Self-Rated Health and Diabetes of Long Duration

The Wisconsin Epidemiologic Study of Diabetic Retinopathy

BARBARA E.K. KLEIN, MD
RONALD KLEIN, MD
SCOT E. MOSS, MA

OBJECTIVE — To evaluate the self-reported quality of life in individuals with diabetes of long duration.

RESEARCH DESIGN AND METHODS — An interview was administered 14 years after baseline to two cohorts of individuals with diabetes who have been followed in an epidemiological study periodically since 1980. Responses to the Medical Outcomes Study Short Form 36 as related to complications of diabetes, age, glycosylated hemoglobin level, and other characteristics were assessed.

RESULTS — Physical function, physical role, general health scales, and a general question about health were related to diabetes characteristics in older- and younger-onset individuals. Symptoms of sensory neuropathy were associated with the four measures in both younger- (n = 645) and older-onset (n = 292) individuals. Other descriptive variables in the younger-onset group were the presence of nephropathy, cardiovascular disease, smoking, peak expiratory flow, physical activity, and glycosylated hemoglobin. Hypoglycemic reactions were of only borderline significance and that for only one scale (physical role). In older-onset individuals, cardiovascular disease, physical activity, and sex were descriptive of responses to the quality-of-life questions.

CONCLUSIONS — Factors related to diabetes contribute to self-assessed health. Some of these factors may be modifiable, which, if altered, may lead to improved quality of life.

Many studies of self-rated health have found that individuals with diabetes mellitus score lower than individuals without the disease (1–3). Diabetes-specific attributes, such as medical regimens (4,5) and complications resulting from this disease (6), have been investigated. Thus, regarding the former, the use of insulin, the frequency of such use, glucose monitoring, and hypoglycemic episodes have been found in various studies to be either adversely (4), positively, or not (6–8) related to self-rated health measures. Complications in general have a negative impact on self-rated health (6).

The type of diabetes may also influence self-rated health (9). Whether this is related to intensity of insulin use, the duration of diabetes, or other factors is unclear. Type 1 diabetes is relatively less common than type 2 diabetes. Because self-rated health is regarded as an important outcome of the care of people with both younger- and older-onset diabetes, it is important to attempt to quantify the relative importance of factors that influence this. Such data may be especially revealing in those with diabetes of long duration when complications are manifest.

We report our findings concerning these issues, using measures of self-rated health from the Medical Outcomes Study (MOS) Short Form 36 (SF-36) (3) obtained in a well-defined cohort of individuals with diabetes of at least 14 years' duration in Wisconsin.

RESEARCH DESIGN AND METHODS

— The Wisconsin Epidemiologic Study of Diabetic Retinopathy (WESDR) is a population-based study of the prevalence and incidence of diabetic retinopathy. The methods used in identifying the population and results describing the study findings have been reported in other publications and are summarized below (10–15).

The State Division of Health provided a list of all 500 primary care physicians who were practicing medicine in July 1979 in an 11-county area in southern Wisconsin (population, 839,324) (10). Of the 500 physicians, 452 (90.4%) chose to participate in the study, and 10,135 patients were identified from their records. A review of 9,283 of their charts was performed by a team consisting of a physician and two registered nurses according to a written protocol. The criteria used for the inclusion of cases of diabetes were that the patients: *1*) had been diagnosed as having diabetes by a physician; 2) were considered to be under the primary care of the participating physician during the study period from 1 July 1979 to 30 June 1980; and *3*) were alive and resided within the 11-county area during the same period. Of the cases reviewed, 8,135 met these criteria.

A sample of 2,990 subjects was selected for the baseline examination. The sample was composed of two groups: the first group consisted of all 1,210 subjects who were diagnosed with diabetes before 30 years of age and who took insulin (younger-onset) (11); the second group consisted of 1,780 subjects who were diagnosed with diabetes at 30 years of age or older (older-onset) (12). This latter group consisted of a probability sample of older-onset subjects, stratified by duration of diabetes, in order to have an adequate number of subjects in each duration group to perform meaningful statistical analyses. Therefore, there were 576 individuals with a duration of diabetes

From the Department of Ophthalmology and Visual Sciences, University of Wisconsin Medical School, Madison, Wisconsin.

Address correspondence to Barbara E.K. Klein, MD, MPH, Department of Ophthalmology and Visual Sciences, University of Wisconsin at Madison, 610 N. Walnut St., 460 WARF, Madison, WI 53705-2397.

Received for publication 17 June 1997 and accepted in revised form 21 October 1997.

Abbreviations: EVGFP, excellent, very good, good, fair, or poor; MOS, Medical Outcomes Study; PDR, proliferative diabetic retinopathy; SF-36, Medical Outcomes Study Short Form 36; WESDR, Wisconsin Epidemiologic Study of Diabetic Retinopathy.

Downloaded from http://ada.silverchair.com/care/article-pdf/21/2/236/585674/21-2-236.pdf by guest on 10 April 2024

Table 1—*Baseline characteristics of participants in the 14-year follow-up study*

Diabetes cohort and characteristic	Participants	Live nonparticipants	Deceased	P*	P†
Younger-onset					
Age (years)	654 (26.7 ± 11.1)	128 (23.9 ± 11.0)	214 (40.4 ± 14.8)	<0.01	<0.0001
Duration of diabetes (years)	654 (12.4 ± 8.9)	128 (11.6 ± 9.0)	214 (23.5 ± 11.6)	0.35	<0.0001
Glycosylated hemoglobin (%)	622 (10.6 ± 2.0)	123 (10.9 ± 2.1)	205 (11.4 ± 2.3)	0.13	<0.0001
Systolic blood pressure (mmHg)	652 (120.2 ± 16.0)	125 (118.8 ± 15.2)	210 (141.6 ± 27.4)	0.37	<0.0001
Diastolic blood pressure (mmHg)	651 (77.3 ± 10.8)	124 (76.7 ± 10.1)	209 (84.2 ± 13.6)	0.57	<0.0001
BMI (kg/m²)	654 (23.4 ± 4.1)	128 (22.8 ± 3.8)	212 (24.4 ± 5.0)	0.12	<0.005
Percentage male	654 (49.4 ± 2.0)	128 (50.8 ± 4.4)	214 (57.9 ± 3.4)	0.85	<0.05
Older-onset					
Age (years)	333 (57.9 ± 10.1)	42 (58.4 ± 11.2)	995 (69.9 ± 9.9)	0.76	<0.0001
Duration of diabetes (years)	333 (8.8 ± 6.5)	42 (8.9 ± 6.7)	995 (13.0 ± 8.4)	0.93	<0.0001
Glycosylated hemoglobin (%)	312 (9.3 ± 1.9)	41 (9.6 ± 2.6)	917 (9.8 ± 2.0)	0.37	<0.0005
Systolic blood pressure (mmHg)	333 (140.1 ± 20.4)	42 (136.9 ± 17.2)	991 (150.3 ± 24.7)	0.33	<0.0001
Diastolic blood pressure (mmHg)	332 (81.6 ± 10.5)	42 (81.9 ± 9.0)	987 (78.2 ± 12.5)	0.86	<0.0001
BMI (kg/m²)	333 (29.8 ± 6.1)	42 (29.6 ± 5.5)	987 (28.3 ± 5.4)	0.84	<0.0001
Percentage male	333 (39.0 ± 2.7)	42 (50.0 ± 7.7)	995 (48.7 ± 1.6)	0.18	<0.005

Data are *n* (means ± SD) or *P*. *Participants versus live nonparticipants; †deceased versus participants.

of <5 years, 579 individuals with a duration of 5–14 years, and 625 individuals with a duration of >15 years who were selected for inclusion in the study.

The tenets of the Declaration of Helsinki were followed, informed signed consent was obtained, and institutional human experimentation committee approval was granted.

Of the younger-onset individuals, 996 participated in the baseline examination (1980 to 1982) (11), 891 were in the 4-year follow-up (13), 765 were in the 10-year follow-up (14), and 654 were in the 14-year follow-up. Of the 1,780 eligible older-onset individuals, 1,370 participated in the baseline examination (12), 987 were in the 4-year follow-up (15), 533 were in the 10-year follow-up (14), and 333 consented to a telephone interview 14 years after baseline. Reasons for nonparticipation and comparisons between participants and nonparticipants at baseline and the 4- and 10-year follow-ups have been presented elsewhere (11–15). The most common reason for nonparticipation since the baseline examination has been death. The mean time between the baseline and the most recent follow-up examination or interview was 14.4 ± 0.5 years.

The duration of diabetes was the time between diagnosis and the 14-year examination. During each study interview, subjects were queried about whether they took medication for diabetes and, if so, the names and doses of such preparations.

When evaluating risk factors, data from the 14-year follow-up examination were used in the analyses. Younger-onset individuals were seen in a mobile examination van. For this examination only, older-onset individuals were interviewed by telephone and no physical data were obtained. During the medical interview, individuals were asked whether they had smoked >100 cigarettes in their lives and, if so, how many cigarettes per day they had smoked and for how many years (one pack-year was equivalent to smoking one pack per day for a year) and whether a doctor ever told them that they had had a heart attack, angina, or a stroke. All medications and dosages, including the frequency of insulin use, were recorded. Subjects were asked whether they had had a low blood sugar reaction to insulin in the past year and, if so, how often such reactions occurred. Other questions included whether, since being diagnosed with diabetes, they had had numbness or tingling in their hands or feet (other than from "falling asleep"), loss of sensation in their hands or feet, and/or decreased ability to feel the hotness or coldness of things they touched. A symptom index was constructed with a value equal to the number of positive responses (0 to 3).

End-stage renal disease was defined as a history of kidney transplant or being on renal dialysis. History of lower-extremity amputation was ascertained by questionnaire or direct observation. The SF-36 questionnaire was administered during the study. In addition, all subjects were asked whether their health was excellent, very good, good, fair, or poor (EVGFP scale).

In rating their physical activity, subjects were asked to estimate how many flights of stairs they climbed each day, how many city blocks they walked each day, and whether they would describe their usual activity as sedentary (0), moderate (1), or strenuous (2). In addition, subjects were asked how many times a week they engaged in a regular activity long enough to work up a sweat. A sedentary lifestyle was defined as less than three such activities per week.

For those examined, after the interview, a measure of peak expiratory flow was obtained for three trials. The data used in the analyses reflects the maximum of the

Table 2—*Summary descriptions of the distributions of SF-36 scales for the younger-onset cohort*

	PF	RP	BP	GH	VT	SF	RE	MH	EVGFP
n	645	644	644	645	644	644	644	644	644
Mean	79	78	74	62	57	88	87	75	54
SD	26	35	24	23	20	19	29	17	22

PF, physical functioning; RP, physical role; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, emotional role; MH, mental health.

Downloaded from http://ada.silverchair.com/care/article-pdf/21/2/236/585674/21-2-236.pdf by guest on 10 April 2024

Table 3—*Summary descriptions of the distributions of SF-36 scales for the older-onset cohort*

	PF	RP	BP	GH	VT	SF	RE	MH	EVGFP
n	292	288	291	292	291	291	289	291	292
Mean	58	59	67	56	56	87	77	78	44
SD	32	38	27	23	25	23	33	18	24

PF, physical functioning; RP, physical role; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, emotional role; MH, mental health.

Table 4—*Multiple linear regression analyses of the scales of self-rated health and study variables in individuals with younger-onset diabetes*

Scale and characteristic	Step	Coefficient	*P*
General health			
Neuropathy symptoms (0–3)	1	−6.9	<0.0001
Cardiovascular disease	Present	−9.1	<0.001
Proteinuria	Present	−9.8	<0.0001
End-stage renal disease	Present	−13.0	<0.0001
Smoking history	Current	−7.2	<0.005
Peak expiratory flow	100	4.1	<0.0001
Blocks walked per day	10	2.1	<0.01
Total to HDL cholesterol ratio	1	−1.4	<0.01
Glycosylated hemoglobin (%)	1	−1.6	<0.005
Physical functioning			
Age (years)	10 years	−3.5	<0.0001
Neuropathy symptoms (0–3)	1	−8.2	<0.0001
Cardiovascular disease	Present	−8.8	<0.005
Amputation	Present	−11.3	<0.05
Smoking history	Current	−6.0	<0.01
Retinopathy (0–14)	1	−0.4	<0.05
Peak expiratory flow	100	4.5	<0.0001
Flights of stairs per day	10	4.4	<0.005
Blocks walked per day	10	3.4	<0.0001
Self-rated activity (0–2)	1	4.0	<0.005
Physical role			
Age (years)	10 years	−3.3	<0.05
Neuropathy symptoms (0–3)	1	−10.9	<0.0001
Amputation	Present	−35.8	<0.0001
Smoking history	Current	−12.3	<0.0005
Peak expiratory flow	100	4.8	<0.0005
Blocks walked per day	10	2.0	0.08
Total to HDL cholesterol ratio	1	−3.3	<0.0001
Reactions (0–4)	1	−2.7	<0.05
EVGFP			
Neuropathy symptoms (0–3)	1	−3.9	<0.0001
Cardiovascular disease	Present	−7.2	<0.05
Proteinuria	Present	−4.2	0.08
End-stage renal disease	Present	−6.4	0.05
Smoking history	Current	−7.4	<0.005
Retinopathy (0–14)	1	−0.5	<0.05
Peak expiratory flow	100	3.1	<0.0005
Sedentary lifestyle	Present	−4.0	<0.05
Total to HDL cholesterol ratio	1	−1.9	<0.005
Glycosylated hemoglobin (%)	1	−1.5	<0.05

three trials. Color stereoscopic fundus photographs were taken of each eye. They were subsequently graded and classified according to the Modified Airlie House Classification as described by the Early Treatment Diabetic Retinopathy Study (16,17). In general, gradings are ranked according to severity. The scheme specifies 13 levels of severity of retinopathy. For the analyses presented, the level in the worse eye was used and was grouped into four categories: no retinopathy (level 10), mild nonproliferative retinopathy (levels 21–37), moderate nonproliferative retinopathy (levels 43–53), and proliferative diabetic retinopathy (PDR) (levels 60+).

Glycosylated hemoglobin levels were measured by a microcolumn technique on a specimen of venous blood (18). Gross proteinuria was defined as a urine concentration of ≥0.30 *g*/l measured by a reagent strip. Serum was tested for total and high-density lipoprotein cholesterol concentrations.

The SF-36 questionnaire was scored in the standard fashion (19) and was standardized to a 0–100 scale. Eight scales were analyzed: general health (GH), physical functioning (PF), social functioning (SF), mental health (MH), physical role (RP), emotional role (RE), bodily pain (BP), and vitality (VT). In addition, the response to the self-rated health question (EVGFP) was rescaled from 0 (poor) to 100 (excellent). Statistical analysis was performed using SAS (20). The effect of independent variables on the SF-36 scales was assessed by multiple linear regression where the dependent variable was one of the SF-36 scales. Thus, the regression coefficient for each independent variable represents the change on the SF-36 scale for a unit or other specified change in the independent variable.

RESULTS — Baseline data contrasting participants and nonparticipants are given in Table 1. Nonparticipants who were deceased at the 14-year follow-up were more likely to be older and have a poor health profile at baseline than participants in both the younger- and older-onset groups. Living nonparticipants were similar to participants.

Summary descriptors of the distributions of the eight scales of the SF-36 that were used in this study are given in Tables 2 and 3. Because of the differences in age and other characteristics associated with these outcomes as well as the differences in interview settings and less information on covariates for older-onset individuals, sta-

Downloaded from http://ada.silverchair.com/care/article-pdf/21/2/236/585674/21-2-236.pdf by guest on 10 April 2024

tistical comparisons of the differences in distributions of the responses to the questions between the groups in our study were not appropriate. For most scales, means for younger-onset individuals were higher than for older-onset individuals.

In previous studies, it has been found that not all scales are affected by diabetes status. Therefore, the following analyses were performed only for those four scales that we have found to be related to other characteristics of diabetes in our population. Results of these analyses for the younger-onset cohort are shown in Table 4. Higher sensory neuropathy score, cardiovascular disease, proteinuria, renal disease, current smoking, higher ratio of total to high-density lipoprotein cholesterol, and higher glycosylated hemoglobin level were negatively associated, while higher peak expiratory flow and more blocks-walked-per-day were positively associated with general health. For the physical functioning and physical role scales and the EVGFP score, a similar constellation of independent characteristics entered the model. Glycosylated hemoglobin level was a significant descriptor for two of the four scales. Age was significant for both scales describing self-rated physical abilities. Insulin reactions were significant only for the physical role scale.

Because the older-onset subjects did not participate in the examinations at the 14-year follow-up, there was a more circumscribed number of independent characteristics to evaluate. Results for this group are given in Table 5. Sensory neuropathy was a significant descriptor for each scale. Age was important for both self-rated physical ability scales, and men scored higher on each scale than did women. Sedentary lifestyle was a significant descriptor of general health and physical ability.

Table 5—*Multiple linear regression analyses of the scales of self-rated health and study variables in individuals with older-onset diabetes*

Scale and characteristic	Step	Coefficient	*P*
General health			
Neuropathy symptoms (0–3)	1	−7.2	<0.0001
Cardiovascular disease	Present	−13.0	<0.0001
Sex	Male	11.3	<0.0001
Sedentary lifestyle	Present	−6.0	<0.05
Physical functioning			
Age (years)	10 years	−4.3	<0.05
Neuropathy symptoms (0–3)	1	−9.1	<0.0001
Cardiovascular disease	Present	−14.5	<0.0001
Sex	Male	12.8	<0.0005
Amputation	Present	−15.0	<0.05
Sedentary lifestyle	Present	−18.9	<0.0001
Physical role			
Age (years)	10 years	−5.7	<0.01
Neuropathy symptoms (0–3)	1	−14.5	<0.0001
Cardiovascular disease	Present	−12.0	<0.005
Sex	Male	10.9	<0.01
Sedentary lifestyle	Present	−12.1	<0.01
EVGFP			
Neuropathy symptoms (0–3)	1	−6.6	<0.0001
Cardiovascular disease	Present	−13.3	<0.0001
Sex	Male	15.0	<0.0001

CONCLUSIONS — The traditional medical approach to health care is to diagnose, administer curative or restorative treatment when available, and measure the result of those interventions by objective measures, often by assessing certain physical or chemical benchmarks. Examples of these might be X-ray evidence of realigned bone fragments after the reduction of a fracture or the return to a normal temperature after the treatment of a febrile illness. Recently, additional health care outcomes have assumed equal importance. Such outcomes are the patient's assessment of the health care events and the results of their treatment.

To evaluate the self-assessed measures of disease and treatment, questionnaire and interview instruments have been designed and widely tested. One such questionnaire is the MOS SF-36 (3). This interview schedule is composed of 36 questions that measure eight health concepts. The interview has a known reliability, and the usual ranges of responses for several common medical conditions have been published (3). All 36 questions were administered during the course of our study. Wenneker et al. (21) found that their measure of the clinical severity of diabetes and its complications was not significantly related to all scales that are derived from the SF-36 questions. Hammond and Aoki (22) also found that only some scales were informative in their study of diabetic subjects. In univariate analyses of our data, we found that the diabetes characteristics of interest were related to the general health, physical functioning, physical role, and EVGPP scales. Thus, we limited our multivariable analyses to those scales.

The physical functioning scale includes responses to queries about limitations of specific activities, whereas the physical role scale includes responses to questions as to whether physical problems caused limitations in work (and nonwork) activities. The general health scale includes responses to nonspecific questions about health and how long any decrease in health is likely to last. These three scales and the commonly used question "In general, would you say your health is excellent, very good, good, fair, or poor?" had the greatest variability in both our populations and, therefore, were the most informative in evaluating the relationship of the attributes of our two cohorts of subjects with diabetes to their quality of life.

Our findings suggest that the long-term complications of diabetes were commonly associated with poorer scores. Regarding self-assessed physical abilities, age in our populations as well as in the general population was significant in describing poorer scores in both groups (3).

We note that, contrary to expectations, the frequency of hypoglycemic reactions was a significant descriptor of the scores for only one scale, physical role, and only in the younger-onset cohort. In individuals with a long duration of diabetes, such episodes were not infrequent with only 6% of the younger- and 32% of the older-onset individuals using insulin reporting that they never had such a reaction. The interpretation that is most compatible with these data is that such reactions are not very

Downloaded from http://ada.silverchair.com/care/article-pdf/21/2/236/585674/21-2-236.pdf by guest on 10 April 2024

important in the self-rated estimates of function that these scales reflect. Of perhaps greater interest is the fact that glycosylated hemoglobin levels are significantly related to some scales and that the higher the level the lower the score. Thus, in addition to its causal role in the complications of diabetes reflected in lower scores on these scales, there is a residual negative effect attributed to hyperglycemia.

We analyzed the responses to the SF-36 separately for individuals of younger onset and those of older onset. This was done for several reasons. The younger-onset group was questioned face-to-face, whereas the older-onset group was questioned by telephone. Examination variables were not available for the older-onset group. Also, age and distributions of other variables differed significantly between the groups, which may have influenced the relationships observed. Nevertheless, symptoms of neuropathy, a history of cardiovascular disease, and reported measures of activity were significantly related to outcomes in both groups. These may suggest that the complications of diabetes suffered by younger- and older-onset individuals influence the responses to quality-of-life questions in similar ways.

We are limited in our ability to describe other possibly significant associations in the older-onset subjects, since not all study variables were collected from this group. This was because this cohort was, in general, older and more infirm, such that full participation would have been a burden for many of them. We are also limited by the reality that age and a long duration of diabetes are associated with increased mortality. However, for these long-term survivors, we can say that the residual effects of diabetes (e.g., neuropathy) are still causing a diminished quality of life.

It is important to note that in the younger-onset group, there are several characteristics that can be manipulated and that may lead to a relative improvement in quality of life, if not for our cohort, then for those who come after. Smoking, physical activity, and glycosylated hemoglobin are all to some extent governed by behavior. While we do not have data on current smoking, physical activity, and glycosylated hemoglobin at the time of administering the SF-36 in the older-onset cohort, it may well be that we would have found relationships of these to the quality-of-life scales that were similar to those in the younger-onset cohort. These are areas where counseling and patient involvement may lead to diminished limitations. However, cross-sectional data such as we present cannot provide direct information about the antecedent-consequent nature of these associations. Longitudinal studies of these relationships are necessary.

Acknowledgments — This research was supported by National Institutes of Health Grant EYO3083 (R.K. and B.E.K.K.).

References

1. Stewart AL, Greenfield S, Hays RD, Wells K, Rogers WH, Berry SD, McGlynn EA, Ware JE Jr: Functional status and well-being of patients with chronic conditions: results from the Medical Outcomes Study. *JAMA* 262:907–913, 1989
2. Tarlov AR, Ware JE Jr., Greenfield S, Nelson EC, Perrin E, Zubkoff M: The Medical Outcomes Study: an application of methods for monitoring the results of medical care. *JAMA* 262:925–930, 1989
3. Ware JE Jr.: *SF-36 Health Survey Manual and Interpretation Guide*. Boston, MA, The Health Institute, New England Medical Center, 1993, chapter 10
4. Nerenz DR, Repasky DP, Whitehouse FW, Kahkonen DM: Ongoing assessment of health status in patients with diabetes mellitus. *Med Care* 30 (Suppl. 5):MS112–MS124, 1992
5. Anderson RM, Davis WK, Fitzgerald JT, Hiss RG, Wisdom K: A comparison of global versus disease-specific quality-of-life measures in patients with NIDDM. *Diabetes Care* 20:299–305, 1997
6. Johnson JA, Nowatzki TE, Coons SJ: Health-related quality of life of diabetic Pima Indians. *Med Care* 34:97–102, 1996
7. Tilly KF, Belton AB, McLachlan JFC: Continuous monitoring of health status outcomes: experience with a diabetes education program. *Diabetes Educ* 21:413–419, 1995
8. Weinberger M, Kirkman MS, Samsa GP, Cowper PA, Shortliffe EA, Simel DL, Feussner JR: The relationship between glycemic control and health-related quality of life in patients with non-insulin-dependent diabetes mellitus. *Med Care* 32:1173–1181, 1994
9. Jacobson AM, de Groot M, Samson JA: The evaluation of two measures of quality of life in patients with type I and type II diabetes. *Diabetes Care* 17:267–274, 1994
10. Klein R, Klein BEK, Moss SE, DeMets DL, Kaufman I, Voss PS: Prevalence of diabetes mellitus in southern Wisconsin. *Amer J Epidemiol* 119:54–61, 1984
11. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL: The Wisconsin Epidemiologic Study of Diabetic Retinopathy. II. Prevalence and risk of diabetic retinopathy when age at diagnosis is less than 30 years. *Arch Ophthalmol* 102:520–526, 1984
12. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL: The Wisconsin Epidemiologic Study of Diabetic Retinopathy. III. Prevalence and risk of diabetic retinopathy when age at diagnosis is 30 or more years. *Arch Ophthalmol* 102:527–532, 1984
13. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL: The Wisconsin Epidemiologic Study of Diabetic Retinopathy. IX. Four-year incidence and progression of diabetic retinopathy when age at diagnosis is less than 30 years. *Arch Ophthalmol* 107:237–243, 1989
14. Klein R, Klein BEK, Moss SE, Cruickshanks KJ: The Wisconsin Epidemiologic Study of Diabetic Retinopathy. XIV. Ten-year incidence and progression of diabetic retinopathy. *Arch Ophthalmol* 112:1217–1228, 1994
15. Klein R, Klein BEK, Moss SE, Davis MD, DeMets DL: The Wisconsin Epidemiologic Study of Diabetic Retinopathy. X. Four-year incidence and progression of diabetic retinopathy when age at diagnosis is 30 years or more. *Arch Ophthalmol* 107:244–249, 1989
16. Early Treatment Diabetic Retinopathy Study Coordinating Center: *Manual of Operations*. Baltimore, MD, Diabetic Retinopathy Study Coordinating Center, 1985, chapter 13 (National Technical Information Service, accession #PB 85–223006/AS)
17. Klein BEK, Davis MD, Segal P, Long JA, Harris WA, Haug GA, Magli YL, Syrjala S: Diabetic retinopathy: assessment of severity and progression. *Ophthalmology* 91:10–17, 1984
18. Quick-Step: *Fast Hemoglobin Test System*. Akron, OH, Isolab, 1981
19. Ware JE Jr.: *SF-36 Health Survey Manual and Interpretation Guide*. Boston, MA, The Health Institute, New England Medical Center, 1993, chapter 6
20. SAS Institute: *SAS/STAT User's Guide: Version 6, Fourth Edition, Volume 2*. Cary, NC, SAS Inst., 1989, p. 1351–1456
21. Wenneker MB, McHorney CA, Kleszak SM, Ware JE, Greenfield S: The impact of diabetes severity on quality of life: results from the Medical Outcomes Study (Abstract). *Clin Res* 29:PB12A, 1991
22. Hammond GS, Aoki TT: Measurement of health status in diabetic patients: diabetes impact measurement scales. *Diabetes Care* 15:469–477, 1992

Downloaded from http://ada.silverchair.com/care/article-pdf/21/2/236/585674/21-2-236.pdf by guest on 10 April 2024