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ORIGINAL ARTICLE

Adoption of and adherence to the Hellenic Diabetes Association guidelines for the management of subjects with type 2 diabetes mellitus by Greek physicians

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Abstract

Purpose The aim of this study was to evaluate the level of adoption of and adherence to the Hellenic Diabetes Association (HDA) guidelines for the management of individuals with type 2 diabetes mellitus (T2DM) by Greek physicians.

Methods We used a constructed questionnaire distributed to physicians in Greece. The questionnaire assessed the adoption of and adherence to the general and treatment guidelines of the HDA, as well as factors affecting physicians' prescribing habits and demographic characteristics of the participating healthcare professionals. Factors affecting the preferred therapy or glycated hemoglobin target setting were evaluated using non-parametric tests. The likelihood of adherence was estimated by logistic regression models.

Results Adoption of the HDA guidelines was reported by 92.2% of physicians. Adherence to the treatment algorithm was reported by 53.5% and to the general HDA guidelines by 42.0% of healthcare professionals; overall adherence to both general and treatment guidelines was 26.1%. Multivariate analysis demonstrated that the likelihood of adherence to treatment guidelines was higher among individuals attending over five in comparison with those attending under two diabetes seminars per year ($p = 0.037$); in contrast, years of work (professional experience ≥ 21 vs. ≤ 5 years) affected adherence negatively ($p = 0.031$). No significant association was found between other parameters and adherence to either general or overall guidelines.

Conclusions Adoption rates of the guidelines for the management of T2DM were high, while adherence rates to general and treatment guidelines were low. The rate of seminar attendance affected treatment adherence positively, while long professional practice affected treatment adherence negatively.

Keywords Physicians · Adoption · Adherence · Clinical guidelines · Type 2 diabetes mellitus · Greece

Introduction

Type 2 diabetes mellitus (T2DM) is a progressive, long-term, debilitating disease which results in serious and life-threatening complications and constitutes a rising burden for national healthcare systems worldwide. The prevalence of diabetes in Greece is estimated to be around 7% [1, 2], slightly below that of the European Region (8.9%), and this number is expected to increase to 10.3% by 2025 [3]. In order to improve outcomes, several national and international diabetes associations, including the Hellenic Diabetes Association (HDA) [4], have released recommendations for diabetes care and management. The role of clinical practice guidelines is extremely important, as their application can reduce morbidity and mortality rates as well as improve the cost-effectiveness of provided care. In a study by Chen et al., a statistically significant

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lower risk for diabetes complications and mortality was observed with adherence to guidelines for screening, physical activity, and medication among patients with diabetes [5]. The results of another study by Yashkin et al. were similar, showing that compliance with recommendations for diabetes screening and treatment was associated with reduced all-cause mortality as well as with macrovascular complications among elderly patients with newly diagnosed T2DM [6]. Regarding health economics, the annual treatment cost for patients with optimal (within target) glycemic control appears significantly lower compared to that of poorly controlled patients [7, 8]. Management of patients with diabetes based on guidelines seems to be superior to routine clinical practice in terms of cost-effectiveness [9].

Meanwhile, lack of adherence to diabetes guidelines has been highlighted by several studies, with factors related to healthcare professionals, patients with diabetes, and the healthcare system possibly accounting for this discrepancy [10, 11]. Pathman et al. created a simple four-step model to explore the cognitive and behavioral steps that physicians take while adhering to the national practice guidelines [12]. The "A-A framework" was the "awareness-agreement-adoption-adherence" four-step model and was tested through questionnaires concerning pediatric vaccine recommendations mailed to family physicians and pediatricians. According to the latter, healthcare professionals must be aware of the recommendations, agree with them, decide to follow (adopt) them, and then actually follow (adhere to) them in everyday clinical practice. A systematic review, which involved 11 primary studies reporting 29 guideline recommendations, showed that there was a progressive "leakage" across all four steps of the Pathman model in terms of physicians' adherence to guidelines, and that patients may therefore not ultimately derive the full benefits of health research [13].

The primary aim of this study was to evaluate the level of adoption of and adherence to the HDA guidelines, including both general and treatment guidelines for the management of individuals with T2DM by Greek physicians. In addition, we examined for factors that influence the prescription practice of Greek healthcare professionals.

Research design and methods

Questionnaire design and data collection

The study took place from February to July, 2015. A questionnaire including 27 questions (Q) was used (Appendix 1), namely: one question referred to the adoption of the HDA guidelines, five questions to the general HDA guidelines, six to the HDA treatment (medicines) algorithm, two to factors affecting physicians' decisions; and 13 concerned demographic and physicians' characteristics, such as gender, age, country of medical education, publications in medical journals, attendance of diabetes seminars/conferences, professional experience, medical specialization, and number of patients with DM examined per week. The questions were formulated by diabetologists (internists and endocrinologists) who had participated in the development of the HDA guidelines on the basis of the Pathman model [12]. Beyond the questions regarding adoption and adherence to the general and treatment algorithm guidelines, we included more questions on demographic characteristics as well as on the academic profile and the years of experience of the participating physicians. In this study, we used the HDA guidelines published in 2013 [4]. Only one answer was correct for all questions except Q11 about treatment individualization that had two correct answers. The option "other" was also available for those who were not satisfied with the answers and would make a different or combined clinical decision.

The questionnaire was disseminated manually and electronically through the HDA website where a hyperlink directed participants to the questionnaire.

The recommendations assessed by the questionnaire are shown in Table 1. The questionnaire was based on the method of "clinical judgment analysis", a quantitative method of probing the judgment of respondents with systematic differences in their perception of risk and benefit. It uses case studies or vignettes and refers to the process of diagnosis and treatment selection after the evaluation of clinical data and laboratory tests [14].

Outcome variables

We used dichotomous variables to reflect the adoption of HDA guidelines (Q1), adherence to general HDA guidelines (Q3, Q5, Q6, Q7, and Q8), adherence to HDA treatment guidelines (Q9, Q10, Q11, Q12, Q13, and Q14), and adherence to overall HDA guidelines, that is, the combination of general guidelines and treatment algorithm guidelines (Q3, Q5, Q6, Q7, Q8 Q9, Q10, Q11, Q12, Q13, and Q14) (Appendix 1) [3]. Specifically, Q1 concerns the adoption of HDA guidelines; Q3 refers to glycemic target for patients with T2DM; Q5 deals with T2DM first diagnosis and treatment initiation; Q6 is about the management of newly diagnosed patients and the need for screening for microvascular complications; Q7 reflects the holistic management of the metabolic syndrome; Q8 refers to the management of albuminuria in patients with T2DM; Q9 is about treatment options in obese individuals with T2DM; and Q10 addresses the management of newly diagnosed patients with T2DM with severe renal impairment [stage 4 chronic kidney disease with estimated glomerular filtration rate (eGFR) < 30 ml/min/1.73m^2] where metformin is contraindicated. Q11 refers to step 2 in T2DM management, in other words, the addition of a second medication to a patient treated with the maximum tolerated dose of

Table 1 Recommendations of the Hellenic Diabetes Association guidelines assessed by the questionnaire

Statement in the guideline	
Recommendation 1	A HbA1c goal of ≤ 7% is recommended in general for patients with diabetes mellitus (DM).
Recommendation 2	Diagnosis of DM can be confirmed and treatment should be started if random blood glucose value ≥ 200 mg/dl + classical symptoms of DM (unexplained weight loss, polyuria, and polydipsia).
Recommendation 3	After type 2 DM diagnosis, the patient should be referred to an ophthalmologist.
Recommendation 4	A statin should be added to the treatment of a patient with DM without cardiovascular disease (CVD) if he is > 40 years old and has at least one risk factor for CVD (smoking, hypertension, nephropathy, and family history for CVD).
Recommendation 5	An angiotensin-converting enzyme (ACE) inhibitor or an angiotensin II receptor blocker (ARB) should be added to the treatment of a patient with DM in the presence of albuminuria/proteinuria even in the absence of arterial hypertension.
Recommendation 6	Metformin should be used as first-line treatment for newly diagnosed patients with DM in the absence of contraindications.
Recommendation 7	Linagliptin can be used as first-line treatment to newly diagnosed patients with type 2 DM and stage 4 renal chronic kidney disease if HbA1c ≤ 8.5%.
Recommendation 8	A dipeptidyl peptidase 4 (DPP-4) inhibitor or basal insulin can be added to metformin if blood glucose levels are not adequately controlled (individualization of treatment).
Recommendation 9	A GLP-1 analog can be added to metformin (step 2 treatment) in the presence of increased body mass index and BP readings.
Recommendation 10	Basal insulin can be added to metformin in patients with high HbA1c values when the combination of metformin-sulfonylurea is not effective. The use of sulfonylurea should be reconsidered.
Recommendation 11	Basal insulin should be titrated (+ 4 units) if blood sugar levels remain > 180 mg/dl for 3 consecutive morning blood glucose readings.

metformin when the HbA1c target is not achieved. In this question, individualization of treatment for T2DM has been addressed, offering the participant the option to choose between two correct answers (vildagliptin or basal insulin). Questions 12 to 14 (Q12, Q13, and Q14) deal with treatment options for non-adequately controlled patients with T2DM.

Physicians were considered adherent to the general HDA guidelines (Q3 and Q5–8) if they followed at least four out of five recommendations correctly. In addition, healthcare professionals were considered adherent to the treatment HDA guidelines (Q9–14) if they followed at least four out of six recommendations correctly. Moreover, physicians were considered adherent to the overall HDA guidelines (Q3 and Q5–14) if they followed at least eight out of 11 recommendations correctly.

Two additional questions were included, namely: one question for factors affecting prescribing choices (Q2), which was graded from "rarely" (grade 1) to "always" (grade 4) on a scale from 1 to 4; and one question (Q4) for factors affecting HbA1c target according to various patient parameters and comorbidities and which was graded as "not at all" (grade 0) to "very important" (grade 5) on a scale from 0 to 5 (Appendix 1).

Other variables

Information on the personal, academic, and professional profile of the respondents was collected (Q15–27). The personal profile included information on gender (men vs. women) and age group (25–44, 45–54, and 55+ years). The academic profile included questions on country of university degree (other than Greece vs. Greece), number of publications in medical journals (≤ 5, 6–10, 11–20, and 21+); and number of diabetes seminars/conferences attended per year (< 2, 2–5, and 5+). Finally, the professional profile included variables reflecting job environment (hospital, private setting, or both), medical specialty (general practitioner, internist, endocrinologist, or other medical specialty/trainee), work experience in years (< 6, 6–10, 11–20, and 21+), number of patients seen per week, and number of patients with diabetes seen per week.

Statistical analysis

Data were assessed for normal distribution of their values using the Kolmogorov-Smirnov test. Descriptive statistics are presented as absolute and relative (%) frequencies for the

categorical variables, and as median (interquartile range) for the quantitative variables. We used the chi-square test to test for the differences in categorical variables and the Mann-Whitney test to examine differences of non-parametric data between the study groups. To assess the relationship between physicians' demographic, professional, and academic characteristics and adherence to the guidelines, we conducted univariate logistic regression analysis using as dependent variable each one of the three dichotomous variables reflecting adherence to the algorithms. Those variables found to have a p value < 0.2 in univariate analysis were entered into the multivariate models to assess the clear effect after adjusting for potential confounders. The analysis was performed using the Stata/SE 11.0 for Windows statistical package. A p value < 0.05 (two-tailed) was considered statistically significant.

Results

In total, 299 questionnaires were collected (101 manually and 198 electronically). Out of 299 questionnaires, 73 (24%) were partially completed and excluded from analysis. The total sample consisted of 226 completed questionnaires, 149 (65.9%) completed by male physicians and 77 (34.1%) by female healthcare professionals. We could only assess the response rate of the manually distributed questionnaires, which was 75.2%. The respective response rate for the electronically disseminated questionnaires could not be estimated. Therefore, it was not feasible to estimate an overall response rate.

The characteristics of the physicians are shown in Table 2. Participants were predominantly male (65.9%), most of them were in the age groups 35–44 and 45–54 years (77.8%), and 75.2% of them studied medicine in Greece. In addition, 54.0% of them had < 5 scientific publications in their academic profile, while 43.8% declared that they attend > 5 diabetes conferences/seminars per year. The proportion of those working in either public hospitals or in a private setting was almost equally distributed (42.9% and 43.8% respectively), whereas most of them (64.6%) were internists. There were few differences among the participants in terms of duration of work experience. The median number of patients examined by participants each week was 70, and approximately 20 of these patients had diabetes.

A total of 92.2% of participants declared that they follow/adopt HDA guidelines (Fig. 1). With regard to adherence to the general recommendations, Q5, which concerned T2DM first diagnosis and treatment initiation, was that which physicians follow most (77.7%), while Q6, concerning management of newly diagnosed patients and the need for screening for microvascular complications, received the smallest proportion of correct responses (40.2%).

As far as the treatment algorithm is concerned, Q11, on the addition of a second medication to a patient treated with the maximum tolerated dose of metformin when HbA1c target level is not achieved, received a high proportion of correct answers (80.8%). By contrast, Q10, on the management of newly diagnosed patients with T2DM with severe renal impairment (stage 4 chronic kidney disease with eGFR 26 ml/min/1.73m^2), where metformin is contraindicated, had a low response rate of correct answers (15.49%) (Fig. 1).

In total, adherence to the general algorithm was reported by 42.0% and to the treatment HDA guidelines by 53.5% of physicians; the overall adherence to both general and treatment guidelines was 26.1% (Table 3).

In univariable logistic regression analysis, no significant association was found between adherence to the general, treatment, or overall HDA guidelines, and gender, country of medical education, number of publications in medical journals, job environment, and medical specialty (Table 3). Older physicians (≥ 55 years of age) vs. younger ones (25–44 years of age) and those with long work experience (≥ 21 years) vs. those with less (≤ 5 years) work experience had poorer adherence to the treatment guidelines ($p = 0.026$ and $p = 0.015$, respectively). Participants who attended 2–5 diabetes seminars/conferences per year showed better compliance with treatment guidelines in comparison to those who attended < 2 diabetes seminars/conferences per year ($p = 0.031$), and there was a trend for association with those who attended > 5 diabetes seminars/conferences per year ($p = 0.051$) (Table 3).

Multivariable logistic regression analysis demonstrated that participants who attended > 5 vs. those attending < 2 diabetes seminars/conferences per year had better adherence to treatment guidelines ($p = 0.031$), while those with work experience of ≥ 21 years vs. those with work experience ≤ 5 years had poorer adherence to treatment guidelines ($p = 0.037$). No significant associations were found between age group or medical specialty and adherence to either general or overall guidelines (Table 4).

We also examined the participants' answers to two additional questions, Q2 (which factors influence your prescribing choices?) and Q4 (how would you rate the importance of the following factors when setting individualized HbA1c targets?). The results in Q2 (Table 5) showed that information provided by industry, HDA treatment algorithm, government policy, and patient's preference were the most important factors that affected physician prescribing choices; professional experience and evidence-based guidelines were graded as less important in the decision-making process. In addition, treatment HDA algorithm influenced the prescribing choices of male physicians more than of female physicians ($p = 0.003$).

Table 6 presents the factors affecting physicians when choosing HbA1c targets for patients with T2DM, as was extracted from physicians' answers to Q4. Male in comparison to female physicians rated with higher scores patient's age ($p = 0.010$), comorbidities ($p = 0.040$), and treatment cost as well as the effectiveness of the treatment to reduce HbA1c to target ($p = 0.05$) as factors affecting HbA1c target. In contrast,

Table 2 Characteristics of the participant physicians

	Males	Females	Total
n	149	77	226
Personal profile	*n* (%)	*n* (%)	*n* (%)
Age group			
25 to 34	8 (5.4)	14 (18.2)	22 (9.7)
35 to 44	63 (42.2)	31 (40.3)	94 (41.6)
45 to 54	53 (35.6)	23 (29.9)	76 (33.6)
55 to 64	18 (12.1)	7 (9.0)	25 (11.1)
65+	7 (4.7)	2 (2.6)	9 (4.0)
Academic profile			
Country of medical degree			
Greece	112 (75.2)	58 (75.3)	170 (75.2)
Other than Greece	37 (24.8)	19 (24.7)	56 (24.8)
Publications in medical journals			
≤ 5	80 (53.7)	42 (54.5)	122 (54.0)
6 to 10	30 (20.1)	16 (20.8)	46 (20.3)
11 to 20	19 (12.8)	11 (14.3)	30 (13.3)
21+	20 (13.4)	8 (10.4)	28 (12.4)
Number of diabetes seminars/conferences attended per year			
< 2	21 (14.1)	12 (15.6)	33 (14.6)
2–4	64 (42.9)	30 (38.9)	94 (41.6)
5+	64 (42.9)	35 (45.5)	99 (43.8)
Work environment			
Public hospital	59 (39.6)	38 (49.3)	97 (42.9)
Private setting	67 (45.0)	32.0 (41.6)	99 (43.8)
Both public hospital and private setting	23 (15.4)	7 (9.1)	30 (13.3)
Medical specialty			
GP	31 (20.8)	12 (15.6)	43 (19.0)
Internist	96 (64.4)	50 (64.9)	146 (64.6)
Endocrinologist	16 (10.7)	6 (7.8)	22 (9.7)
Other medical specialty/trainee	6 (4.1)	9 (11.7)	15 (6.7)
Years of work			
≤ 5	33 (22.2)	21 (27.3)	54 (23.9)
6–10	34 (22.8)	21 (27.3)	55 (24.3)
11–20	45 (30.2)	20 (26.0)	65 (28.8)
21+	37 (24.8)	15 (19.4)	52 (23.0)
Median number (interquartile range) of patients seen per week			
Total number of patients	70 (50–120)	50 (25–80)	70 (25–100)
Number of patients with diabetes	20 (10–40)	15 (10–30)	20 (10–40)

"Country of medical degree" refers to the location of the university (in Greece or abroad) where the doctor had completed his/her undergraduate studies. "Publications" refers to the total number of publications in national or international medical journals the physician has made until the questionnaire is completed. *GP* general practitioner

patient's body mass index (BMI), T2DM duration, life expectancy, and hypoglycemia were equally taken into consideration when choosing HbA1c target by physicians of both genders (all $p > 0.05$).

Some additional information is presented in Supplementary Fig. 1, which depicts the prevalence of adoption of and adherence to guidelines according to the physician's gender. Both men and women showed an increased adoption rate (> 90%), and gender did not influence the responses to both the general and treatment algorithm questions; however, a higher proportion of females (66.2%) responded correctly to Q12 (use of exenatide as add-on therapy to

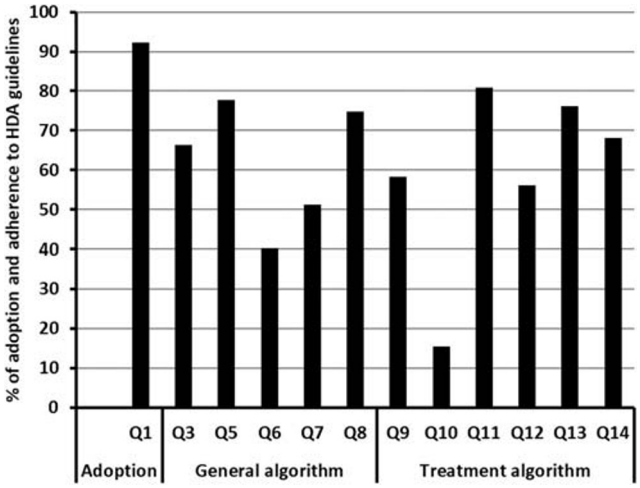

Fig. 1 Adoption and adherence rates to the general and treatment algorithm guidelines of the Hellenic Diabetes Association (HDA). For the definition of the questions (Q) see the text

metformin in obese patients with high HbA1c) in comparison to male physicians (51.0%) ($p = 0.029$). Supplementary Fig. 2 also depicts the rates of adoption of and adherence to guidelines according to physicians' age. Although the questionnaire included five age groups, we decided to reduce them to three, as shown below, since the number of physicians included in groups 1 (25–34) and 5 (65+) was too small. All age groups reported high rates (> 90%) of adoption of HDA guidelines, but there were significant differences between them in both general and treatment algorithm. To begin with, in Q5, the 55+ age group reported more correct answers than the other two age-groups, which were, namely, 25–44 and 45–54 (94.1 vs. 73.3 and 72.0%, respectively, $p = 0.023$). The results of Q7 on treatment initiation and lifestyle intervention in a newly diagnosed person with T2DM were similar: specifically, physicians in the 55+ age group had more correct answers when compared to physicians in the 45–54 age group (64.7% vs. 39.5%, $p = 0.025$). By contrast, with regard to treatment options for non-adequately controlled patients with T2DM as assessed by Q12, physicians < 45 years used exenatide more often than their older (55+) counterparts (62.93 vs. 35.29%, $p = 0.017$) (Supplementary Fig. 2).

Discussion

We conducted this study in order to assess physicians' adoption and adherence to T2DM clinical guidelines, to highlight potential discrepancies, and, in accordance with our results, to recommend necessary changes in everyday clinical practice. We decided to use the Pathman four-step model based on the hypothesis that a physician has first to be aware of the guidelines, then to intellectually agree with them, and finally to decide to adopt the guidelines in order to adhere to them. In this study, we assessed the last two steps of the Pathman model and sought to compare our results to the literature data.

Our study suggests that, even though healthcare professionals may declare a high degree of adoption of the guidelines, they do not necessarily adhere to them. Only one out of four physicians surveyed answered eight or more questions out of eleven correctly, which is a relatively low rate (26.1%) of adherence. Although most of the physicians self-reported that they adopt the HDA clinical guidelines, our results indicate that there is a large gap between adoption (92.2%) and adherence (26.1%) rates. This finding is in accordance with the "leakage" phenomenon in Pathman's framework that was identified in a systematic review [13]. Mickan et al. included 29 guideline recommendations from 11 studies and found that there is an average 15% "leakage" between each step in the Pathman awareness-to-adherence model. According to this model, the pathway from guideline publication to utilization is likened to a "pipeline," with progressive leakage occurring across stages, which results in a failure to apply research data to practice [13]. Interestingly, in the latter study, several recommendations had higher adoption than agreement rates, suggesting that physicians may adopt recommendations with which they do not necessarily agree.

Similarly, several studies from different countries have shown that non-compliance of healthcare professionals with guidelines is as high as 70% [15–20]. According to a study from Saudi Arabia, 43.2% of the surveyed physicians were unaware of the diabetes guidelines, while 35.7% were aware but never or rarely adhered to them. In that study, no association was found between duration of work experience and adherence to guidelines [21]. In another study from China, 83% of the participating physicians were aware of the diabetes guidelines; however, adherence to treatment guidelines was only 52%, adherence to HbA1c goals was 68%, and adherence to recommendations concerning diabetes diagnostic criteria varied (from 97% for the oral glucose tolerance test to 83% for the random blood glucose test) [22]. In addition, 89% of 399 primary care physicians in Indonesia declared familiarity with the T2DM guidelines, while adoption varied from 48 to 68%, adherence to recommendations for diabetes screening was 2%, and for diagnostic criteria it was 45% [23]. According to recent data from the Mediterranean Region, 79.2% of 2841 physicians who were interviewed were aware of the diabetes guidelines, while adherence to guidelines for DM diagnosis and HbA1c targets varied from 44.8 to 87% [24]. Thus, despite the methodological heterogeneity of the aforementioned studies, the results agree with those of this study and reveal that a considerable proportion of healthcare professionals are familiar with T2DM recommendations but do not follow them in everyday clinical practice.

This adoption/adherence discrepancy can be partly explained by our arbitrary definition of optimal adherence rate,

Table 3 Univariate logistic regression analysis of the associations between the study parameters and adherence to guidelines

	General guidelines	Treatment guidelines	Overall guidelines
	(Q3, 5, 6, 7, 8)	(Q9, 10, 11, 12, 13, 14)	(11 questions)
	4 or 5 vs. < 4*	4–6 vs. < 4*	≥ 8 vs. < 8**
n (%) of adherence	95 (42.0)	121 (53.5)	59 (26.1)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Gender			
Male	Reference group	Reference group	Reference group
Female	0.90 (0.52–1.58)	1.15 (0.66–2.01)	1.35 (0.73–2.51)
Age-group			
25 to 44	Reference group	Reference group	Reference group
45 to 54	1.06 (0.59–1.90)	1.03 (0.57–1.86)	0.93 (0.48–1.78)
55+	0.83 (0.38–1.83)	0.40 (0.18–0.90[a])	0.53 (0.20–1.39)
Country of medical degree			
Other than Greece	Reference group	Reference group	Reference group
Greece	1.49 (0.79–2.81)	0.73 (0.40–1.36)	1.33 (0.64–2.74)
Publications in medical journals			
≤ 5	Reference group	Reference group	Reference group
6 to 10	1.14 (0.57–2.26)	0.97 (0.49–1.93)	0.73 (0.33–1.59)
11 to 20	0.80 (0.35–1.83)	0.94 (0.42–2.09)	0.47 (0.17–1.32)
21+	0.72 (0.31–1.70)	0.88 (0.38–2.03)	0.64 (0.24–1.72)
Number of diabetes seminars/conferences attended per year			
< 2	Reference group	Reference group	Reference group
2–5	2.29 (0.96–5.46)	2.47 (1.09–5.60[b])	2.06 (0.72–5.92)
5+	2.08 (0.88 to 4.95)	2.25 (1.00–5.09[c])	2.46 (0.86–7.01)
Work environment			
Public hospital only	Reference group	Reference group	Reference group
Private clinic only	1.30 (0.73–2.29)	1.31 (0.74–2.30)	1.12 (0.59–2.11)
Other***	1.02 (0.44–2.35)	0.94 (0.41–2.13)	0.69 (0.25–1.88)
Medical specialty			
GP	Reference group	Reference group	Reference group
Internist	1.75 (0.86–3.59)	1.52 (0.77–3.01)	2.09 (0.86–5.07)
Endocrinologist	1.43 (0.50–4.15)	0.96 (0.34–2.69)	2.40 (0.72–8.03)
Other medical specialty/trainee	1.38 (0.41–4.65)	2.07 (0.60–7.20)	2.06 (0.50–8.46)
Years of work			
≤ 5	Reference group	Reference group	Reference group
6–10	1.16 (0.54–2.50)	0.99 (0.46–2.12)	1.27 (0.55–2.88)
11–20	1.13 (0.54–2.36)	1.23 (0.58–2.61)	0.96 (0.42–2.17)
21+	0.98 (0.45–2.14)	0.38 (0.17–0.83[d])	0.53 (0.21–1.35)

*At least 4 correct answers in either the general guidelines or the treatment guidelines

**At least 8 correct answers out of 11 the questions in overall guidelines

***Other includes physicians working in both outpatient hospital clinics and in private clinics

[a] $p = 0.026$; [b] $p = 0.031$; [c] $p = 0.051$; [d] $p = 0.015$. No other significant associations were found

OR, odds ratio; *CI*, confidence intervals; *GP*, general practitioners

as described in the outcome variables section. Furthermore, it should be noted that the 36% adherence rate reported by Mickan et al. is higher than the 26.1% rate of our study, but, as the authors state, this could be even lower in clinical practice given that adherence was self-reported [13]. In addition, professional experience and individualization of treatment may affect management. In this study, multivariate analysis demonstrated that longer professional experience was

Table 4 Multivariate logistic regression analysis of the associations between the study parameters and adherence to guidelines

	General guidelines	Treatment guidelines	Overall guidelines
	(Q3, 5, 6, 7, 8)	(Q9, 10, 11, 12, 13, 14)	(11questions)
	4 or 5 vs. < 4*	4–6 vs. < 4*	≥ 8 vs. < 8**
n (%) of adherence	95 (42.0)	121 (53.5)	59 (26.1)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Age-group			
25 to 44	Reference group	Reference group	Reference group
45 to 54	0.99 (0.43–2.30)	1.41 (0.60–3.33)	1.20 (0.46–3.09)
55+	0.78 (0.22–2.69)	1.01 (0.29–3.56)	0.94 (0.21–4.15)
Number of diabetes seminars/conferences attended per year			
< 2	Reference group	Reference group	Reference group
2–5	2.16 (0.88–5.31)	2.34 (0.97–5.60)	1.91 (0.63–5.78)
5+	1.95 (0.79–4.79)	2.66 (1.09–6.45[a])	2.47 (0.82–7.42)
Medical specialty			
GP	Reference group	Reference group	Reference group
Internist	1.67 (0.79–3.56)	1.71 (0.82–3.59)	2.26 (0.90–5.69)
Endocrinologist	1.46 (0.47–4.50)	1.06 (0.33–3.31)	2.92 (0.80–10.63)
Other medical specialty/trainee	1.39 (0.39–4.97)	2.21 (0.59–8.27)	2.01 (0.46–8.80)
Years of work			
≤ 5	Reference group	Reference group	Reference group
6–10	1.07 (0.48–2.41)	0.88 (0.39–2.00)	1.18 (0.49–2.85)
11–20	0.98 (0.37–2.61)	0.94 (0.35–2.53)	0.73 (0.24–2.22)
21+	0.94 (0.27–3.20)	0.26 (0.08–0.92[b])	0.36 (0.08–1.53)

*At least 4 correct answers in either the general guidelines or the treatment guidelines

**At least 8 correct answers out of 11 the questions in overall guidelines

[a] $p = 0.031$; [b] $p = 0.037$

OR, odds ratio; *CI*, confidence intervals; *GP*, general practitioners

associated with poorer compliance with treatment guidelines. A study from South Africa also described lower adherence rates to hypertension guidelines by older, more experienced physicians [25]. Moreover, even though guidelines suggest individualized treatment targets and several effective treatment approaches, many physicians fail to escalate treatment

Table 5 Factors affecting physicians prescribing choices according to their gender

	Men	Women	*p* value
Professional experience	1.5 (1.0–2.0)	1.5 (1.0–2.0)	0.972
Evidence-based guidelines	1.0 (1.0–2.0)	1.0 (1.0–2.0)	0.332
Government policy	3.0 (2.0–4.0)	2.5 (1.0–3.0)	0.092
Industry information*	3.0 (2.0–4.0)	3.0 (2.0–4.0)	0.899
Treatment HDA algorithm	3.5 (2.0–4.0)	2.0 (1.0–3.0)	0.030
Patient preference	3.0 (2.0–4.0)	2.5 (2.0–4.0)	0.123

p values are for comparisons by the Mann-Whitney test

Data are shown as median value (interquartile range) of physicians considering the factor as "rarely" (grade 1) to "always" (grade 4) on a scale from 1 to 4

*Industry information: Information from pharmaceutical companies

HDA Hellenic Diabetes Association

Table 6 Factors considered by attending physicians when setting HbA1c target according to their gender

	Men	Women	*p* value
Age	1.5 (1.0–3.0)	1.0 (0.0–2.0)	0.010
Diabetes duration	2.0 (1.0–3.0)	1.5 (1.0–3.0)	0.127
Life expectancy	1.5 (0.0–3.0)	1.0 (0.0–2.0)	0.190
Comorbidities	2.0 (0.0–4.0)	1.0 (0.0–3.0)	0.040
Hypoglycemia	1.5 (0.0–3.0)	1.0 (0.0–3.0)	0.249
Complications	1.0 (0.0–2.0)	1.5 (0.0–3.0)	0.289
Body mass index	2.0 (1.0–4.0)	2.0 (1.0–3.0)	0.233
Treatment cost and effectiveness	2.5 (2.0–4.0)	2.0 (1.0–3.0)	0.050

p values are for comparisons by the Mann-Whitney test

The importance of each factor when setting HbA1c target was scored as "not at all important" (grade 0) to "very important" (grade 5) on a scale from 0 to 5. Data are shown as median value (interquartile range) of the score of each factor

Treatment cost refers to the cost of treatment and treatment effectiveness refers to its ability to reduce HbA1c levels to target

and to achieve treatment goals [26]; this condition is named "clinical inertia" and is characterized by recognition of the problem but failure to act [26]. Apart from healthcare professionals, patients and the health system are also important factors leading to this phenomenon [27]. This situation is particularly common in T2DM, especially when initiation is considered of combination therapies or insulin treatment in the early stages of T2DM when HbA1c is very high [28]. The discrepancy between being aware of guidelines and implementing them in clinical practice could be also attributed to the fact that physicians are not aware of the latest guidelines or that, although they are aware of the guidelines, they do not follow the recommendations for various reasons.

One of the most important questions of our questionnaire was that regarding the standard HbA1c target for patients with T2DM (Q3). Only 66.4% of physicians answered correctly (HbA1c ≤ 7%), though this can be partly explained by the results of the following question, Q4, which examined the importance of factors that could affect the glycemic target. We formed several assumptions to explain some of the results. In Q5, the 55+ age group was more willing to start treatment for T2DM in the presence of symptoms and a random increased blood glucose test, as this is recommended by the guidelines, in comparison to younger physicians [4, 29]. This may be attributed to physicians' clinical experience, which makes them more "sensitive" to identifying the symptoms of T2DM and more aggressive in treating patients as per recommendations because of the fear of life-threatening complications. On the other hand, the lower adherence rates of the other two age groups may be due to hesitance to start treatment or even lack of awareness of the standard guidelines. Moreover, in Q12, the < 45 age-group of physicians were more likely to use exenatide as an adjunct to metformin. It is likely that older physicians (> 55 years) are used to prescribing certain standard therapies and probably less acquainted with the use of newer treatments in comparison with younger peers. It should also be emphasized that patients' preferences can often make physicians deviate from their standard practices. It is noteworthy that the option "patient preferences" was third in the overall order of factors affecting physicians' prescribing choices. However, a recent multicenter study demonstrated that patients and physicians differ in the perception of the relative importance of treatment outcomes and drug characteristics [30].

We performed univariate analysis to examine for associations between certain physicians' characteristics (gender, age, number of scientific publications, years of work, medical specialty, diabetes seminar/conference attendance, and job environment) with the general and treatment guidelines as well as overall recommendations adherence. In our study, there was no significant difference in adherence between men and women, except for question Q12, and we thus conclude that gender does not significantly affect adherence rate. Two of the parameters measured were physicians' specialty (GP, endocrinologist, internist, and other/trainee) and work environment (hospital or private setting). We expected to find a higher overall rate of compliance among internists and endocrinologists when compared to GPs, our hypothesis being based mainly on the assumption that they are more acquainted with T2DM patients and possess extensive knowledge and experience in the field of diabetes. Previous studies reported higher adherence rates among specialists in comparison to GPs [10, 12, 31, 32]; however, we did not find any association in our study. The working environment can also influence physicians' choices, this mostly applying in the private setting where patient preferences can easily cause doctors to deviate from treatment standards in their effort to preserve a good relationship with patients [33]. Our study, however, did not reveal any significant associations between overall, general, and treatment algorithm adherence and physicians work environment.

The systematic review by Choudhry et al. assessed the relationship between clinical experience and quality of health [34]. A significant number of the studies included in that analysis (74%, 11/19) found a negative association between physicians' age or length of time in practice and adherence to appropriate therapy [34]. We also determined in the univariate analysis that age and professional experience adversely influenced treatment algorithm adherence. In particular, physicians > 55 years of age were less likely to follow treatment recommendations when compared to the younger counterparts ($p = 0.026$). We also found that those working for more than 21 years were less likely to comply with the treatment recommendations ($p = 0.015$). The latter findings seem controversial, but these differences probably stem from the following two factors: first, physicians who have recently completed their education are more likely to be trained according to recent medical practice; and second, physicians close to retirement are less likely to update their knowledge and improve their methods of practice [35], probably due to lack of continuous professional development incentives and experience in the use of new and advanced T2DM treatments. Moreover, physicians with longer professional experience may be less adherent to guidelines because they practice medicine based more on their own personal experience. Clinical guidelines are published and updated in the interest of convenience, with older physicians possibly having less access to this information. This deters them from keeping up with appropriate standards of care and makes them less receptive to new evidence-based therapies [35].

Diabetes seminar and conference attendance were found to positively influence physicians' adherence to treatment algorithm recommendations. This is not uncommon, as, during these sessions, physicians have the chance to update their knowledge, share their experiences in clinical cases, participate in clinical workshops, and discuss and exchange views with their counterparts. As part of a personal professional

development plan, they can enhance competence in medical knowledge and skills.

Finally, in multivariate analysis, we found that only diabetes seminar/conference attendance and years of work/professional experience have a significant impact on adherence to treatment recommendations, but not on overall adherence.

Clinical practice guidelines are developed on the basis of examination of the current evidence-based medical data and aim to guide decisions on diagnosis, management, and treatment of diseases; implementation of clinical guidelines improves patients' health outcomes, improves physicians' quality of clinical decisions, and reduces health-associated costs for the healthcare system [36]. As regards patients, guidelines recommend those interventions that have been shown to improve morbidity, mortality, and quality of life and, in parallel, disapprove of those that are ineffective or may cause harm [36]. In addition, management of the same disease may vary across different geographical regions, and the use of guidelines can assist to eradicate this phenomenon [36, 37]. Regarding the advantages of the guidelines for the healthcare professionals, they can help them make the right decision when it comes to managing a disease or condition when they are not sure which is the best option is [36]. In addition, healthcare professionals may refer to guidelines for protection from litigation or from administrators who may have objections to treatment options [36]. Healthcare systems benefit from the guidelines, since they suggest the best option for disease management while taking into account cost-effectiveness of available treatments [36, 38]. Therefore, when clinical practice guidelines are not being followed, patients, healthcare professionals, and healthcare systems are not benefited.

Our study has certain limitations that may have influenced the results. First, the "other" option was offered in each question as an alternative for those who did not agree or selected more than one of the answers. We had to exclude these additional questions from further analysis as it was very difficult to distinguish whether the responding physicians were adherent of not. Secondly, we set an arbitrary definition of optimal compliance rate: physicians who answered eight out of 11 questions correctly were considered as adherent, which translated to a 72% score (at least four correct answers in both general and treatment algorithm recommendations, respectively). In addition, the total number of physicians who participated in the study is relatively small, and the study population may not be representative of the population of practitioners managing patients with T2DM in Greece. Moreover, we used vignettes/case studies in our study to examine adherence of physicians to guidelines. If the vignettes/case studies are well designed and their content reflects decision-making in the appropriate way, these can be generalized to real life and can consequently increase the validity of the results [39]. However, the process of vignette/case study construction should involve certain steps in terms of validity [40], as follows: first, development of a large number of case studies, from which the researcher should choose the most appropriate; second, submission to a panel of experts for a review; and third, pilot testing process. This procedure was not followed appropriately, and this can be considered as a limitation.

Nevertheless, our study was the first conducted in Greece that measured physicians' adherence to diabetes guidelines and can be used as a reference for further research. The method used (clinical judgment analysis) is considered to have several advantages in comparison to others in terms of applicability and ethical concerns, such as patient record reviews (time constraints and confidential health data), interviews (social desirability bias), and standardized patients (expensive) [40].

Conclusions

Although the results cannot be generalized to all physicians, the findings of this study indicate that the adherence of Greek physicians to diabetes guidelines is low. Professional experience is the main obstacle to compliance with recommendations, whereas continuing education has a positive impact on adherence to guidelines. We believe that further research is needed to identify the magnitude of this problem and to explore ways to overcome the barriers that drive physicians away from evidence-based medicine.

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Data availability Data are available from the corresponding author upon request.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval Note applicable.

Informed consent Note applicable.

Research involving human participants and/or animals Not applicable.

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