly associated with lower HRQL than diabetes-related characteristics, including duration of diabetes and insulin use.

Geriatric syndromes may be associated with HRQL to a comparable or greater degree than diabetes complications because they cause high morbidity, disability, are difficult to treat, and are less recognized (13). For example, unlike many complications that can be treated with pharmacotherapy, reducing falls requires a multifactorial approach (21). Also, because we have become more successful at preventing diabetes complications (22), more patients are living longer with age-associated syndromes that interfere with HRQL. Because several geriatric syndromes were associated with substantively worse HRQL in older patients with diabetes, more research is needed on how to effectively screen and manage these conditions, especially depression and falls. There are likely complex interactions between geriatric syndromes, diabetes complications, and hypoglycemia that deserve further study.

We found that hypoglycemia was associated with lower mental HRQL, which provides additional support for relaxing glycemic targets in certain older adults with diabetes at high risk for hypoglycemia (1,2). Older frail adults are at high risk for severe sequelae of hypoglycemia, including falls (2), dementia (23), and even death (24). Results from the recent Action to Control Cardiovascular Risk in Diabetes (ACCORD) Trial (25), which evaluated very intensive glycemic control in older adults, have heightened concerns about the harms associated with intensive glycemic control.

Our main analysis and sensitivity analysis showed some noteworthy differences. Chronic pain, depression, and incontinence were associated with lower HRQL in survey data compared with administrative data. The HRQL instrument included questions on emotional health and bodily pain, which likely caused some overestimation of the associations between HRQL and the survey-defined conditions. However, the overall findings that lower HRQL was associated with geriatric syndromes and hypoglycemia to at least the

Table 4—*Differences in HRQL scores associated with the presence versus absence of self-reported individual geriatric syndromes, diabetes complications, and hypoglycemia in older adults with diabetes* (n = 6,317)*†

		Physical HRQL		Mental HRQL	
Variable	*n* (%)	β-Coefficient (95% CI)	*P*	β-Coefficient (95% CI)	*P*
Any geriatric syndrome	2,340 (37)	−10.1 (−10.6 to −9.7)	<0.001	−3.2 (−3.7 to −2.7)	<0.001
Chronic pain	2,116 (33)	−10.3 (−10.8 to −9.8)	<0.001	−2.4 (−2.9 to −1.9)	<0.001
Depression	210 (3)	−10.3 (−11.7 to −8.8)	<0.001	−17.3 (−18.4 to −16.1)	<0.001
Urinary incontinence‡	241 (8)	−7.3 (−8.7 to −5.9)	<0.001	−4.6 (−5.9 to −3.3)	<0.001
Any diabetes complication	1,624 (26)	−5.8 (−6.4 to −5.3)	<0.001	−2.0 (−2.5 to −1.5)	<0.001
Peripheral neuropathy	1,225 (19)	−5.8 (−6.5 to −5.2)	<0.001	−2.1 (−2.6 to −1.5)	<0.001
Hypoglycemia	635 (10)	−4.1 (−5.1 to −3.2)	<0.001	−2.7 (−3.5 to −1.9)	<0.001

*Specified exposures of interest were identified using DISTANCE survey data. †Individual exposures of interest were modeled in exposure-specific models. All models were adjusted for sex, age, race/ethnicity, marital status, education, income, smoking/alcohol history, physical activity, diabetes duration, diabetes treatment, self-monitoring of glucose, and obesity. ‡Urinary incontinence was measured only in female respondents.

same, or greater, degree as diabetes complications was also observed in the sensitivity analysis.

Our study has several important strengths and limitations. This study included a large, ethnically diverse cohort of older adults with diabetes with detailed information on multiple comorbidities from both administrative and survey data. One important consideration in interpreting our results is that the study design was cross-sectional. Because HRQL was captured using survey data, there is likely a selection bias that would favor higher HRQL scores in respondents of the HRQL instrument than in nonrespondents. Characteristics of this managed care population may make some findings less generalizable. These limitations will likely affect absolute HRQL scores; however, relative differences in scores due to certain conditions are less likely to be affected. Also, we were not powered to study differences in HRQL by type of diabetes, and we could not study dementia because patients with dementia were under-represented in the survey.

In summary, we find that geriatric syndromes, diabetes complications, and hypoglycemia are associated with lower HRQL to a comparable degree in older adults with diabetes. In our efforts to maximize quality of life of older adults with diabetes, screening for and managing geriatric syndromes, and avoiding hypoglycemia, should be considered as high a priority as preventing diabetes complications.

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