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ORIGINAL RESEARCH

Factors associated with adequate levels of knowledge about type 2 diabetes mellitus among outpatients of health service networks in Bogotá D.C., Colombia

Factores asociados con niveles adecuados de conocimientos sobre diabetes mellitus tipo 2 en pacientes de redes de servicios de salud en Bogotá D.C., Colombia

Skarlet Marcell Vásquez[1,2] Juan Carlos Villar[1] Luz Ángela Torres-López[1] Edgar Camilo Barrera[1] Ángela Manuela Balcázar-Muñoz[1]

[1] Fundación Cardioinfantil - Institute of Cardiology - Research Center - Bogotá D.C. - Colombia.
[2] Universidad Autónoma de Bucaramanga - Faculty of Health Sciences - Bucaramanga - Colombia.

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Corresponding author: Juan Carlos Villar. Centro de Investigaciones, Instituto de Cardiología, Fundación Cardioinfantil. Bogotá D.C. E-mail: jvillarc@lacardio.org.

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Abstract

Introduction: One of the factors impacting the clinical outcomes of patients with type 2 diabetes mellitus (T2DM) is the level of knowledge about their condition. Little is known regarding knowledge of T2DM among Colombian patients and the factors associated with their level of knowledge.
Objective: To identify the factors associated with having an adequate level of knowledge about T2DM in patients with this diagnosis treated in outpatient health services of Bogotá, D.C., Colombia.
Materials and methods: Cross-sectional study conducted in 1068 adults with T2DM treated in 2021 in the outpatient services of 53 health care institutions of four health networks of Bogotá D.C. Consecutive patients were recruited at each institution for a telephone survey based on a randomly selected case. A questionnaire with 9 questions on T2DM was administered to the participants (6 questions were validated due to their relationship with the age of diagnosis [in years] or HbA1c levels). An adequate level of knowledge was understood as correctly answering 4 of the 6 validated questions. A multiple logistic regression analysis was performed to identify factors associated with having an adequate level of knowledge.
Results: Participants' median age was 63.97 years, 64.98% were women, and the time elapsed since diagnosis was >10 years in 26.68%. Furthermore, 24.72% (95%CI: 22.23-27.39) showed an adequate level of knowledge. Being female (OR=1.63), having a level of schooling above elementary education (OR=1.82), having an occupation (OR=1.70), having a diagnosis of T2DM >5 years (OR=1.49), and having ≥1 comorbidity/history of major health condition (OR=1.48) were associated with an adequate level of knowledge about T2DM.
Conclusion: One in four patients with T2DM in Bogotá showed an adequate knowledge of their condition. Given the amount and variety of patients with low levels of knowledge, it is essential to implement educational programs, particularly for men with a low level of education and recent diagnosis.

Resumen

Introducción. Uno de los factores que influyen en la evolución clínica de los pacientes con diabetes *mellitus* tipo 2 (DMT2) es su nivel de conocimientos sobre su condición. Se conoce poco sobre el nivel de conocimientos sobre DMT2 en pacientes colombianos y sobre los factores asociados a dicho nivel.
Objetivo. Identificar los factores asociados con tener un nivel adecuado de conocimientos sobre DMT2 en pacientes con este diagnóstico atendidos en servicios ambulatorios de salud de Bogotá, D.C., Colombia.
Materiales y métodos. Estudio transversal realizado en 1068 adultos con DMT2 atendidos en 2021 en los servicios ambulatorios de 53 instituciones de salud pertenecientes a cuatro redes de salud de Bogotá, D.C. A partir de un caso seleccionado aleatoriamente en cada institución, se eligieron pacientes consecutivos para realizar una encuesta telefónica. A los participantes se les aplicó un cuestionario con 9 preguntas sobre DMT2 (6 preguntas fueron validadas debido a su relación con la antigüedad del diagnóstico (en años) o los niveles de HbA1c). Se definió como nivel adecuado de conocimientos responder correctamente 4 de las 6 preguntas validadas. Se realizó un análisis de regresión logística múltiple para identificar los factores asociados con tener un nivel adecuado de conocimientos.
Resultados. La mediana de edad de los participantes fue 63.97 años, 64.98% eran mujeres y en 26.68% el tiempo desde el diagnóstico era >10 años; además, 24.72% (IC95%: 22.23-27.39) mostraron un nivel adecuado de conocimientos. Ser mujer (OR=1.63), tener un nivel de escolaridad mayor a educación primaria (OR=1.82), tener una ocupación (OR=1.70), tener un diagnóstico de DMT2 >5 años (OR=1.49) y tener ≥1 comorbilidad/antecedente de condición de salud importante (OR=1.48) se asociaron con tener un nivel adecuado de conocimientos sobre DMT2.
Conclusiones. Uno de cada 4 pacientes con DMT2 en Bogotá muestra un nivel adecuado de conocimientos sobre su condición. Dada la cantidad y diversidad de pacientes con conocimientos inadecuados, es urgente implementar programas de educación, especialmente en hombres de bajo nivel educativo con diagnóstico reciente.

Introduction

Type 2 diabetes mellitus (T2DM) is a chronic disease with a high and increasing burden of disease. Estimates suggest that in 2021 there were approximately 529 million people suffering from diabetes worldwide (i.e., 6.1% of the world's population) and 96% of them had T2DM.[1] It is also expected that the global age-standardized prevalence of diabetes increases by 59.7% (from 6.1 to 9.8%) between 2021 and 2050, which means that more than 1.31 billion people will have diabetes in 2050.[1]

According to data from the Global Burden Disease Study 2017, deaths from type 1 diabetes mellitus (T1DM) and T2DM increased by 15.1% and 43.0%, respectively, worldwide between 2007 and 2017, but it should be noted that the mortality rate associated with T1DM decreased by 11.0% in this period, while mortality from T2DM increased by 5.9%.[2] Furthermore, based on data from the Global Burden Disease Study 2016, diabetes was the 11th, 14th, 9th, 17th, and 21st leading cause of years of life lost in high-, high-middle-, middle-, low-middle-, and low-income countries, respectively.[3]

Since it is a chronic disease, self-care and the level of knowledge about T2DM are known to positively influence its clinical course. In this regard, several systematic reviews have consistently reported that the promotion of self-care and education on the management of their condition among these patients improves their knowledge of T2DM, promotes better habits and medication adherence, and reduces glycosylated hemoglobin (HbA1c) levels.[4-6] Accordingly, diabetes prevention and care programs that include the use of educational interventions have been implemented in high-income countries, proving to be effective in controlling this chronic disease.[7]

In Latin America, small sample studies have reported a low-moderate level of knowledge in 40-80% of patients with T2DM, mainly on general aspects of the disease, complications, diet, and recommended lifestyles.[8-10] In this regard, some studies in the region have identified the time elapsed since diagnosis, the patient's educational level, age, and income as factors associated with the level of knowledge about the disease.[10-12] Studies in other regions of the world, such as the Middle East and Africa, have also described additional factors such as sex, marital status, family history of diabetes, and occupation, although it is important to mention that these factors are contradictory among these studies.[13-15]

The limited level of knowledge of patients with T2DM about their disease described in the region and the uncertainty about the factors related to this knowledge highlight the need for studies that seek to estimate the proportion of patients with adequate knowledge and to define the determinants of the level of knowledge about T2DM in Colombia. This would allow designing and developing health education interventions, both collective and directed to specific groups of patients. In view of the above, the objective of the present study was to identify the factors associated with having an adequate level of knowledge about T2DM among patients with this diagnosis treated in outpatient health services of Bogotá, D.C., Colombia.

Materials and methods

Study design

Multicenter cross-sectional study from a cluster experiment designed to assess changes in terms of knowledge and recommended practices in adult patients with different noncommunicable diseases after receiving information about their disease through different channels.

Study population, sample, and participant recruitment

The study population consisted of adults (≥18 years) with T2DM treated in 2021 in the outpatient services of 53 health institutions ascribed to 4 health networks of Bogotá D.C. (3 public networks and 1 private network).

The sample size was calculated using the software G-power, considering a statistical power of 0.80, an alpha error probability of 0.05, a probability of an event under the null hypothesis of 0.2 (assuming a minimum frequency of adequate knowledge of T2DM of 20%, as reported in the literature for these patients in Latin America[8-10]), and an effect size (OR) of 1.25 for the multiple logistic regression, thus obtaining a minimum sample size of 994 patients.

Participants were recruited as follows: first, and in accordance with the objective of the cluster experiment from which this cross-sectional study is derived, the four health networks provided a list containing the data of the patients from the healthcare institution where they were treated in 2021. Then, in each list, patients with a diagnosis of T2DM were identified (information obtained from the data provided in the lists based on the patients' medical records) and from them, one patient was selected by simple random sampling to subsequently contact them via telephone and invite them to participate in the study; this process was carried out consecutively until approximately 20 individuals were recruited, forming a conglomerate. This process was carried out in the 53 healthcare institutions (53 clusters) and a total of 1 068 patients were recruited, thus anticipating possible biases related to the lack of information for some of the factors to be evaluated. It should be noted that the patients who did not have adequate cognitive and sensory capacity to respond to the telephone survey were not considered.

Procedures and sources of information

Patients were contacted by telephone between May and August 2021. Once the patient's identity was confirmed (matching their identification details with the data reported in the lists provided by each healthcare institution) and their informed consent was obtained (which was logged by recording the call), each participant was given a questionnaire-based survey to obtain information on sociodemographic and anthropometric variables (age, sex, schooling, socioeconomic level according to the DANE classification,[16] occupation, marital status) and clinical variables (time elapsed since diagnosis, presence of comorbidities, and/or history of major health condition, among others), which are detailed in Annex 1. In Colombia, socioeconomic status is divided into 6 strata depending on the place of residence and access to basic services (strata 1 and 2 correspond to the low socioeconomic level; strata 3 and 4, to the medium socioeconomic level; and strata 5 and 6, to the high socioeconomic level).[16]

Also, based on the review of the information extracted through the migration of clinical records data (provided by each health network), the most recent data on the following variables were collected: body mass index (BMI), HbA1c levels, and blood creatinine levels.

Then, during a second call, a questionnaire was administered to assess the patient's knowledge of T2DM; this instrument is described in the following subsection. In addition, to reduce information biases related to variability in the administration of the questionnaire, the telephone surveys were conducted by trained health professionals and following a predesigned script.

Instrument

The questionnaire designed to assess knowledge of T2DM was based on a literature review and the recommendations included in the Clinical Practice Guidelines (CPG) for the management of T2DM issued by the Colombian Ministry of Health and Social Protection.[17] The questions were formulated by a group of internists, general practitioners and nurses, who evaluated the face and content validity of the instrument, appraising the wording and comprehensibility of the questions and verifying that the number of questions was consistent with the recommendations found in the CPG and related literature, respectively. The instrument included nine questions on aspects related to T2DM such as definition, follow-up, and complications. All the questions in the instrument were closed-ended (single or multiple choice) (Annex 2).

Variables of interest

Adequate knowledge of T2DM, defined as correctly answering 4 of the 6 questions under consideration for the analysis of the construct "knowledge" (see data analysis and results sections), was defined as the dependent variable. Each answer was scored as correct following predefined criteria (Annex 2), and each question was given a similar weight to calculate the final score. On the other hand, time elapsed since diagnosis and HbA1c levels were established as main independent variables. In addition, age, sex and schooling were considered as covariates in accordance with what was found in the literature review.[18-20]

Statistical analysis

The sociodemographic, anthropometric, and clinical characteristics of the participants, as well as the results they obtained in the knowledge test, are presented for the whole sample and by ranges of time elapsed since diagnosis (<5 years, 5-10 years, >10 years) using absolute and relative frequencies for discrete variables and medians and interquartile ranges for continuous variables, since the data showed a nonparametric distribution (Kolmogorov-Smirnov test). Moreover, null hypotheses between these three groups were tested using Chi-square or Kruskal-Wallis tests, respectively.

The frequency of correct answers to each question in the questionnaire was also measured. For predictive validation purposes and to establish the construct of T2DM knowledge, the distribution of the frequency of correct responses was examined based on two criteria: years since diagnosis of T2DM and HbA1c levels adjusted for years of diagnosis. The question was considered to discriminate the level of knowledge if the proportion of correct answers increased significantly as the years since diagnosis increased (by performing a Chi-square test to assess the trend of the distribution), or if the adjusted HbA1c levels were significantly higher in patients who had answered incorrectly, which was assessed using a general linear model where ranges of time elapsed since diagnosis were entered as a covariate.

Questions that met at least one of the two validity criteria were used to dichotomize the knowledge level variable into adequate (4 or more correct answers on the 6 validated questions) or inadequate (less than 4 correct answers on the 6 validated questions). The internal consistency of the 6 questions was evaluated by calculating Cronbach's Alpha coefficient.

Additionally, to explore the relationship between level of knowledge and patient characteristics, the distribution for the two groups (adequate level of knowledge vs. inadequate level of knowledge) was described, and then null hypotheses between these groups were evaluated using the Chi-square test or the Kruskall-Wallis test, depending on the nature of the variable.

In order to determine the variables independently associated with having an adequate level of knowledge about T2DM, variables with a $p<0.20$ in the bivariate analysis and variables identified in the literature review (age, sex, and schooling)[18-20] were selected as candidates for inclusion in the logistic regression model. Regression models were constructed based on these variables for the entire sample, and then a sensitivity analysis was performed by age (up to 60 years or older than 60 years) or sex, limiting the number of predictors to at least 10 events (participants with adequate knowledge of T2DM) for each predictor in the model.

Finally, the category inadequate level of knowledge was taken as a reference for the outcome variable, so the model reflects the increase in the probability of having an adequate level of knowledge about T2DM for each factor. The goodness of fit of the model was evaluated using the Hosmer-Lemeshow test. Statistical analyses were performed in the STATA software (version 12.0) and a statistical significance level of 5% (two-tailed) was considered in all analyses.

Ethical considerations

This study followed the ethical principles for the conduct of biomedical studies involving human subjects established in the Declaration of Helsinki[21] and the scientific, technical and administrative standards for health research in Resolution 8430 of 1993 issued by the Colombian Ministry of Health.[22] The study was also approved by the Research Ethics Committee of the Secretaría Distrital de Salud de Bogotá (Bogotá Health Department) (Minutes No. 2016EE62783 of September 30, 2016) and the Institutional Research Ethics Committee C.I.E.I CAFAM (Minutes No. 520 of October 16, 2019). Additionally, as reported in the procedures section, informed consent was obtained from all participants.

Results

Selection of participants

Figure 1 presents the flowchart for the selection of study participants. Of the 1 560 patients approached, 1 102 (70.64%) agreed to participate in the study and, of these, 1 068 answered the T2DM knowledge questionnaire. Most of the patients who answered the questionnaire were treated in institutions of the three public health networks (86.98%).

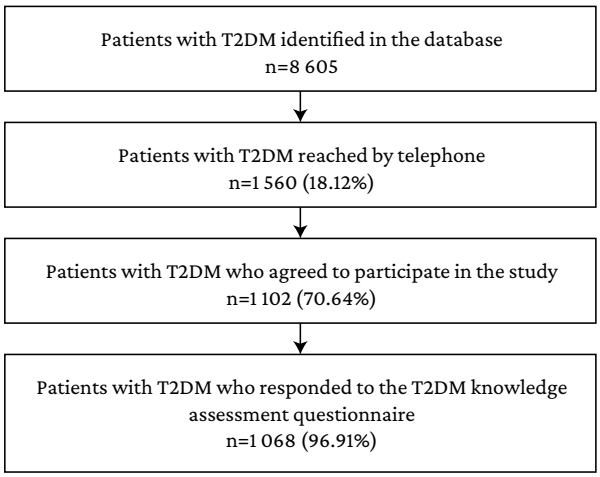


Figure 1. Study participant selection process.

Characteristics of the participants

The median age of the participants was 63.97 years (IQR: 56.73-71.66), 65.15% were women, 79.59% belonged to the socioeconomic strata 1 and 2, 53.93% reported "housework" as their occupation, and only 18.26% had completed secondary school. With regard to clinical characteristics, the following was found: the median HbA1c level was 7.14% (IQR: 6.24-9.00), 91.25% had at least one comorbidity and/or history of a major health condition, with a history of hypertension (59.18%) and dyslipidemia (19.57%) being the most frequent. In addition, 43.82% of patients reported that they had been assessed by the same physician in less than 20% of their follow-up appointments (Table1).

When comparing by years elapsed since T2DM diagnosis, statistically significant differences were observed between the three groups (<5, 5-10, >10 years) in the following variables: distribution of sex, marital status, occupation, BMI, Hb1Ac level, creatinine level, presence of comorbidities and/or history of major health condition, and presence of hypertension, chronic kidney disease and COPD (Table 1).

Table 1. Characteristics of study participants.

	All participants (n=1068) n (%)	**Years elapsed since diagnosis**			
		< 5 (n=394) n (%)	**5 - 10 (n=389) n (%)**	**> 10 (n=285) n (%)**	***p*-value**
Age (years) Median (IQR)	**63.97 (56.73 - 71.66)**	**61.82 (55.01 - 68.35)**	**63.77 (56.75 - 89.66)**	**67.64 (60.38 - 68.35)**	**<0.001**
Female sex	**694 (64.98)**	**280 (71.07)**	**246 (63.24)**	**168 (58.95)**	**0.003**
Schooling					0.244
Elementary	808 (75.66)	306 (77.66)	281 (72.24)	221 (77.54)	
Secondary	195 (18.26)	66 (16.75)	86 (22.11)	43 (15.09)	
Higher	56 (5.24)	18 (4.57)	20 (5.14)	18 (6.32)	
No data	9 (0.84)	4 (1.02)	2 (0.51)	3 (1.05)	
Socioeconomic stratum					0.101
1	311 (29.12)	116 (29.44)	118 (30.33)	77 (27.02)	
2	539 (50.47)	208 (52.79)	200 (51.41)	131 (45.96)	
≥3	212 (19.85)	68 (17.26)	69 (17.74)	75 (26.32)	
No data	6 (0.56)	2 (0.51)	2 (0.51)	2 (0.70)	
Marital status					**0.008**
Single	591 (55.34)	242 (61.42)	205 (52.70)	144 (50.53)	
Married/domestic partnership	475 (44.47)	151 (38.33)	184 (47.30)	140 (49.12)	
No data	2 (0.19)	1 (0.25)	-	1 (0.35)	
Occupation					**<0.001**
Housework	576 (53.93)	212 (53.81)	211 (54.24)	153 (53.68)	
Unemployed	302 (28.28)	126 (31.98)	112 (28.79)	64 (22.46)	
Employee	112 (10.49)	38 (9.64)	48 (12.34)	26 (9.12)	
Retiree	61 (5.71)	10 (2.54)	17 (4.37)	34 (11.93)	
No data	17 (1.59)	8 (2.03)	1 (0.26)	8 (2.81)	
BMI (kg/m²) Median (IQR)	27.44 (24.34 - 31.11)	28.26 (24.91-31.66)	27.39 (24.36 - 31.23)	26.29 (23.70 - 29.26)	**<0.001**
Hb1Ac (%) Median (IQR)	7.14 (6.24 - 9.00)	7.00 (6.00 - 8.23)	7.20 (6.46 - 9.04)	7.60 (6.53 - 9.10)	**<0.001**

Table 1. Characteristics of study participants. (Continued)

	All participants (n=1068) n (%)	Years elapsed since diagnosis			
		< 5 (n=394) n (%)	5 - 10 (n=389) n (%)	> 10 (n=285) n (%)	*p*-value
Creatinine mg/dL Median (IQR)	0.80 (0.68 - 1.03)	0.77 (0.65 - 0.90)	0.80 (0.67 - 1.00)	0.94 (0.73 - 1.40)	**<0.001**
Comorbidity and/or history of major health condition					
Hypertension	632 (59.18)	207 (52.54)	233 (59.90)	192 (67.37)	**0.001**
Dyslipidemia	209 (19.57)	86 (21.83)	68 (17.48)	55 (19.30)	0.306
Chronic kidney disease	109 (10.21)	26 (6.60)	30 (7.71)	53 (18.60)	**<0.001**
Acute coronary syndrome	77 (7.21)	20 (5.08)	29 (7.46)	28 (9.82)	0.060
COPD	59 (5.52)	20 (5.08)	14 (3.60)	25 (8.77)	**0.013**
Left ventricular hypertrophy	40 (3.75)	12 (3.05)	18 (4.63)	10 (3.51)	0.492
Atrial fibrillation	13 (1.22)	4 (1.02)	5 (1.29)	4 (1.40)	0.891
Peripheral vascular disease	8 (0.75)	2 (0.51)	3 (0.77)	3 (1.05)	0.717
Asthma	8 (0.75)	5 (1.27)	1 (0.26)	2 (0.70)	0.258
# comorbidities and/or history of major health conditions					**0.023**
None	307 (28.74)	120 (30.46)	116 (29.82)	71 (24.91)	
1	520 (48.69)	197 (50.00)	193 (49.61)	130 (45.61)	
2	192 (17.98)	67 (17.00)	60 (15.43)	65 (22.81)	
≥3	49 (4.59)	10 (2.54)	20 (5.14)	19 (6.67)	
% of follow-up appointments with the same physician					0.784
0-20%	468 (43.82)	164 (41.62)	177 (45.50)	127 (44.56)	
>20-40%	130 (12.17)	54 (13.71)	43 (11.05)	33 (11.58)	
>40-60%	106 (99.3)	43 (10.91)	33 (8.48)	30 (10.53)	
>60-80%	89 (83.3)	34 (8.63)	33 (8.48)	22 (7.72)	
>80-100%	274 (25.66)	99 (25.13)	103 (26.48)	72 (25.26)	
No data	1 (0.09)	-	-	1 (0.35)	

*: The sum of the % does not equal 100 as some patients could have more than 1 comorbidity and/or history of major health condition.
COPD: chronic obstructive pulmonary disease; Hb1Ac: glycosylated hemoglobin; BMI: body mass index; IQR: interquartile range.

Level of knowledge about type 2 diabetes mellitus

The proportion of correct answers to each question varied widely (9.93%-87.73%). For example, kidney injury (70.04%) and eye damage (60.58%) were the most frequently recognized consequences of poor T2DM control, whereas less than 30% of participants identified other types of consequences (Annex 3).

In 6 of the 9 questions, an ascending gradient was observed in the proportion of patients who answered correctly as the years elapsed since diagnosis increased, these differences being statistically significant (p<0.05) (Table 2). Regarding HbA1c levels, although they were numerically higher in patients with wrong answers in 7 of the 9 questions, the difference was statistically significant only in the question on the definition of HbA1C (8.12 vs. 7.44%; mean difference= 0.68; 95%CI: 0.17-1.18; p<0.001). This question also showed an upward gradient in the proportion of patients who answered correctly as the years since diagnosis increased. Therefore, to determine the level of knowledge about

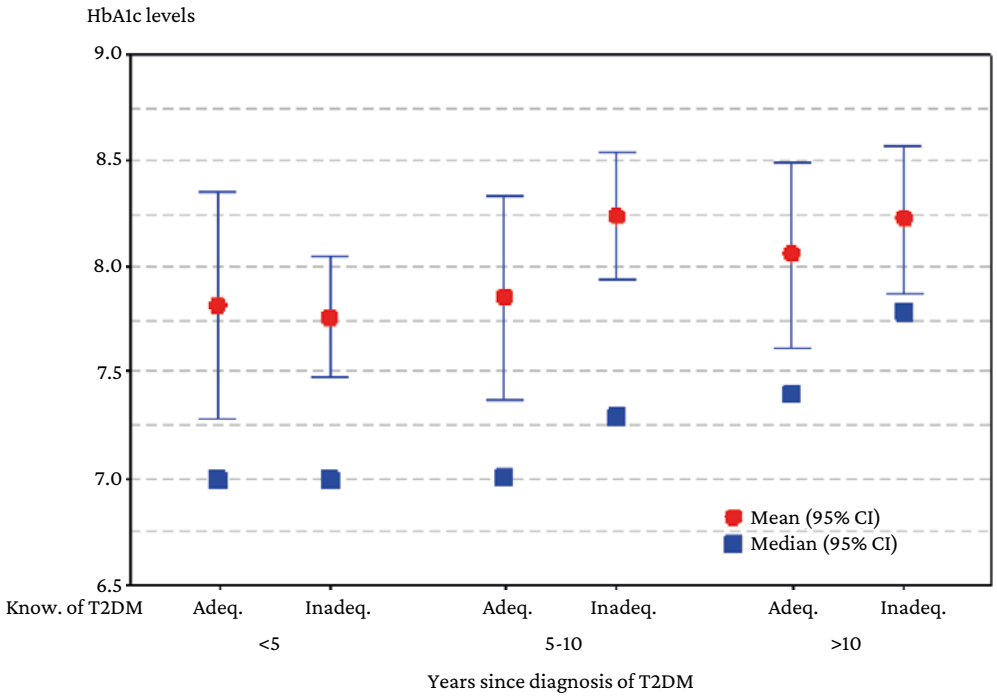
T2DM, the 6 questions in which significant differences were observed in the proportion of correct answers by years elapsed since diagnosis were considered valid for determining the level of knowledge about T2DM. The alpha coefficient for this set of responses was 0.36 (95%CI: 0.30-0.42), with a range of values between 0.30 and 0.37 if any of the 6 questions of the questionnaire were removed.

Table 2. Distribution of correct answers in the questionnaire by years elapsed since diagnosis and average HbA1c levels.

		Correct answers by range of years elapsed since diagnosis n (%)				**Mean HbA1c values according to response classification**		
Question	**Correct answers - total participants (n= 1068) n (%)**	**<5 (n= 394)**	**5- 10 (n= 389)**	**>10 (n= 285)**	**p-value**	**Incorrect answer**	**Correct answer**	**Δ (95%CI)**
What is diabetes?	790 (73.97)	285 (72.34)	291 (74.81)	214 (75.09)	0.599	8.21	8.0	0.21 (-0.12, 0.56)
What is HbA1c?	106 (9.93)	28 (7.11)	33 (8.48)	45 (15.79)	<0.001	8.12	7.44	0.68 (0.17, 1.18)
How often do you need to see a doctor for proper control of your disease?	937 (87.73)	338 (85.79)	332 (85.35)	267 (93.68)	0.003	8.24	8.03	0.21 (-0.25, 0.68)
What are the consequences of poor diabetes control?	663 (62.08)	229 (58.12)	230 (59.13)	204 (71.58)	0.001	7.79	8.20	-0.40 (-0.09, -0.71)
What tests can help identify diabetic nephropathy?	326 (30.52)	109 (27.66)	103 (26.48)	114 (40.00)	<0.001	8.03	8.01	0.07 (-0.40, 0.26)
What is the impact of diabetes complications on your life?	892 (83.52)	325 (82.49)	326 (83.80)	241 (84.56)	0.676	8.08	8.05	0.03 (-0.38, .044)
Which of the following are likely to be complications from your diabetes?	447 (41.85)	168 (42.64)	159 (40.87)	120 (42.11)	0.878	8.02	8.09	-0.08 (-0.38, 0.23)
Besides the drugs you use for diabetes, are there specific drugs that protect the kidney?	178 (16.67)	59 (14.97)	56 (14.40)	63 (22.11)	0.015	8.05	8.03	0.03 (-0.38, 0.43)
What should your physician evaluate during the consultation to consider that you have undergone a comprehensive physical examination?	646 (60.49)	228 (57.87)	226 (58.10)	192 (67.37)	0.021	8.08	8.03	0.06 (-0.25, 0.36)

HbA1c: glycosylated hemoglobin; 95%CI: 95% confidence interval.

Both knowledge level and Hb1Ac levels were associated with years elapsed since diagnosis (p<0.001 in both associations). In that sense, we explored the relationship between these two independent variables, as shown in Figure 2. It presents the distribution of HbA1c levels (means and medians) by level of knowledge of T2DM (adequate; inadequate) in the 3 groups (defined by years elapsed since diagnosis). It can be seen that HbA1c levels in two of the three groups (those with a longer history) are higher in patients with an inadequate level of knowledge, confirming the validity of the knowledge construct.



Adeq.: adequate; Know. of T2DM: knowledge of diabetes mellitus; T2DM: type 2 diabetes mellitus; HbA1c: glycosylated hemoglobin; Inadeq.: inadequate.

Figure 2. Glycosylated hemoglobin level according to the level of knowledge about T2DM in the three groups (defined by years elapsed since diagnosis).

Factors associated with having an adequate level of knowledge about T2DM

According to the established definition, 264 patients (24.72%, 95%CI: 22.23-27.39%) showed an adequate level of knowledge about T2DM (Table 3). Furthermore, schooling, socioeconomic stratum, reporting an occupation (including housework), creatinine level, years elapsed since diagnosis, and number of comorbidities and/or history of major health condition were associated with having an adequate level of knowledge about T2DM in the bivariate analysis.

Table 4 reports the results of the regression models evaluated. After incorporating the 8 factors as a whole (6 potentially related, in addition to age and sex), it was observed that female sex (OR=1.63, 95%CI: 1.14-2.34), having a level of schooling higher than elementary education (OR=1.82, 95%CI: 1.21-2.72), reporting an occupation (OR=1.70, 95%CI: 1.12-2.58), having a diagnosis of T2DM >5 years (OR=1.49, 95%CI: 1.21-1.83), and having ≥1 comorbidity and/or history of major health condition (OR=1.48, 95%CI: 1.22-1.79) were independently associated with having an adequate level of knowledge about T2DM.

On the other hand, the lower part of Table 4 presents the sensitivity analysis, which shows consistency in most of the associations identified in the sample. For the female sex, an association of similar magnitude (OR=1.59 and OR=1.63) was observed in the two age groups (≤60 years and over 60 years). As for education, the association was notable in those over 60 years of age (OR=2.09) and in male participants (OR=1.85). Reporting an occupation had a strong association (OR>1.50) in several subgroups, although it was statistically significant only in those over 60 years of age. Finally, the number of years elapsed since T2DM diagnosis and the number of comorbidities and/or history of major health condition showed a significant association in 3 of the 4 subgroups: older than 60 years, men and women, age ≤60 years, older than 60 years, and men, respectively.

Table 3. Association of the variables considered with having an adequate level of knowledge about T2DM. Bivariate analysis.

	Level of knowledge n (%)			
Variables	**All participants n= 1068 n (%)**	**Adequate n= 264 (24.72%)**	**Inadequate n= 804 (75.28%)**	***p*-value**
Age (years) Median (IQR)	63.96 (56.73-71.66)	63.85 (57.32-74.77)	63.99 (56.71- 70.93)	0.265
Female sex	694 (64.98)	180 (68.18)	514 (63.93)	0.209
Schooling				0.008
Elementary	808 (76.30)	184 (70.23)	624 (78.29)	
Secondary or higher education	251 (23.70)	78 (29.77)	173 (21.71)	
No data	9 (0.84)	2 (0.75)	7 (0.87)	
Socioeconomic stratum				0.002
1	311 (29.28)	70 (26.62)	241 (30.16)	
2	539 (50.75)	121 (46.01)	418 (52.32)	
≥3	212 (19.96)	72 (27.38)	140 (17.52)	
No data	6 (0.56)	1 (0.38)	5 (0.62)	
Marital status				0.508
Single	591 (55.34)	151 (57.20)	440 (54.73)	
Married/domestic partnership	475 (44.48)	113 (42.80)	362 (45.02)	
No data	2 (0.19)	-	2 (0.25)	
Occupation				0.002
Housework	576 (53.93)	135 (51.14)	441 (54.85)	
Unemployed	302 (28.28)	68 (25.76)	234 (29.10)	
Employee	112 (10.49)	27 (10.23)	85 (10.57)	
Retiree	61 (5.71)	28 (10.61)	33 (4.10)	
No data	17 (1.59)	6 (2.27)	11 (1.37)	
BMI (kg/m2) Median (IQR)	27.44 (24.34- 31.11)	26.81 (23.87- 31.63)	27.54 (24.44- 31.11)	0.590
Hb1Ac (%) Median (IQR)	7.14 (6.24- 9.00)	7.24 (6.30- 9.00)	7.10 (6.21- 9.00)	0.815
Creatinine mg/dL, Median (IQR)	0.80 (0.68- 1.03)	0.90 (0.70- 1.26)	0.80 (0.67- 1.00)	<0.001
Years elapsed since T2DM diagnosis				<0.001
<5	394 (36.89)	77 (29.17)	317 (39.43)	
5-10 years	389 (36.42)	76 (28.79)	313 (38.93)	
>10	285 (26.69)	111 (42.05)	174 (21.64)	
# of comorbidities and/or history of major health condition				<0.001
None	292 (27.34)	55 (20.83)	237 (29.48)	
1	480 (44.94)	110 (41.67)	370 (46.02)	
2	221 (20.69)	74 (28.03)	147 (18.28)	
≥3	75 (7.03)	25 (9.47)	50 (6.22)	
% of follow-up appointments with the same physician				0.249
0-20%	468 (43.82)	112 (42.42)	356 (44.28)	
>20 - 40%	130 (12.17)	34 (12.88)	96 (11.94)	
>40-60%	106 (9.93)	25 (9.47)	81 (10.07)	
>60-80%	89 (8.33)	15 (5.68)	74 (9.20)	
>80-100%	274 (25.66)	78 (29.55)	196 (24.38)	
No data	1 (0.99)	-	1 (0.12)	

COPD: chronic obstructive pulmonary disease; BMI: body mass index; Hb1Ac: glycosylated hemoglobin; IQR: interquartile range.

Table 4. Factors associated with having an adequate level of knowledge about T2DM. Regression models.

Factor	Bivariate analysis OR (95%CI)		Multivariate analysis
			Model 1 All the population (226 events)
Age	1.01 (1.00- 1.02)		1.00 (0.98-1.01)
Sex (female)	1.21 (0.90-1.63)		1.63 (1.14-2.34)
Schooling©	1.89 (1.23-2.90)		1.82 (1.21-2.72)
Socioeconomic stratum†	2.00 (1.37-2.91)		1.30 (0.86-1.97)
Occupation reported	2.18 (1.40-3.41)		1.70 (1.12-2.58)
Creatinine	1.26 (1.08-1.47)		1.11 (0.97-1.27)
Years since diagnosis*	1.77 (1.41-2.23)		1.49 (1.21-1.83)
# of comorbidities**	1.37 (1.13-1.67)		1.48 (1.22-1.79)
(p H-L) value	.		0.452
	Multivariate analyses		
	Model 2 Age ≤60 years (74 events)	Model 3 Over 60 years old (152 events)	Model 4 Male (73 events)	Model 5 Female sex (153 events)
Age	-	-	1.00 (0.98-1.01)	1.01 (0.98 1.03)
Sex (female)	**1.59 (0.83- 3.07)**	**1.63 (1.05- 2.53)**	-	-
Schooling	1.39 (0.75-2.58)	**2.09 (1.24- 3.52)**	**1.85 (1.10- 3.09)**	1.80 (0.91 3.53)
Socioeconomic stratum	0.77 (0.29-2.05)	1.45 (0.92- 2.29)	1.54 (0.93- 2.56)	0.93 (0.45 1.93)
Occupation reported	1.25 (0.61-2.56)	1.88 (1.11- 3.18)	1.61 (0.90- 2.89)	1.82 (0.99 3.32)
Creatinine	1.09 (0.89-1.33)	1.13 (0.94- 1.35)	1.16 (0.92- 1.47)	1.09 (0.92 1.30)
Years since diagnosis	1.37 (0.96-1.95)	**1.57 (1.22- 2.03)**	**1.38 (1.07- 1.78)**	**1.81 (1.24 2.64)**
# of comorbidities	**1.49 (1.05-2.11)**	**1.49 (1.18- 1.87)**	**1.66 (1.30- 2.12)**	1.23 (0.90 1.69)
(p H-L) value	0.784	0.106	0.520	0.393

© Reference group: elementary schooling versus secondary schooling and higher education groups.
* Reference group: <5 years of diagnosis versus groups 5-10 years, 11-15 years, and >15 years of diagnosis.
† Reference group: stratum 1-2 versus stratum 3-4 and stratum 5-6 groups.
** Reference group: no comorbidity and/or history of major health condition vs. groups with 1, 2 and ≥ 3 comorbidities and/or history of disease.

Discussion

In the present study, 1 out of 4 patients with T2DM showed an adequate level of knowledge about their disease. Moreover, this attribute was positively associated with having a level of schooling higher than elementary education, having a diagnosis of T2DM >5 years, being female, having ≥1 comorbidity and/or history of major health condition, and reporting an occupation, with those over 60 years of age and men being the subgroups in which the most statistically significant associations with these factors were observed (Table 4).

As in the present study, multiple studies in Latin America have also reported that the proportion of patients with T2DM with insufficient knowledge is high (45.45%-68.20%).[8,10,23,24] Having a diagnosis of T2DM >5 years in the present study was independently associated with having an adequate level of knowledge about the disease (OR:1.49, 95%CI: 1.21-1.83). In this regard, several studies have also reported a positive association between a longer time elapsed since being diagnosed with T2DM and a better level of knowledge among these patients.[14,15,25] This association suggests that longer exposure to follow-up consultations and, therefore, more opportunities to receive information about T2DM may have an effect. Consequently, it is important to use better health education strategies in persons newly diagnosed (<5 years) with T2DM.

On the other hand, more frequent contact with health care services could explain the association found between the presence of ≥1 comorbidity and/or history of major health condition and an adequate level of knowledge about T2DM, both for the whole sample (OR=1.48, 95%CI: 1.22-1.79) and for several subgroups (men: OR=1.66; age >60 years: OR=1.49, and age ≤60 years: OR=1.49). However, it should be noted that in our study the proportion of follow-up appointments with the same physician was not associated with having an adequate level of knowledge, suggesting the existence of additional mechanisms that help to acquire such knowledge.

In this study, the median HbA1c level was 7.14%, that is, most participants had adequate control ranges; furthermore, after stratifying the sample by time elapsed since diagnosis, it was observed that in the three established groups (<5, 5-10, >10 years) hbA1c levels were higher in patients with an inadequate level of knowledge. These results support the validity of our knowledge measurement strategy and confirm the association between an inadequate level of T2DM knowledge and worse glycemic control reported by several studies.[26,27] However, it is worth noting that adequate HbA1c control has not been associated with improved knowledge about T2DM.[10,13,28] Accordingly, our findings suggest that T2DM education strategies, in addition to being sustained over time, should be aimed at achieving adequate glycemic control.

The relationship between patients' age and their level of knowledge about T2DM has been shown to be discordant between studies.[12,15,20,25] For example, Santana-Amaral *et al.*,[12] in a study carried out in 412 people with T2DM registered in a primary healthcare network in a municipality of northeastern Brazil, reported that being ≥60 years old was associated with an insufficient level of knowledge about T2DM (OR=2.2, 95%CI: 1.3-3.6), whereas Li *et al.*,[20] in a multicenter study conducted in 40 hospitals in 26 provinces of China with data from 6 441 patients with T2DM (mostly outpatients; less than 10% were hospitalized), found no significant association between being older than 65 years and the level of knowledge about the disease (OR=0.92, 95%CI: 0.80-1.06; p=0.260).

In this respect, although age was not directly associated with having an adequate level of knowledge about T2DM in our study, it did have a modifying effect on the factors that showed an association in model 1 (the whole sample). For example, having a schooling level higher than elementary education, having an occupation, and having a diagnosis of T2DM >5 years seemed to have a stronger association with having an adequate level of knowledge in patients older than 60 years old, as these factors showed a significant association in model 3 (older than 60 years) but not in model 2 (≤60 years).

In the present study, having a schooling level higher than elementary education was the factor that showed the strongest association with having an adequate level of knowledge about T2DM (OR=1.82, 95%CI:1.21-2.72), a finding in line with that reported in several studies.[11,13,25,27] On the other hand, there was an association found in our study between being a woman and having an adequate level of knowledge (OR=1.63, 95%CI= 1.14-2.34), a finding that is inconsistent in other populations.[14,27,29] For example, in the study by Obirikorang *et al.*[14] in 630 patients with T2DM attending a diabetes clinic in Ghana, being a female was independently associated with adequate knowledge of T2DM (aOR=2.31, 95%CI:1.56-3.41), while in the studies by Bukhsh *et al.*[27] in 218 adults with T2DM from three different health care centers in Pakistan and Chekol *et al.*[29] in 422 diabetic patients in public hospitals in Addis Ababa (Ethiopia), this variable was not associated with having an adequate level of knowledge. The variations in these results could be attributed to different reasons, all related to sociodemographic aspects linked to the condition of women in these communities.

Finally, the association between having an occupation (including housework) and having an adequate level of knowledge found in our study (OR=1.70, 95%CI: 1.12-2.58) is a finding

that has also been described by other authors.[27,29] In our case, this association could be related to better access to healthcare services and health information by employed individuals, or a greater willingness to use these services by those whose occupation is housework.

It is relevant to point out that this study has some strengths and limitations. Its strengths include the representativeness and size of the sample of patients with T2DM attending multiple health care centers of Bogotá D.C. Furthermore, despite not administering a formal questionnaire (e.g. the Diabetes Knowledge Questionnaire-24 - DKQ24), we conducted a validation process to select questions to assess the knowledge of these patients about their disease, which in turn were mainly based on the recommendations of the Colombian CPG for the treatment of T2DM,[17] in order to identify the minimum knowledge that a person with T2DM should have to adequately control their disease. Additionally, the sample size (>200 events) allowed more robust regression models, facilitating the identification of subgroups at higher risk of inadequate knowledge, e.g., men with low educational level and recent diagnosis.

Regarding its limitations, it should be noted that the questionnaire used to assess knowledge was administered by telephone (the main reason being the COVID-19 pandemic), which could lead to various information biases (e.g., poor understanding of the questions by the patient or lack of support from caregivers). Moreover, although the instrument was subjected to a face validation process by an interdisciplinary group of experts, this process can be considered incomplete because no pre-assessment or pilot test was performed on individuals with T2DM. Similarly, the criterion validity assessment process did not establish the relationship between levels of knowledge about T2DM and health care-related outcomes (e.g., adherence to medications).

Furthermore, some contextual factors that could have been related to the level of knowledge about T2DM (e.g., other family members with diabetes mellitus, number of consultations made by nursing professionals, sources of access to health information, or attendance at specific training groups) were not considered in this study. However, the measures taken to minimize the impact and the confounding role of the coexistence of interrelated variables (HbA1C level and knowledge, both related to the time elapsed since diagnosis) should be considered. Finally, since this is a specific population, the results of this study may not be applicable to populations in other regions.

Conclusion

In the present study, about 1 in 4 patients with T2DM treated in 4 of the health networks of Bogotá D.C. had an adequate level of knowledge about their condition. The years elapsed since diagnosis, having comorbidities and/or a history of a major health condition, having a level of schooling higher than elementary school, being female, and having an occupation (including housework) were identified as factors associated with having an adequate level of knowledge about T2DM. Given the number and diversity of patients with inadequate knowledge, it is imperative to implement education programs, especially aimed at low-educated men with a recent diagnosis.

Conflicts of interest

None stated by the authors.

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Annex 1

Variables measured in the telephone survey.

Variable	Measuring method	Type of answer
Age	Continuous	Numerical
Sex	Discrete	Female Male
Schooling	Discrete	Elementary Secondary Higher education
Marital status	Discrete	Single Married/domestic partnership
Socio-economic level *	Discrete	1 2 3 4 5 6
Occupation	Discrete	No occupation Employee Retiree Housework
Percentage of times you have been seen by the same physician for follow-up appointments	Discrete	0-20% 21-40% 41-60% 61-80% 81-100%
Time elapsed since diagnosis	Discrete	<5 years 5-10 years >10 years
History of major health condition	Discrete	Dyslipidemia Acute coronary syndrome Peripheral vascular disease Atrial fibrillation Asthma
Comorbidities	Discrete	Arterial hypertension Chronic kidney disease Left ventricular hypertrophy Chronic obstructive pulmonary disease
Total number of comorbidities and major health condition	Continuous	Sum of number of history of disease and comorbidities

* It should be noted that the socioeconomic level in Colombia is divided into 6 strata depending on the place of residence and access to basic services (strata 1 and 2: low socioeconomic level; strata 3 and 4: medium socioeconomic level; strata 5 and 6: high socioeconomic level).

Annex 2

Questionnaire items and criteria for defining correct answers.

Question	Type of answer	Answer options	Criteria to define that the answer is correct
1. What is diabetes?	Single answer	High blood pressure	Selecting option c)
		Insulin in blood	
		High blood sugar	
		Blurred vision, eye problems	
		Unknown	
		No answer	
2. What is HbA1c?	Multiple answers	a) Blood sugar	Selecting at least 2 of the 4 options between a) and d)
		b) Every 3 months	
		c) Average	
		d) Blood test	
		e) Sugar in urine	
		f) Diary	
		g) Self-tested	
		h) A sample is taken from you	
		i) Unknown	
3. How often do you need to see a doctor for proper control of your disease?	Single answer	a) Every 3 to 6 months	Selecting option a)
		b) Once a year	
		c) Only when you have symptoms or are sick	
		d) Unknown	
		e) No answer	
4. What are the consequences of poor diabetes control?	Multiple answers	a) Increased risk of heart disease	Selecting at least 2 of the following options: a), b), d), e), g), h) o i)
		b) Diabetic nephropathy	
		c) Lung damage	
		d) Increased risk of thrombosis or brain damage	
		e) Eye damage	
		f) Bone disease	
		g) Increased risk of infections	
		h) Risk of amputation	
		i) Loss of sensibility	
5. What tests can identify diabetic nephropathy?	Multiple answers	a) Single urine sample	Selecting at least 2 of the following options: a), b), o d)
		b) 24-hour urine collection	
		c) 12-hour urine collection	
		d) Blood sample (creatinine)	
		e) Unknown	
6. What is the impact of diabetes complications on your life?	Single answer	a) Living a shorter life	Selecting option a)
		b) Live longer	
		c) Complications do not affect the life span	
		d) No answer	
7. Which of the following are likely to be complications from your diabetes?	Multiple answers	a) Impaired vision	Selecting at least 3 out of the 4 options between a) and d)
		b) Impaired sensibility in legs and arms	
		c) Impaired sex life	
		d) Impaired feeding	
8. Besides the drugs you use for diabetes, are there specific drugs that protect the kidney?	Single answer	Yes	Selecting option a)
		No	
		No answer	
9. What should your physician evaluate during the consultation to consider that you have undergone a comprehensive physical examination?	Multiple answers	a) Leg sensitivity	Selecting at least 3 out of the 4 options between a) and d)
		b) Weight	
		c) Blood pressure	
		d) Vision	

Annex 3

Distribution of answers to the questionnaire.

Question	n (%)
What is diabetes?	
High blood pressure	8 (0.75)
Insulin in blood	41 (3.84)
High blood sugar	790 (73.97)
Blurred vision, eye problems	1 (0.09)
Unknown	226 (21.16)
No answer	2 (0.19)
What is HbA1c?	
Blood sugar	138 (12.92)
Every 3 months	79 (7.40)
Average	30 (2.81)
Blood test	79 (7.40)
Urine sugar	1 (0.09)
Daily	1 (0.09)
Self-tested	2 (0.19)
A sample is taken from you	50 (4.68)
Unknown	20 (1.87)
How often do you need to see a doctor for proper control of your disease?	
Every 3 to 6 months	937 (87.73)
Once a year	5 (0.47)
Only when you have symptoms or are sick	10 (0.94)
Unknown	112 (10.49)
No response	4 (0.37)
What are the consequences of poor diabetes control?	
Increased risk of heart disease	303 (28.37)
Kidney damage	748 (70.04)
Lung damage	112 (10.49)
Increased risk of thrombosis or brain damage	199 (18.63)
Eye damage	647 (60.58)
Bone disease	79 (7.40)
Increased risk of infections	166 (15.54)
Risk of amputation	318 (29.78)
Loss of sensation	152 (14.23)
What tests can identify diabetic nephropathy?	
Single urine sample	196 (18.35)
24-hour urine test	50 (4.68)
12-hour urine test	8 (0.75)
Blood sample (creatinine)	148 (13.86)
Unknown	756 (70.79)
What is the impact of diabetes complications on your life?	
Living a shorter life	892 (83.52)
Living longer	25 (2.34)
Complications do not affect life span	145 (13.58)
No response	6 (0.56)
Which of the following are likely to be complications from your diabetes?	

Question	n (%)
Impaired vision	811 (75.94)
Impaired sensation in the legs and arms	558 (52.25)
Impaired sex life	246 (23.03)
Impaired feeding	665 (62.27)
Impaired vision	
Besides the drugs you use for diabetes, are there specific drugs that protect the kidney?	
Yes	178 (16.67)
No	888 (83.15)
No answer	2 (0.19)
What should your physician evaluate during the consultation to consider that you have undergone a comprehensive physical examination?	
Sensitivity legs	718 (67.23)
Weight	979 (91.67)
Blood pressure	1023 (95.79)
Vision	807 (75.56)