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Ten-year change in vision-related quality of life in type 1 diabetes: Wisconsin Epidemiologic Study of Diabetic Retinopathy

Flavio E. Hirai[1,2], **James M. Tielsch**[3], **Barbara E. K. Klein**[4], and **Ronald Klein**[4]

[1] Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health

[2] Department of Ophthalmology, Federal University of Sao Paulo

[3] Department of International Health, Johns Hopkins Bloomberg School of Public Health

[4] Department of Ophthalmology and Visual Sciences, School of Medicine and Public Health, University of Wisconsin – Madison

Abstract

Purpose—To investigate changes of vision-related quality of life during a 10-year period in a type 1 diabetes population.

Design—Prospective cohort study

Participants—Individuals who had their diabetes diagnosed before 30 years of age were considered to have type 1 diabetes (N=1,210). Those who participated in both 14-year (1995–96) and 25-year (2005–07) follow-up examinations were included in the current analysis (N=471).

Methods—Vision-related quality of life was measured with the National Eye Institute Vision Function Questionnaire (NEI-VFQ-25).

Main Outcome Measures—Changes in vision-related quality of life scores.

Results—Loss of three lines in the Early Treatment Diabetic Retinopathy Study (ETDRS) chart was the most important factor related to negative changes in the NEI-VFQ-25 scores in our study after controlling for confounders. Most important changes were observed in subscales such as general vision (−6.46 points); mental health (−10.19 points); role difficulty (−6.06 points); and driving (−10.43 points). Unemployment and the development long-term complications such as nephropathy were also associated with negative changes in some NEI-VFQ-25 subscale scores. On the other hand, changes in diabetic retinopathy status were not related to changes in any subscale after 10 years.

Corresponding Author: Flavio E. Hirai, MD, PhD, Department of Ophthalmology, Federal University of Sao Paulo, Sao Paulo, Brazil, Phone: 55-11-9117-8076, Fax: 55-11-3831-4488, fhirai@jhsph.edu, fhirai@yahoo.com.

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This article contains online-only material. The following should appear online only: Tables 2 and 3.

The sponsor or funding organization had no role in the design or conduct of this research.

Conclusions—Change in visual acuity was the most important factor associated with changes in vision-related quality of life scores in individuals with type 1 diabetes during a 10-year period. Our findings support the necessity of close follow-up of type 1 diabetes individuals in order to avoid development of long-term complications and vision loss to improve quality of life.

Introduction

Traditionally, visual acuity has been the main outcome measure used in clinical practice and research to assess function. However, visual acuity may not optimally assess ability to do specific tasks and does not measure a patient's self assessment of well-being, expectations and demands. In order to investigate the effects of visual impairment in self-perception of quality of life, vision-related questionnaires such as the National Eye Institute Visual Function Questionnaire (NEI-VFQ-25) has been developed[1].

The NEI-VFQ-25 is a reliable and valid[1] 25-item questionnaire that has been used to investigate the impact of many ocular diseases on visual functioning and health-related quality of life[2–4]. It has been used to evaluate the influence of diabetic retinopathy[5–6] and interventions such as retinal laser photocoagulation[7] on quality of life among those with diabetes in previous cross-sectional studies. However, few epidemiological studies have investigated changes in quality of life among individuals with type 1 diabetes over time[8].

The purpose of this study was to investigate changes of vision-related quality of life during a 10-year period in a type 1 diabetes population.

Methods

Study population

Data for the current analysis come from the Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR). The WESDR was initiated in 1979–80 as a prospective cohort study of individuals with types 1 and 2 diabetes. Details on the methodology have been previously described[9–11]. Briefly, 10,135 individuals with diabetes who were receiving medical care in 11 counties of southern Wisconsin were identified and a final sample of 2,990 was selected to participate in the study. Individuals who had their diabetes diagnosed before 30 years of age were categorized as the "younger-onset" group (N=1,210). Of the individuals with type 1 diabetes, 996 participated in the baseline examination (1980–82), 891 in the 4-year follow-up (1984–86), 765 in the 10-year follow-up (1990–92), 654 in the 14-year follow-up (1995–96), 567 in the 20-year follow-up (2000–01), and 550 in the 25-year follow-up (2005–07). This is the group considered to have type 1 diabetes based on C-peptide testing and was included in the current analysis. Refusal rates were low for all follow-up phases[12–16].

Procedures

Examinations followed standardized protocols[10] and included an ophthalmic evaluation. The eye examination included measurement of best-corrected visual acuity using a modified Early Treatment Diabetic Retinopathy Study (ETDRS) chart after refraction[17], anterior segment biomicroscopy, tonometry, and fundoscopy after pupil dilation. Stereoscopic color fundus photographs of 7-standard fields were taken to assess diabetic retinopathy status and other fundus abnormalities[18]. Participants were asked questions by trained interviewers regarding their current and past medical conditions, use of medications, information about alcohol consumption, and cigarette smoking. Laboratory tests included blood levels of glycosylated hemoglobin, and total and high-density lipoprotein cholesterol concentrations. Urine samples were tested for the presence of gross proteinuria.

Vision-related quality of life was assessed using the NEI-VFQ-25[1]. Participants answered the questions during regular study visit and responses were transformed to a score ranging from 0 to 100. Higher scores indicate better health status. The following subscales were analyzed using the NEI-VFQ-25: general health (GH), general vision (GV), near vision (NV), distance vision (DV), driving (DR), peripheral vision (PV), color vision (CV), ocular pain (OP), and vision specific role limitations (RL), dependency (DP), social function (SF), and mental health (MH). In addition, the 25-item composite score was calculated [1]. The NEI-VFQ-25 questionnaire was administered only in the 1995–96 and 2005–07 examinations.

Definitions

Age was defined as age at examination. Duration of diabetes was the time between diagnosis and each follow-up visit. Education was defined as number of years of school completed. Employment was categorized into “full/part-time workers”, “retired”, “not working”, and “other” (e.g., students or homemakers) at the time of examination. Individuals were asked whether they had smoked more than 100 cigarettes in their lives. If they answered positively, the number of cigarettes per day and the number of years smoked were recorded. Pack years smoked at each visit was calculated (one pack year was equivalent to smoking one pack per day for a year) at each examination. Alcohol consumption was calculated in ounces per day. Individuals also answered questions regarding their marital status, health insurance, and insulin use.

Nephropathy was defined as history of kidney transplant, being on renal dialysis, or having gross proteinuria (defined as urine concentration of ≥0.30g/l measured by reagent strip). Neuropathy was defined as history of numbness or tingling in hands or feet, loss of sensation in hands or feet, and/or decreased ability to feel the hotness or coldness of things touched. Limb amputation was assessed by questionnaire or direct observation. Cardiovascular disease was defined as history of angina, myocardial infarction, coronary bypass surgery, and/or stroke.

Diabetic retinopathy (DR) was graded using the fundus photographs according to a modified Airlie House classification scheme[19]. For each eye, the maximum grade in any of the 7 standard photographic fields was determined for each of the lesions used in defining the retinopathy levels. The retinopathy level for a participant was derived by combining the levels for both eyes, giving the eye with the higher level greater weight. This scheme provided a 15-step scale (10/10, 21/<21, 21/21, 31/<31, 31/31, 37/<37, 37/37, 43/<43, 43/43, 47/<47, 47/47, 53/<53, 53/53, 60+/<60+, and 60+/60+) when all levels of proliferative retinopathy were grouped as one level. For purposes of classification, if the retinopathy severity could not be graded in an eye, it was considered to have a score equivalent to that in the other eye. Diabetic retinopathy was grouped according to the worse eye into “no retinopathy” (level 10), “mild non-proliferative DR” (level>10 and ≤37), “moderate NPDR” (level>37 and ≤47), “severe NPDR” (level>47 and <60), and “proliferative DR” (level≥60). Individuals were classified as having glaucoma if their physicians told they had the disease or if they were using glaucoma medication.

For visual acuity, the ETDRS protocol was used to determine best-corrected visual acuity[17]. The total number of letters read by each participant was recorded and transformed into logarithm of minimum angle of resolution (LogMar) scale.

Changes between the 1995–96 and 2005–07 examinations

Changes in NEI-VFQ-25 scores and other continuous variables such as glycosylated hemoglobin, smoking, and alcohol consumption were also defined as the difference between

the 1995–96 and 2005–07 examinations. Employment was categorized as: “full- or part-time job” for those who remained employed or got a full- or part-time job between visits; “retired” for those who retired between visits; “not working” for those who stopped working between visits; and “others” for those who did not change status (e.g., students, homemakers, or those who remained retired). Change in marital status was defined as “no change”, “got partner”, and “lost partner”. For each long-term condition (cardiovascular disease, nephropathy, neuropathy, and limb amputation), individuals were classified as “yes” if they have developed the condition during the interval or already had the condition at baseline and “no” if they have not developed the condition during the study period.

Change in visual acuity was calculated by subtracting the baseline visual acuity LogMar score from the follow-up score. In our regression models, change in visual acuity represented a change of 3 lines on the ETDRS chart, an equivalent to 15 letters or a doubling the visual angle in the better eye. Changes in diabetic retinopathy status were classified in “No change” for those who did not change status and “Improvement” or “Progression” if individuals had at least a 2-step change in their status in 10 years.

Because all participants had the same change for age and diabetes duration between visits, age and diabetes duration at baseline were used in our statistical analyses. Education did not change significantly during this period and its value at baseline was used in our analysis.

Statistical analysis

Comparisons of continuous variables between two visits were done with the Wilcoxon’s signed-rank test and categorical variables were compared with the chi-square and McNemar’s tests.

Linear regression models were built using the “change score method”[20]. In this method, the change in NEI-VFQ-25 score was the dependent variable. One unit of change in the independent variable corresponded to increase (positive) or decrease (negative) in one unit of change in the NEI-VFQ-25 score between examinations. We built our multivariable models including factors that were significantly associated with the NEI-VFQ scores in our univariable analysis. In our final models, we also added other factors believed to be potential confounders based on previous knowledge about vision-related quality of life in people with type 1 diabetes. Long-term complications such as nephropathy, neuropathy, limb amputation, and retinopathy were analyzed in separate models and together in a final full model in each of the NEI-VFQ-25 subscales. Interactions were also tested in our multivariable models. A p-value less than 0.05 was considered to be statistically significant. Analyses were performed using Stata v.10 (College Park, Texas).

The Institutional Review Board of the University of Wisconsin, Madison, approved the study, and all participants provided consent. This research was conducted in accordance with the principles of the Declaration of Helsinki.

Results

Four hundred and seventy one individuals had complete data on the NEI-VFQ-25 questionnaires and were included in the current analysis. There were no statistically significant differences between individuals included and those excluded from the analysis regarding gender, age, level of glycosylated hemoglobin, employment status, physical activity, smoking status, and presence of long-term complications such as nephropathy, neuropathy, and limb amputation. Excluded individuals tend to drink less alcohol, have higher prevalence of proliferative retinopathy, and worse visual acuity ($p<0.05$).

The mean age at the 2005–07 examination was 49.2 ± 9.4 years, 49.3% of whom were males. Levels of glycosylated hemoglobin (9.3 ± 1.4 % vs. 7.6 ± 1.3 %, p<0.001) and serum total cholesterol (192.5 ± 40.9 mg/dl vs. 167.0 ± 36.4 mg/dl, p<0.001) were lower and serum HDL cholesterol (50.9 ± 15.8 mg/dl vs. 56.3 ± 17.1 mg/dl, p<0.001) was higher at the 2005–07 examination. More of the cohort was using an insulin pump at the 2005–07 (36.9%) compared to the 1995–96 (4.0%, p<0.001) examination. A significant proportion of people either retired (1.5% vs. 10.6%) or stopped working (7.2% vs. 14.7%, p<0.001). The proportion of former smokers was higher after 10 years (23.0% vs. 27.8%, p<0.01). The prevalence of microvascular and macrovascular complications increased after 10 years: cardiovascular disease (7.4% vs. 26.3%, p<0.001); nephropathy (23.2% vs. 48.6%, p<0.001); neuropathy (26.3% vs. 58.6%, p<0.001); lower limb amputation (1.9% vs. 6.6%, p<0.001); proliferative diabetic retinopathy (39.7% vs. 46.6%, p<0.001). The mean visual acuity was slightly but statistically significantly poorer in the 2005–07 examination (−0.03 ± 0.16 LogMar ($20/20^{+2}$) vs. 0.03 ± 0.20 LogMar ($20/25^{+3}$)).

Table 1 shows mean scores and differences for all NEI-VFQ-25 domains and the composite score. There was a decrease in all scores except for mental health. All differences were statistically significant except for differences in ocular pain, social functioning, and mental health.

In univariable analysis (Tables 2 and 3, available at http://aaojournal.org), not working, developing of nephropathy, neuropathy, and cardiovascular disease and a decrease in visual acuity were significantly related to reduction of composite scores. Some of these factors also influenced specific NEI-VFQ-25 domains in the univariable analyses. The most significant changes were seen with changes in visual acuity. Loss of 3 lines in visual acuity was associated with decreases in all scores except for overall health.

Table 4 shows the multivariable analyses for all domains of the NEI-VFQ-25 and the composite score. Because results did not significantly differ between models that included each long-term complication separately and the full model, only the results from our full models for each subscale were shown. Not working, development of nephropathy, and doubling of visual angle were associated with decrease in the composite score. Similar to our univariable analysis, visual acuity remained as the most important factor related to lower NEI-VFQ-25 scores in our study. On the other hand, changes in diabetic retinopathy status were not related to any subscale. A one unit (1%) increase in levels of glycosylated hemoglobin was associated with decrease in overall health score and increase in mental health score after adjustment for confounders.

Discussion

In persons with long duration of diabetes, change in visual acuity over a 10-year period of follow-up was the most important predictor for decreased scores in most NEI-VFQ-25 domains. Stopping work during the study period and the presence of systemic comorbidities such as nephropathy were also strongly associated with changes in vision-related quality of life scores.

Our findings in the WESDR that decreases in visual acuity are associated with poorer self-perceived quality of life are consistent with data from other studies[21–23]. The same association was seen among people with diabetes, especially those with macular edema[24]. The importance of vision loss on quality of life was shown by Coyne et al[23] in a study which investigated the impact of diabetic retinopathy on quality of life in a group of people with types 1 and 2 diabetes. They observed that the presence of diabetic retinopathy combined

with visual loss had a greater impact on quality of life than the impact of mild retinopathy without visual impairment.

In the current analysis, a loss of 3 lines in visual acuity in the better eye was associated with relatively large score changes not only in domains directly related to visual function, such as near and distant activities, but in domains such as mental health, role difficulties, dependency, and driving. Matza et al[8] reported a longitudinal analysis investigating changes in visual acuity and quality of life scores in patients with diabetic retinopathy. Similar to our study, mental health, role limitations, dependency, and driving were the domains most affected by visual acuity worsening by more than 10 letters. Coyle et al[23] also showed that those with visual impairment reported a negative influence of poor visual acuity on every aspect of their quality of life, including, physical, social, leisure, and daily activities.

Progression or improvement of diabetic retinopathy was not associated with any vision-specific quality of life domain, when analyzed independent of visual acuity changes in our study. Because proliferative diabetic retinopathy (PDR) not affecting vision (due to traction on the macula or vitreous hemorrhage) is often asymptomatic, this was not unexpected. Also participants with severe long-standing PDR may have adapted to the changes in vision due to their retinopathy. Only seven people developed incident macular edema in their better-seeing eye during the 10-year period, limiting our ability to analyze the role of this condition in our population although this may have contributed to the association of vision with change in VFQ score.

Visual acuity was not associated with domains such as overall health, color vision, and peripheral vision in the current study. In a cross-sectional evaluation of the complication of age-related macular degeneration prevention trial (CAPT), visual acuity was the measurement most strongly associated with most VFQ subscales, except for driving and color vision. These two subscales were most strongly associated with contrast sensitivity, suggesting that other measurements of visual function affect quality of life differently than measurement of visual acuity[25].

Because visual acuity may be influenced by other ocular conditions, we investigated the impact of glaucoma on our findings. After excluding those with glaucoma at both follow-up visits, we did not observe any changes in our findings regarding the associations between visual acuity, diabetic retinopathy, and quality of life (data not shown). Because changes in the severity of cataract between the two visits were not determined, we could not to evaluate the effect of cataract on changes in visual acuity in the current analysis. Approximately 18% of the people in the study population had undergone cataract surgery in either eye at the 2005–07 visit. Because cataract surgery has been available and easily accessible to this relatively young population, we believe that development of a cataract causing visual impairment in the absence of other ocular disease (e.g., severe retinopathy) would have been removed and would be unlikely to have influenced our results.

The NEI-VFQ-25 questionnaire was sensitive in capturing the influence of complications such as cardiovascular disease and nephropathy in domains such as near vision activities, role difficulties, driving, and peripheral vision. The presence of these conditions could indicate a poorer health state limiting the execution of role activities or those requiring the individual to be relatively free of physical limitations such as for driving. However, the relationship between development of cardiovascular disease and changes in near vision activities and peripheral vision was not clear. These findings suggest that the presence of macro- and microvascular complications should be taken into account when investigating vision-related quality of life in people with type 1 diabetes.

The WESDR provided an opportunity to explore the potential influences of factors other than those directly related to diabetes on quality of life. Stopping work was associated with decreases in the vision-specific social functioning, mental health, role difficulties, and peripheral vision NEI-VFQ domains. None of the previous studies have explored the impact of employment on vision-specific quality of life. As we observed in the current analysis, the domains that were most strongly associated with changes in employment status were those related to well-being and distress, to activities requiring interpersonal interactions such as visiting people in their homes or entertaining friends, and limitations in role activities at work or home due to low vision. Unemployment, especially among those of working age, adds a significant psychological burden to these individuals. Studies have shown that the loss of a job can have an important influence on one's perception of non-vision-specific quality of life[26]. This could explain our findings, regardless of the fact that NEI-VFQ-25 questions were focused on function related to the individual's vision.

This study has some limitations that should be considered. Visual acuity was the only measurement of visual function used in WESDR. There were no objective measurements of contrast sensitivity, glare recovery, and visual field that might have captured other components of visual function not explained by visual acuity alone[6, 27]. This is a cohort of survivors with long-term type 1 diabetes. The ones who were excluded from the analysis had lower vision-related quality of life scores than those who participated in both exams and this might have resulted in an underestimation of the associations examined in this analysis. Finally, the availability of data from only two points in time over a 10-year period also limits the ability to perform a more comprehensive longitudinal analysis of more acute changes. Despite its limitations, the strengths of the WESDR should also be considered. The use of standard protocols such as the ETDRS refraction and visual acuity measurements and fundus photographs and standardized classification scheme for diabetic retinopathy allow detailed assessment of this condition decreasing chances of misclassification. The population-based design provides an opportunity to generalize our findings to persons with long-term type 1 diabetes.

In summary, change in visual acuity, independent of other factors such as the presence of comorbidities, was the most important factor associated with changes in vision-related quality of life scores in individuals with long-term type 1 diabetes over a 10-year period. In addition, psychosocial factors such as employment or marital status may influence quality of life and should be considered in future studies. Our findings support the current guidelines about the necessity of timely dilated eye examinations and treatment in people with type 1 diabetes to prevent vision loss and improve quality of life.

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Table 1

Mean scores for each NEI-VFQ-25 domain and composite score in 1995–96 and 2005–07.

	1995–96	2005–07	Difference	P-value
Overall Health	63.7 ± 22.9	57.5 ± 23.9	−6.2 ± 23.2	<0.001
General Vision	82.2 ± 14.1	79.3 ± 16.2	−2.9 ± 16.9	<0.001
Ocular Pain	93.1 ± 12.4	92.9 ± 12.2	−0.2± 13.1	0.79
Near Activities	90.5 ± 13.8	86.4 ± 17.9	−4.0 ± 15.4	<0.001
Distance Activities	89.2 ± 15.1	87.5 ± 17.2	−1.7 ± 13.7	<0.01
Social Functioning	96.5 ± 9.8	95.6 ± 11.7	−0.9 ± 10.4	0.06
Mental Health	86.7 ± 15.8	87.4 ± 16.5	0.7 ± 16.3	0.39
Role Difficulties	94.2 ± 15.2	90.7 ± 18.4	−3.4 ± 16.6	<0.001
Dependency	95.5 ± 13.3	94.1 ± 13.1	−1.4 ± 13.4	0.02
Driving	89.0 ± 17.5	84.1 ± 21.5	−4.9 ± 18.1	<0.001
Color Vision	96.5 ± 10.9	94.5 ± 15.6	−2.1 ± 13.5	<0.001
Peripheral Vision	91.6 ± 18.3	86.6 ± 23.1	−4.9 ± 18.5	<0.001
VFQ-25 Composite	91.9 ± 10.3	89.7 ± 12.4	−2.2 ± 9.1	<0.001

NEI-VFQ-25: National Eye Institute Visual Function Questionnaire

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Table 2

Univariable analysis of change in health-related quality of life scores in each NEI-VFQ-25 domain between 1995–96 and 2005–07.

	Composite	OH	GV	OP	NA	DA
Age, per 1 year	−0.08	**−0.28** *	0.09	**−0.19** **	−0.02	−0.16
Sex, vs. female	0.24	−2.76	2.31	−0.81	−0.56	1.33
Education, per 1 year	0.16	0.03	0.33	−0.12	0.23	−0.07
Employment, vs. Full/part-time job						
Retired	−2.85	−8.06	−0.08	−4.08	−2.20	−2.31
Not working	**−6.28** **	−5.20	−0.46	1.23	**−6.54** **	**−6.87** **
Other	−0.33	−2.46	−2.96	−0.36	1.26	0.23
Marriage, vs. no change						
Got partner	1.36	−0.55	1.79	1.23	3.87	2.17
Lost partner	1.43	−2.28	0.07	3.64	2.79	1.46
Smoking, per 1 packyear	0.06	−0.01	−0.06	0.07	−0.04	−0.01
Alcohol consumption per 1oz/day	2.17	−2.07	0.71	0.07	2.15	2.49
Glycosylated Hb, per 1 unit %	0.90	−0.05	−0.31	**1.34** **	0.90	**1.18** **
Diabetes duration, per 1 year	−0.05	**−0.30** *	0.14	**−0.22** *	−0.04	−0.02
Hypoglycemia, vs. no change						
Less events	2.07	−0.81	0.19	0.60	1.54	1.91
More events	0.74	−0.49	1.83	1.15	0.93	1.77
Nephropathy, vs. no	**−2.43** **	−0.09	−2.04	**−2.61** *	−2.42	−1.78
Neuropathy, vs. no	**−2.77** **	**−4.49** *	−1.78	**−2.72** *	−2.57	**−3.36** *
Amputation, vs. no	−0.55	−4.90	−4.29	−3.03	−1.46	0.50
Cardiovascular, vs. no	**−2.48** *	−0.87	1.14	−1.46	**−3.26** *	**−3.32** *
Visual acuity, per 3-line decrease	**−7.22** **	3.03	**−5.35** **	**−3.20** **	**−8.00** **	**−8.67** **
Diabetic retinopathy, vs. no change						
Improvement	0.80	−0.43	−1.07	0.30	0.66	1.45
Progression	0.29	−3.85	−0.99	−1.05	0.27	−0.68

* p<0.05;

** p<0.01;

(−) sign means decrease in 1 score unit in domain change

NEI-VFQ-25: National Eye Institute Visual Function Questionnaire

Composite: VFQ-25 composite score; OH: overall health; GV: general vision; OP: ocular pain; NA: near activities; DA: distance activities

Table 3

Univariable analysis of change in health-related quality of life scores in each NEI-VFQ-25 domain between 1995–96 and 2005–07.

	SF	MH	RD	DP	DR	CV	PV
Age, per 1 year	0.05	−0.01	−0.07	−0.01	−0.16	−0.11	−0.10
Sex, vs. female	−2.04	−1.61	−2.25	−1.21	1.72	−0.42	0.65
Education, per 1 year	−0.01	0.07	0.37	0.11	0.38	0.34	0.36
Employment, vs. Full/part-time job							
Retired	−1.19	−0.63	**−7.58****	−2.60	−5.54	−2.41	**−7.64***
Not working	**−4.48****	**−8.28****	**−12.98****	−3.84	**−10.40****	−3.74	**−15.42****
Other	−4.16	1.88	**−6.42****	0.97	1.26	−0.76	−3.28
Marriage, vs. no change							
Got partner	0.23	−0.77	0.17	1.14	4.15	2.14	2.52
Lost partner	0.75	1.09	2.49	0.24	1.07	0.55	1.40
Smoking, per 1 packyear	**−0.14****	−0.01	**−0.16****	0.01	0.05	**−0.15****	−0.06
Alcohol consumption per 1oz/day	1.86	0.54	**5.36***	**5.52***	4.44	1.53	4.38
Glycosylated Hb, per 1 unit %	0.47	**1.58****	**1.76****	**1.24****	**1.62****	**0.98***	**1.98****
Diabetes duration, per 1 year	**0.17***	−0.03	−0.01	−0.05	−0.12	−0.10	**−0.26***
Hypoglycemia, vs. no change							
Less events	−0.03	2.75	1.13	3.25	−0.22	0.05	3.29
More events	0.81	2.35	−0.41	2.93	−0.50	1.77	0.66
Nephropathy, vs. no	**−2.24***	−0.74	**−5.55****	−1.97	**−4.02***	**−4.52****	**−5.38****
Neuropathy, vs. no	−1.76	**−3.71***	**−5.87****	−2.01	**−3.81***	−1.65	−3.32
Amputation, vs. no	−2.21	−1.46	**−6.67***	0.02	−4.67	−3.31	−1.01
Cardiovascular, vs. no	−0.32	−0.57	**−6.46****	−0.32	**−6.25****	**−3.20***	**−6.93****
Visual acuity, per 3-line decrease	**−4.50****	**−11.35****	**−9.87****	**−7.93****	**−13.07****	−1.04	**−6.42****
Diabetic retinopathy, vs. no change							
Improvement	−0.34	−1.32	1.04	−0.41	4.39	1.09	4.29
Progression	−0.72	−2.24	−0.72	0.45	3.49	3.15	2.17

*p<0.05;

** p<0.01;

(−) sign means decrease in 1 score unit in domain change

NEI-VFQ-25: National Eye Institute Visual Function Questionnaire

SF: vision specific social functioning; MH: vision specific mental health; RD: vision specific role difficulty; DP: vision specific dependency; DR: driving; CV: color vision; PV: peripheral vision

Table 4

Multivariable analysis of change in the VFQ-25 between 1995–96 and 2005–07.

	Composite	OH†	GV	OP†	NA	DA	SF	MH	RD	DP	DR	CV	PV
Age, per 1 year	0.02	−0.09	−0.03	−0.15	0.11	−0.16	0.06	0.22	0.12	0.20	0.02	−0.08	0.24
Sex, vs. female	−0.76	−4.48	2.82	0.09	−1.89	−0.08	**−3.42****	**−4.52***	**−3.00***	−1.73	0.01	−0.34	−1.07
Employment, vs. Full/part-time job													
Retired	−1.24	−7.59	1.05	−0.26	0.03	1.42	−2.21	−1.11	**−8.59***	**−5.46***	−1.21	1.54	−7.05
Not working	**−4.50***	−6.52	1.74	3.14	−2.50	−3.60	**−3.12***	**−9.60***	**−10.51****	−4.30	−5.99	−3.36	**−11.60***
Other	0.82	1.40	0.82	2.69	4.57	3.56	−0.50	−0.79	**−6.77****	0.89	7.17	2.48	1.81
Glycosylated Hb, per 1 unit %	0.57	**−1.65***	−0.29	0.70	0.46	0.57	0.26	**1.44***	0.97	1.15	0.85	0.45	1.24
Diabetes duration, per 1 year	−0.01	−0.12	0.24	−0.11	−0.11	0.10	0.15	−0.18	0.28	0.06	−0.06	−0.01	−0.31
Cardiovascular, vs. no	−2.52	1.79	−0.47	1.63	**−4.23***	−2.42	−1.64	−0.09	**−6.95****	−1.69	**−6.95***	−2.12	**−6.58***
Nephropathy, vs. no	**−1.73***	1.39	−1.94	−1.46	−1.76	−1.09	−1.95	1.78	−2.45	−0.23	−3.45	**−3.87***	−2.77
Neuropathy, vs. no	0.18	−2.02	0.16	−0.42	0.98	−1.10	−0.56	−1.19	−0.85	−0.35	1.86	0.17	0.58
Amputation, vs. no	1.98	−5.87	−3.57	−3.03	0.49	1.69	2.43	3.43	−1.73	1.04	−0.67	−2.56	6.48
Diabetic retinopathy, vs. no change													
Improvement	0.37	1.63	−3.77	1.09	−0.60	−0.08	−1.39	0.78	1.82	−0.75	−0.40	2.34	1.59
Progression	0.69	1.20	0.22	−1.81	−0.44	−1.20	−0.29	−0.13	1.34	4.01	3.68	1.93	0.41
Visual acuity, per 3-line decrease	**−5.69****	2.72	**−6.46****	**−4.05***	**−6.88****	**−6.17****	**−3.06****	**−10.19****	**−6.90****	**−6.06****	**−10.43****	−0.06	−1.27

*p<0.05;

**p<0.01;

(−) sign means decrease in 1 score unit in domain change.

NEI-VFQ-25: National Eye Institute Visual Function Questionnaire

Composite: VFQ-25 composite score; OH: overall health; GV: general vision; OP: ocular pain; NA: near activities; DA: distant activities; SF: vision specific social functioning; MH: vision specific mental health; RD: vision specific role difficulty; DP: vision specific dependency; DR: driving; CV: color vision; PV: peripheral vision

†Models also adjusted for body-mass index.