



Research article

Evaluating the quality of care for patients with type 2 diabetes mellitus based on the HbA1c: A national survey in Iran

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ABSTRACT

Objective: The present study was conducted to evaluate the quality of care for type2 diabetic patients based on the HbA1c in Iran.**Materials and methods:** This cross-sectional study was conducted in 2019 among patients with type 2 diabetes in Iran. The data were collected through a three-part questionnaire including demographic information, disease-related records, and HbA1C status of patients. Multiple logistic regression was used to investigate the relationship between the outcome variable (HbA1c status) and the independent variables in Stata 12.**Results:** The mean HBA1c was $8.01 \pm 1.76\%$ among 1,198 diabetic patients, and more than 66% of them had HBA1c above 7%, i.e. they had uncontrolled blood sugar levels. HBA1c has the highest average among people with more than 10 years of diabetes ($8.47 \pm 1.77\%$), self-employed people ($8.36 \pm 1.94\%$), illiterate people or those with elementary education ($8.13 \pm 1.76\%$) and people with poor economic status ($8.12 \pm 1.79\%$). Also, in the final model, people with more than 10 years of disease history had the highest prevalence of HBA1C > 7 with a chance ratio of 3.28 ($P < 0.001$, 95%CI: 2.37–4.53) and followed by illiterate people or those with elementary education with a chance ratio of 1.6 ($P = 0.020$, 95%CI: 1.08–2.39) compared to those with high school diploma or academic education.**Conclusion:** The prevalence of adverse HBA1c in 66% of the studied subjects indicates an inappropriate status of diabetes control in Iran. This indicates the poor quality of services provided to the diabetics. This is a warning sign and requires appropriate interventions to improve the quality of services provided to diabetic patients.

1. Introduction

Diabetes is one of the most important health challenges in the world and affected about 422 million adults worldwide, according to the 2014 WHO report. Also it was predicted to become the seventh leading cause of death in the world by 2030, with an increase of 69% among the adult population in developing countries [1]. People with diabetes are at risk for cardiovascular, renal, nervous and eye diseases, as well as pregnancy complications. In addition, the disease was the direct cause of 1.6 million people in 2016 and high blood glucose has been led to another 2.2 million death in 2012 [2]. According to the WHO report, the prevalence of diabetes in Iran in 2016 was estimated to be 10.3% in people over 18 years of age, which was 9.6% in men and 11.1% in women; and in terms of the prevalence of type 2 diabetes, which includes more than 90% of all diabetic patients, Iran ranks third in the EMRO region [1, 3].

Evaluating the Diabetes Care Program is the first step in ensuring how health care is provided to diabetic patients. Its practical purpose is to provide quality care for diabetic patients under the coverage of health care centers in order to prevent complications and disabilities through follow-up, continuous care and changes in policies. The consequences of neglecting this and providing low quality services are irreparable in many cases and face the health system with a variety of direct and indirect costs. Quality plays a key role in achieving health goals. Therefore, evaluating the quality of health care and providing the results will inform service recipients, providers and policy makers, and provides the ground for improving the quality of services; it is also a mechanism for measuring the accuracy of diagnostic and treatment services [4, 5, 6].

Today, increasing usage of quantitative indicators is an approach to increase the quality of care for diabetics. Glycated hemoglobin (HbA1c) is a valuable quantitative indicator for long-term monitoring of blood

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sugar control and a valid measurement tool for assessing the condition of diabetes and the quality of provided care [7]. HbA1c measurement has been one of the most important laboratory medical advances in diabetes care for years. Its use in laboratory diagnoses in the 1970s showed a turning point in the follow-up of diabetic patients and their treatment [8]. At the same time, the role of HbA1c in the management of diabetes and its association with complications of diabetes has been enhanced through two prominent clinical trials: Diabetes Control and Complications Trial (DCCT) on type 1 diabetes and the United Kingdom Prospective Diabetes Study (UKPDS) on type 2 diabetes [9]. According to the Stratton study, 1% decrease in mean HbA1c levels leads to 21% reduction in diabetes-related deaths, 14% reduction in myocardial infarctions and 37% reduction in microvascular complications [10]. In addition, studies show that regular measurement of HbA1c in patients with diabetes and stable blood sugar control at a level of less than 7% can reduce long-term effects of diabetes to 76% by showing long-term glycemc status and predicting the risk of diabetic complications [11]. However, despite the importance of using the HbA1c index in controlling blood sugar, no comprehensive study has been conducted to assess the quality of care provided by diabetic service providers. Therefore, the present study was conducted to evaluate the quality of care for type 2 diabetic patients based on the HbA1c in Iran.

2. Materials and methods

2.1. Study design and participants

This cross-sectional study was conducted in 2019 on type 2 diabetic patients in three Iranian provinces: Kurdistan, Isfahan and South Khorasan. The statistical population included all patients with type 2 diabetes who referred to diabetes clinics and urban health centers in Iran. Assuming that 50% of the patients referring to the centers have uncontrolled blood sugar ($HbA1c > 7\%$). The sample size was estimated to be 385 (with the confidence level of 95% and the accuracy rate of 5%) for

each province and 1152 for all three provinces using the following formula.

$$n = \frac{Z^2 \cdot \frac{q}{2} \times P(1-P)}{d^2} = \frac{(1.96)^2 \cdot 0.25}{0.0025} = 384 \Rightarrow 384 \times 3 = 1152$$

Considering the likely dropouts/loss of the participants during the sampling, the loss rate was set 0.05 and the number of the final sample was calculated 1210 for all three provinces.

Participants were selected through multi-stage sampling. For this purpose, the Iranian provinces were divided into three geographical clusters based on their geographical location, and one province was selected from each cluster. Then, the center of the provinces (Sanandaj, Isfahan and Sabzevar) (Figure 1) were selected among the cities of the province, and target centers and study samples were randomly selected from the list of diabetic centers and clinics in each city. Then, based on the list of patients covered by the center, participants were selected based on simple random sampling and were invited to visit the center to complete the questionnaire and perform some periodic blood sugar tests. Having an active file and being under care coverage in the centers for at least 12 months were the inclusion criteria.

2.2. Data collection

Participants were first contacted and, if they wished to participate in the study, a time was set for face-to-face interviews and the completion of a questionnaire at diabetes centers. The interview was conducted in each province by a group of interviewers, including a physician, nurse, and health expert who had received the necessary training. In order to ensure the quality of information collection, the head of the interviewers checked the entire questionnaire. The checklist included demographic information (age, sex, marital status, job, education, type of insurance, socioeconomic status), disease history (BMI and duration of diabetes), and HbA1C status of patients. For face and content validity, the checklist was reviewed by research and clinical experts and their comments were



Figure 1. Map of the selected provinces.

also taken into account. It should be noted that the samples were taken from patients and HbA1c hemoglobin devices. Blood sampling was performed intravenously on an empty stomach by laboratory experts stationed at each center. To the standardization of laboratory procedure of HbA1c measurement, we used a unite kit to assessing HbA1c by a group of expert, who had received the necessary training.

2.3. Outcome and independent variables

Outcome variable: The American Diabetes Association's recommendations of HbA1c <7% as treatment goals [12] and the best cut-off value for HbA1c as a screening tool in patients with diabetes mellitus [13]. Therefore it seems that HbA1c could be used as an objective measure of glycaemic control. The HbA1c status of patients is a quantitative variable, which is a two-state variable in this study ($7 \geq / < 7$).

Independent variables: The method proposed by O'Donnell et al. was used to determine the socioeconomic status of households [14]. The questionnaire was used to assess household assets, including LCD TVs, separate refrigerator and freezers, washing machines, dishwashers, microwave ovens, cell phones, internet access, private cars, private homes, and the number of rooms. The asset index for each individual was calculated using principal component analysis (PCA), and the study population was divided into three groups: weak, moderate, and good. Previous studies have used the asset index to determine socio-economic surveys (SES) in the Iranian population [15, 16]. Other independent variables include sex (male, female), age group (less than 50, 50–59, 60–69, above and equal to 70), employment status (housewife/unemployed, retired, self-employed, employee), education (illiterate/elementary, middle/high school, academic education), marital status (single, married, divorced/widowed), type of health insurance (Iranian

Table 1. The average HbA1c index of type 2 diabetic patients.

	Number (%)	Mean HbA1c (SD)	P-value
Sex			
Female	848 (70.78)	8.01 (1.77)	0.980*
Male	350 (29.22)	8.01 (1.75)	
Age			
<50	196 (16.42)	8.09 (1.94)	0.411**
50-59	384 (32.16)	8.05 (1.79)	
60-69	432 (36.18)	8.03 (1.76)	
70 ≤	182 (15.24)	7.81 (1.50)	
Education			
Illiterate and elementary education	834 (69.85)	8.13 (1.76)	<0.001**
Middle school or high school education	119 (9.97)	7.99 (1.68)	
High school diploma and academic education	241 (20.18)	7.62 (1.77)	
Marital status			
Married	1075 (90.26)	7.99 (1.74)	0.424**
Single	29 (2.43)	8.03 (1.89)	
Separated, widowed/widower, divorced	87 (7.30)	8.25 (2.06)	
Occupation			
Employee	49 (4.11)	7.37 (1.47)	0.002**
Self-employed	156 (13.08)	8.36 (1.94)	
Retired	189 (15.84)	7.82 (1.56)	
Housewife, unemployed	799 (66.97)	8.03 (1.78)	
Period of diabetes			
≤5	379 (31.90)	7.45 (1.63)	<0.001**
5-10	383 (32.24)	8.05 (1.74)	
>10	426 (35.86)	8.47 (1.77)	
Basic insurance type			
Public health insurance/government employees health insurance/rural health insurance	475 (39.82)	8.03 (1.82)	0.094**
Armed forces health insurance	83 (6.96)	8.01 (1.91)	
Social Security insurance	554 (46.44)	7.93 (1.67)	
Other (Relief Foundation; Welfare Organization; banks)	81 (6.79)	8.46 (1.91)	
Supplementary insurance			
Yes	453 (38.39)	7.91 (1.75)	0.141*
No	727 (61.61)	8.06 (1.74)	
Economic status			
Poor	406 (34.91)	8.12 (1.79)	0.001**
Moderate/average	399 (34.31)	8.07 (1.80)	
Good	358 (30.78)	7.75 (1.68)	
BMI			
Normal (<25)	225 (18.81)	8.12 (1.93)	0.376*
Overweight (25–30)	482 (40.30)	8.04 (1.83)	
Obesity (≥30)	489 (40.89)	7.93 (1.61)	

* Obtained from T-test ANOVA.

** Obtained from ANOVA.

insurance, armed forces insurance, social security insurance, and other insurances), supplementary insurance (yes, no), family size (1–2, 3–4, and 5≤), and diabetes duration (5≥, 5–10, >10).

2.4. Statistical analysis

After data collection, ANOVA and t-test were used to analyze quantitative objectives. Also, multiple logistic regression was used to investigate the relationship between the outcome variable (HbA1c status) and independent variables. All analyzes were performed in Stata 12.0 (Stata Corporation, College Station, TX, USA) and $p < 0.05$ was considered as statistical significance level.

2.5. Ethical considerations

The questionnaires were completed anonymously while receiving oral and written consent from all participants. The proposal of this study was reviewed by the ethics committee of Kurdistan University of Medical Sciences and was approved with the code No. IR.MUK.REC.1397.135.

3. Results

The HbA1c average of 1,198 participants was $8.01 \pm 1.76\%$. There was a significant difference between the average HbA1c of people with different levels of education, different types of jobs, place of residence and period of diabetes ($P > 0.05$). HbA1c has the highest average among people with more than 10 years of diabetes ($8.47 \pm 1.77\%$), self-employed people ($8.36 \pm 1.94\%$), illiterate people or those with elementary education ($8.13 \pm 1.76\%$) and people with poor economic status ($8.12 \pm 1.79\%$) (Table 1).

Based on the results of the prevalence of “HbA1C above 7” and the results of the “final model of multivariate logistic regression”, the overall prevalence of uncontrolled blood sugar level is 66% (Based on the prevalence of HbA1C > 8 uncontrolled blood sugar level is 40.5%). However, people with more than 10 years of diabetes, with a 3.28-fold chance ratio ($P < 0.001$, 95% CI: 2.37–4.53), with a prevalence of 79% HbA1C > 7, had the highest blood sugar ratio among participants. After that, the highest prevalence (about 70%) was in illiterate and elementary education groups, which had a 1.60-fold chance ($P = 0.020$, 95% CI: 1.08–2.39) than those with high school diploma or academic education. Also people with Heart complications had a 1.52-fold chance ($P = 0.002$, 95% CI: 1.16–1.98) compared to people without this complications.

The results of univariate logistic regression showed that self-employed people had 2.37-fold chance ($P = 0.010$, 95% CI: 1.23–4.57) and the unemployed and housewives had a 1.89-fold chance ($P = 0.031$, 95% CI: 1.08–2.39) compared to employees. Based on these results, people without supplementary insurance had a 1.38-fold chance ($P = 0.011$, 95% CI: 1.08–1.76), people with poor economic status had a 1.51-fold chance ($P = 0.007$, 95% CI: 1.12–2.05) compared to other categories and people with Neurological complications had a 1.32-fold chance ($P = 0.038$, 95% CI: 0.74–1.32) compared to people without this complications. However prevalence of HbA1C > 7 for patients over 60 years was 65.9%, there is no a significant relationship between HbA1c level and age-ranges (Table 2).

4. Discussion

In the present study, the mean HbA1c of diabetic patients was $8.01 \pm 1.77\%$, and more than 66% of them had HbA1c above 7%, i.e. they had uncontrolled blood sugar levels. This level of HbA1c is a evidence to poor blood sugar control. Also, the prevalence of HbA1c above 7% increased when the duration of type 2 diabetes increased, and the education level and socioeconomic status of individuals reduced. Also, patients without supplementary insurance and government employment had higher HbA1c levels. In the studies conducted elsewhere, the results for prevalence of HbA1c>7% among people with type 2

diabetes were consistent with the present study: 66.7% in Kuwait [17], 73% in Saudi Arabia [18], 67% in Thailand [19] and 74% in Malaysia [20]. It seems that one of the main reasons for this consistency is the similarity of lifestyle and cultural, behavioral and habit patterns in these areas and Iran [21]. A comparison of the results of previous studies in Iran shows that the prevalence of HbA1c>7% has not changed much in recent years. In a 2006 study in Iran, for example, about 60% of people had uncontrolled HbA1c [22]. In Majid Kazemi's study in 2014, about 66% of people had HbA1c>7%, which was similar to the present study [23]. In the study by Meidani et al. in 2013, the average HbA1c was about 8.5% and close to the present study [24]. However, several studies in developed European countries reported that only 25%–42% of patients with type 2 diabetes had poor blood sugar control. For example, in the Netherlands, Italy, Greece, Germany, Belgium, Spain, the United Kingdom and France, the prevalence of HbA1c>7% was reported to be 26%, 28%, 33%, 36%, 38%, 40%, 40% and 42% respectively [25, 26, 27]. Comparing the above results in developing countries with the present study shows that the prevalence of HbA1c>7% and uncontrolled blood sugar levels is significantly higher in Iran. In most European countries, the health care system is free or covered by national insurance companies, and diabetic patients do not pay for health care [27]. This may be the reason for better quality of diabetes care. The result of a national study in Iran indicates that more than 10% of households with type 2 diabetes have endured heavy health costs due to the disease [28]. Another factor influencing the control of symptoms and complications of diabetes is the compliance of patients with physicians' prescriptions in Iran. The results of various studies show that only 40%–60% of people properly follow physicians' instructions [29, 30]. It is to be noted that about 10% of health care costs in Iran is related to diabetes. Even in recent years, after the Health System Transformation Plan which focused on specialized clinics, a larger percentage of the health budget has been allocated for the treatment of similar diseases [31]. Therefore, despite the increased budget allocated to the care of diabetic patients after the Health System Transformation Plan, the HbA1c level is still significantly high in these patients. In other words, the HbA1c level in most patients in Iran is not well controlled.

In the present study, there is a significant relationship between HbA1c level and people's education level based on the final model of multivariate logistic regression. Thus, lower levels of education increased the probability of HbA1c>7%. Other studies confirm these findings [32, 33]. For example, a study by Yan in East Asian countries [34] and Sacerdote's study in European countries [35] found that patients with higher education had better control over blood sugar, which is consistent with the present study. In fact, patients with higher education levels are more aware of the complications of the disease, know how to take care of themselves, how to take medication, follow a diet, and have better access to educational sources [32]. It seems, higher levels of education be associated with improvement in knowledge, attitudes and skills, which leads to better control of the disease. However, in the present study, the majority of patients (70%) had primary and lower levels of education, and this seems to have led to an increase in the average HbA1c among the participants. In this study a significant relationship was reported between longer duration of diabetes and HbA1c>7% prevalence. The prevalence of HbA1c>7% in Qaddoumi's study in 2019 among Kuwaiti diabetic patients with a history of equal or over 10 years of diabetes was 15% higher than in other patients [36]. Various studies have shown that the risk of developing diabetes-induced complications will increase when its duration increases [37, 38]. For example, Turner's study found a significant relationship between increased period of diabetes and its complications [39], which is consistent with the present study. Studies by Gerstl in Germany [40], Hudon in Canada [19] and Liu in China [41] show similar results. In her study, Diana argued that as the age and duration of diabetes increased, the motivation to control blood sugar dropped significantly due to psychological factors and the habit

Table 2. Prevalence of HBA1C > 7 – Single and multivariate logistic regression results based on demographic variables.

	Prevalence of HBA1C > 7		Univariate and multivariate logistic regression			
	HBA1C ≤ 7 Number (%)	HBA1C > 7 Number (%)	OR (95% CI)	P-Value†	AOR (95% CI)	P-value‡
Sex						
Male	119 (34.00)	231 (66.00)	1.00	0.917		
Female	285 (33.69)	561 (66.31)	1.01 (0.78–1.32)			
Age*						
<50	61 (31.12)	135 (68.88)	1.00.			
50-59	133 (34.73)	250 (65.27)	0.85 (0.59–1.23)	0.385		
60-69	144 (33.33)	288 (66.67)	0.90 (0.63–1.30)	0.584		
70 ≤	65 (35.91)	116 (64.09)	0.81 (0.53–1.24)	0.325		
Education						
High school diploma and academic education	107 (44.40)	134 (55.60)	1.00.		1.00.	
Illiterate and elementary education	253 (30.37)	580 (69.63)	1.83 (1.36–2.46)	<0.001	1.60 (1.08–2.39)	0.020
Middle school or high school education	42 (35.59)	76 (64.41)	1.44 (0.92–2.28)	0.112	1.44 (0.86–2.41)	0.161
Marital status						
Single	13 (44.83)	16 (55.17)	1.00.			
Married	359 (33.46)	714 (66.54)	1.62 (0.77–3.40)	0.205		
Separated, widowed/widower, divorced	29 (33.33)	58 (66.67)	1.63 (0.69–3.83)	0.267		
Occupation						
Employee	24 (48.98)	25 (51.02)	1.00.		1.00.	
Self-employed	45 (28.85)	111 (71.15)	2.37 (1.23–4.57)	0.010	1.74 (0.82–3.67)	0.148
Retired	65 (34.39)	124 (65.61)	1.83 (0.97–3.46)	0.062	1.61 (0.80–3.26)	0.184
Housewife, unemployed	268 (33.63)	529 (66.37)	1.89 (1.06–3.38)	0.031	1.09 (0.54–2.18)	0.810
Period of diabetes						
≤5	185 (48.81)	194 (51.19)	1.00.		1.00.	
5-10	130 (33.94)	253 (66.06)	1.86 (1.39–2.49)	<0.001	1.70 (1.25–2.31)	0.001
>10	86 (20.28)	338 (79.72)	3.75 (2.75–5.11)	<0.001	3.28 (2.37–4.53)	<0.001
Basic insurance type						
Public health insurance/government employees health insurance/rural health insurance	159 (33.62)	314 (66.38)	1.03 (0.80–1.34)	0.818		
Armed forces health insurance	32 (38.55)	51 (61.45)	0.83 (0.52–1.34)	0.448		
Social Security insurance	190 (34.30)	364 (65.70)	1.00.			
Relief Foundation; Welfare Organization; banks insurance	20 (24.69)	61 (75.31)	1.59 (0.93–2.72)	0.088		
Supplementary insurance						
Yes	172 (38.05)	280 (61.95)	1.00.		1.00.	
No	224 (30.85)	502 (69.15)	1.38 (1.08–1.76)	0.011	1.28 (0.97–1.70)	0.084
Economic status						
Good	137 (38.38)	220 (61.62)	1.00.		1.00.	
Poor	118 (29.14)	287 (70.86)	1.51 (1.12–2.05)	0.007	1.17 (0.83–1.66)	0.377
Moderate/average	134 (33.58)	265 (66.42)	1.23 (0.91–1.66)	0.170	1.07 (0.77–1.49)	0.687
BMI						
Normal (<25)	76 (33.93)	148 (66.07)	1.00.			
Overweight (25–30)	166 (34.44)	316 (65.56)	0.98 (0.70–1.37)	0.894		
Obesity (≥30)	161 (32.99)	327 (67.01)	1.04 (0.75–1.46)	0.805		
Kidney complications						
No	151 (37.38)	316 (40.00)	1.00			
Yes	253 (62.62)	474 (60.00)	0.90 (0.70–1.15)	0.379		
Heart complications						
No	243 (60.30)	382 (48.66)	1.00	<0.001	1.00	
Yes	160 (39.70)	403 (51.34)	1.60 (1.26–2.04)		1.52 (1.16–1.98)	0.002
Eye complications						
No	196 (48.76)	402 (50.95)	1.00			
Yes	206 (51.24)	387 (49.05)	0.92 (0.72–1.16)	0.474		
Neurological complications						
No	133 (32.92)	214 (27.16)	1.00		1.00	
Yes	271 (67.08)	574 (72.84)	1.32 (1.01–1.71)	0.038	0.98 (0.74–1.32)	0.915

* Prevalence of HBA1C > 7 and HBA1C > 8 for patients over 60 years are 65.9% and 39.3%.

† Crude model.

‡ Adjusted model by remove all variables with higher p-value 0.2.

of taking the drug for a long time [42, 43]. Also, clinically, due to the progressive impairment of insulin secretion because of the failure of beta cells over time, blood sugar control gradually weakens [44], and, as a result, with increasing duration of diabetes, the average HBA1c level increases among the affected people. Also, in the final model of multivariate logistic regression, a significant relationship was reported between Heart complications and HBA1c > 7% prevalence. However Studies showed that diabetes mellitus is a risk factor for cardiovascular disease, heart failure is associated with significant risk for development of diabetes and is considered an insulin resistant [45, 46] actually a high degree of insulin resistance was seen among these patients. In study of Swan patients with chronic heart failure patients were insulin resistant [47]. Patients with chronic heart failure due to coronary artery disease are more likely to have abnormalities in glucose metabolism. Studies stated that the prevalence of diabetes among patients with heart failure is approximately 20–30% and among acute heart failure may be as high as 45% [48, 49]. Therefore in high HBA1c among Heart complications justified which is consistent with the present study.

Also, some results were significant in the univariate regression model, for example, the prevalence of HBA1c > 7% was associated with income level. In Bi Yan [34] and Schoenberg's [50] study, HBA1c level decreased with increasing income, which was consistent with the present study. Low-income people seem to have limited access to optimal care [50]. The occupational status of patients also significantly affected HBA1c levels. Employees seem to have better control over their illness due to follow up on treatment and regular visits to health centers [51]. In the univariate logistic regression model, patients without supplementary insurance had a significantly higher prevalence of HBA1c > 7%. The results of studies in Iran show that although basic health insurance coverage is in a good condition, the range of services covered is not enough as it covers a low percentage of the costs of each service [28, 52]. Therefore, given that one of the risks in the progression of the disease of diabetic patients is the high medical costs imposed on patients and that the additional services are not covered by basic health insurance but the supplementary insurance [31], better blood sugar control in patients with supplementary insurance seems to be justifiable because of their better access to health services. Finally, this study showed that patients with Neurological complications had a significantly higher prevalence of HBA1c > 7%. It seems that poor communication process between medical care, and feedback from patients with Neurological complications may have an impact on adherence and HBA1c outcome.

4.1. Limitation

This study draws its strength from the large sample size and multi-stage sampling method. Also A major strength of the study is that it was conducted at the national level and can ensure the generalization of the study findings.

5. Conclusion

The prevalence of adverse HBA1c in 66% of the studied subjects indicates an inappropriate status of diabetes control in Iran. This indicates the poor quality of services provided to the diabetics. This is a warning sign and requires appropriate interventions to improve the quality of services provided to diabetic patients. It should also be noted that despite the physical development (increased number) of centers providing diabetic care in the past decade and the significant allocation of health care costs to diabetic care, the status of patients has not changed in terms of blood sugar control. The programs of recent years do not seem to have affected the quality of diabetic care. It is suggested that appropriate solutions and models be designed and implemented to provide services to diabetic patients in Iran.

Declarations

Author contribution statement

Ghobad Moradi and Bakhtiar Piroozi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data.

Amjad Mohamadi-Bolbanabad: Conceived and designed the experiments; Performed the experiments.

Azad Shokri: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Bushra Zareie: Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

The data that has been used is confidential.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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References

- [1] Data from: Global report on diabetes [Database on the internet] WHO deposited 2016. <https://www.who.int/health-topics/diabetes>.
- [2] World Health Organisation, Diabetes, 2016.
- [3] World Health Organization, Classification of Diabetes Mellitus, 2019.
- [4] J.H. Hsu, A. Calzavara, S. Vigod, T.A. Stukel, T. Kiran, P. Kurdyak, Factors associated with diabetes care quality among patients with Schizophrenia in Ontario, Canada, *Psychiatr. Serv.* 71 (2) (2020) 188–191.
- [5] Y.J. Kim, S. Chon, S. Oh, J-t Woo, S.W. Kim, S.Y. Rhee, Analysis of diabetes quality assessment findings and future directions for the appropriate management of diabetes in Korea, *Kor. J. Intern. Med.* 34 (1) (2019) 125.
- [6] S.D. Pastakia, B. Nuche-Berenguer, C.R. Pekny, B. Njuguna, E.G. O'Hara, S.Y. Cheng, J. Laktabai, V. Buckwalter, N. Kirui, P. Chege, Retrospective assessment of the quality of diabetes care in a rural diabetes clinic in Western Kenya, *BMC Endocr. Disord.* 18 (1) (2018) 97.
- [7] G. Yousefzadeh, M. Shokoohi, H. Najafipour, Inadequate control of diabetes and metabolic indices among diabetic patients: a population based study from the Kerman Coronary Artery Disease Risk Study (KERCADRS), *Int. J. Health Pol. Manag.* 4 (5) (2015) 271.
- [8] D. Control, C.T.R. Group, The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus, *N. Engl. J. Med.* 329 (14) (1993) 977–986.
- [9] P. King, I. Peacock, R. Donnelly, The UK prospective diabetes study (UKPDS): clinical and therapeutic implications for type 2 diabetes, *Br. J. Clin. Pharmacol.* 48 (5) (1999) 643–648.
- [10] I.M. Stratton, A.I. Adler, H.A. Neil, D.R. Matthews, S.E. Manley, C.A. Cull, et al., Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study, *BMJ* 321 (7258) (2000) 405–412.
- [11] F. Najafipour, M. Mobasseri, A. Yavari, H. Nadrian, A. Aliasgarzadeh, N. Mashinchi Abbasi, et al., Effect of regular exercise training on changes in HbA1c, BMI and VO2max among patients with type 2 diabetes mellitus: an 8-year trial, *BMJ Open Diabet. Res. Care* 5 (1) (2017), e000414.
- [12] A.D. Association, Standards of medical care for patients with diabetes mellitus, *Puert. Rico Health Sci. J.* 20 (2) (2013).

- [13] S.N. Mousavi, K. Kamali, M. Mirbaze, M. Jameshorani, The best cut-off value for HbA1c as a screening tool in Iranian women with gestational diabetes mellitus, *J. Fam. Reprod. Health* 11 (1) (2017) 37.
- [14] O'Donnell O, Van Doorslaer E, Wagstaff A, Lindelow M. *Analyzing Health Equity Using Household Survey Data: a Guide to Techniques and Their Implementation*. The World Bank.
- [15] G. Moradi, A. Moïnafshar, H. Adabi, M. Sharafi, F. Mostafavi, A.M. Bolbanabad, Socioeconomic inequalities in the oral health of people aged 15-40 years in Kurdistan, Iran in 2015: a cross-sectional study, *J. Prevent. Med. Publ. Health* 50 (5) (2017) 303.
- [16] G. Moradi, K. Mohammad, R. Majdzadeh, H.M. Ardakani, K.H. Naieni, Socioeconomic inequality of non-communicable risk factors among people living in Kurdistan Province, Islamic Republic of Iran, *Int. J. Prev. Med.* 4 (6) (2013) 671.
- [17] F.A. Al Sultan, N. Al Zanki, Clinical epidemiology of Type 2 diabetes mellitus in Kuwait, *KMJ-Kuwait Med. J.* (2005) 98–104.
- [18] D.H. Akbar, Is hypertension common in hospitalized type 2 diabetic patients? *Saudi Med. J.* 22 (2) (2001) 139–141.
- [19] C. Hudon, M. Fortin, M.-F. Dubois, J. Almirall, Comorbidity and glycemia control among patients with type 2 diabetes in primary care, *Diabetes, Metab. Syndrome Obes. Targets Ther.* 1 (2008) 33.
- [20] F. Ismail-Beigi, E. Moghissi, M. Tiktin, I.B. Hirsch, S.E. Inzucchi, S. Genuth, Individualizing glycemic targets in type 2 diabetes mellitus: implications of recent clinical trials, *Ann. Intern. Med.* 154 (8) (2011) 554–559.
- [21] G. Monica, Study on the importance of physical education in fighting stress and a sedentary lifestyle among students at the University of Bucharest, *Proc.-Soc. Behav. Sci.* 117 (2014) 104–109.
- [22] F. Dousti, A. Maleki, H. Chiti, S. Faghihzadeh, S.S. Taheri, Investigation of the effect of individual counseling of physical activity based on theory of planned behavior on glycemic indexes in women with gestational diabetes: a randomized clinical trial, *Qom Univ. Med. Sci. J.* 12 (9) (2018) 26–37.
- [23] S. Rahnavard, N. Elahi, D. Rokhafroz, M.H. Hagighi, M. Zakerkish, Comparison of the effect of group based and mobile based education on self-care behaviors in type ii diabetic patients, *Iran. J. Diabet. Metabol.* 18 (2) (2019) 55–63.
- [24] M. Meidani, F. Khorvash, M.R. Rajabpourmikfani, The relationship between controlling HbA 1 C and infected diabetic foot ulcer, *J. Isfahan Med. Sch.* 30 (175) (2012).
- [25] P. de Pablos-Velasco, K.G. Parhofer, C. Bradley, E. Eschwege, L. Gönder-Frederick, P. Maheux, I. Wood, D. Simon, Current level of glycaemic control and its associated factors in patients with type 2 diabetes across Europe: data from the PANORAMA study, *Clin. Endocrinol.* 80 (1) (2014) 47–56.
- [26] J. Brož, D.J. Žďárská, J. Urbanová, M. Brabec, V. Doničová, R. Štěpánová, E. Martinka, M. Kvapil, Current level of glycemic control and clinical inertia in subjects using insulin for the treatment of type 1 and type 2 diabetes in the Czech Republic and the Slovak Republic: results of a multinational, multicenter, observational survey (DIAINFORM), *Diabet. Ther.* 9 (5) (2018) 1897–1906.
- [27] T.M. Kemp, E.L. Barr, P.Z. Zimmet, A.J. Cameron, T.A. Welborn, S. Colagiuri, P. Phillips, J.E. Shaw, Glucose, lipid, and blood pressure control in Australian adults with type 2 diabetes: the 1999–2000 AusDiab, *Diabetes Care* 28 (6) (2005) 1490–1492.
- [28] B. Pirooz, A. Rashidian, G. Moradi, A. Takian, H. Ghasri, T. Ghadimi, Out-of-pocket and informal payment before and after the health transformation plan in Iran: evidence from hospitals located in Kurdistan, Iran, *Int. J. Health Pol. Manag.* 6 (10) (2017) 573.
- [29] S. Farsaei, A.M. Sabzghabae, A.H. Zargarzadeh, M. Amini, Adherence to glyburide and metformin and associated factors in type 2 diabetes in Isfahan, Iran, *Iran. J. Pharm. Res. (IJPR): IJPR* 10 (4) (2011) 933.
- [30] B. Gholamaliei, A. Karimi-Shahanjarini, G. Roshanaei, F. Rezapour-Shahkolaei, Medication adherence and its related factors in patients with type II diabetes, *J. Educ. Commun. Health* 2 (4) (2016) 3–12.
- [31] S. Nouraei Motlagh, H. Yusefzadeh, B. Nabilou, V. Chalesh, Cost effectiveness analysis of type 2 diabetes screening in mahabad public health centers, Iran, *Pharmacophore* 8 (6S) (2017) 8, e-1173604.
- [32] S.D. Persell, N.L. Keating, M.B. Landrum, B.E. Landon, J.Z. Ayanian, C. Borbas, E. Guadagnoli, Relationship of diabetes-specific knowledge to self-management activities, ambulatory preventive care, and metabolic outcomes, *Prev. Med.* 39 (4) (2004) 746–752.
- [33] F.A. Sloan, N.A. Padrón, A.C. Platt, Preferences, beliefs, and self-management of diabetes, *Health Serv. Res.* 44 (3) (2009) 1068–1087.
- [34] Y. Bi, D. Zhu, J. Cheng, Y. Zhu, N. Xu, S. Cui, W. Li, X. Cheng, F. Wang, Y. Hu, The status of glycemic control: a cross-sectional study of outpatients with type 2 diabetes mellitus across primary, secondary, and tertiary hospitals in the Jiangsu province of China, *Clin. Therapeut.* 32 (5) (2010) 973–983.
- [35] C. Sacerdote, F. Ricceri, O. Rolandsson, I. Baldi, M.-D. Chirlaque, E. Feskens, B. Bendinelli, E. Ardanaz, L. Arriola, B. Balkau, Lower educational level is a predictor of incident type 2 diabetes in European countries: the EPIC-InterAct study, *Int. J. Epidemiol.* 41 (4) (2012) 1162–1173.
- [36] M. Qaddoumi, Y. Al-Khamis, A. Channanath, J. Tuomilehto, D. Badawi, The status of metabolic control in patients with type 2 diabetes attending Dasman Diabetes Institute, Kuwait, *Front. Endocrinol.* 10 (2019).
- [37] S.R. Majumdar, W.D. Leslie, L.M. Lix, S.N. Morin, H. Johansson, A. Oden, E.V. McCloskey, J.A. Kanis, Longer duration of diabetes strongly impacts fracture risk assessment: the Manitoba BMD cohort, *J. Clin. Endocrinol. Metab.* 101 (11) (2016) 4489–4496.
- [38] W.C. Duckworth, C. Abraira, T.E. Moritz, S.N. Davis, N. Emanuele, S. Goldman, R. Hayward, G.D. Huang, J.B. Marks, P.D. Reaven, The duration of diabetes affects the response to intensive glucose control in type 2 subjects: the VA Diabetes Trial, *J. Diabetes Complicat.* 25 (6) (2011) 355–361.
- [39] R.C. Turner, C.A. Cull, V. Frighi, R.R. Holman, U.P.D.S. Group, Glycemic control with diet, sulfonylurea, metformin, or insulin in patients with type 2 diabetes mellitus: progressive requirement for multiple therapies (UKPDS 49), *JAMA* 281 (21) (1999) 2005–2012.
- [40] E.-M. Gerstl, W. Rabl, J. Rosenbauer, H. Gröbe, S. Hofer, U. Krause, R. Holl, Metabolic control as reflected by HbA1c in children, adolescents and young adults with type-1 diabetes mellitus: combined longitudinal analysis including 27,035 patients from 207 centers in Germany and Austria during the last decade, *Eur. J. Pediatr.* 167 (4) (2008) 447–453.
- [41] Z. Liu, C. Fu, W. Wang, B. Xu, Prevalence of chronic complications of type 2 diabetes mellitus in outpatients—a cross-sectional hospital based survey in urban China, *Health Qual. Life Outcome* 8 (1) (2010) 62.
- [42] D.B. Petitti, G.J. Klingensmith, R.A. Bell, J.S. Andrews, D. Dabelea, G. Imperatore, S. Marcovina, C. Pihoker, D. Standiford, B. Waitzfelder, Glycemic control in youth with diabetes: the SEARCH for diabetes in Youth Study, *J. Pediatr.* 155 (5) (2009) 668–672, e663.
- [43] E.S. Huang, N. Laiteerapong, J.Y. Liu, P.M. John, H.H. Moffet, A.J. Karter, Rates of complications and mortality in older patients with diabetes mellitus: the diabetes and aging study, *JAMA Int. Med.* 174 (2) (2014) 251–258.
- [44] U.P.D.S. Group, Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33), *The Lancet* 352 (9131) (1998) 837–853.
- [45] J.B. Kostis, M. Sanders, The association of heart failure with insulin resistance and the development of type 2 diabetes, *Am. J. Hypertens.* 18 (5) (2005) 731–737.
- [46] D. Aguilar, B. Bozkurt, K. Ramasubbu, A. Deswal, Relationship of hemoglobin A1C and mortality in heart failure patients with diabetes, *J. Am. Coll. Cardiol.* 54 (5) (2009) 422–428.
- [47] J.W. Swan, S.D. Anker, C. Walton, I.F. Godsland, A.L. Clark, F. Leyva, J.C. Stevenson, A.J. Coats, Insulin resistance in chronic heart failure: relation to severity and etiology of heart failure, *J. Am. Coll. Cardiol.* 30 (2) (1997) 527–532.
- [48] M.R. MacDonald, M.C. Petrie, N.M. Hawkins, J.R. Petrie, M. Fisher, R. McKelvie, D. Aguilar, H. Krum, J.J. McMurray, Diabetes, left ventricular systolic dysfunction, and chronic heart failure, *Eur. Heart J.* 29 (10) (2008) 1224–1240.
- [49] K.F. Adams Jr., G.C. Fonarow, C.L. Emerman, T.H. LeJemtel, M.R. Costanzo, W.T. Abraham, R.L. Berkowitz, M. Galvao, D.P. Horton, A.S.A. Committee, Investigators. Characteristics and outcomes of patients hospitalized for heart failure in the United States: rationale, design, and preliminary observations from the first 100,000 cases in the Acute Decompensated Heart Failure National Registry (ADHERE), *Am. Heart J.* 149 (2) (2005) 209–216.
- [50] N.E. Schoenberg, L.S. Traywick, J. Jacobs-Lawson, C.S. Kart, Diabetes self-care among a multiethnic sample of older adults, *J. Cross-Cult. Gerontol.* 23 (4) (2008) 361–376.
- [51] S. Kashfi, M. Hazavehei, A survey on prevalence of ocular complications and its risk factors in diabetic patients referred to diabetic center of Nader Kazemi Clinic Shiraz-Iran 1998-2010, *J. Fasa Univ. Med. Sci./Majallah-i Danishgah-i Ulum-i Pizishki-i Fasa* 3 (4) (2014).
- [52] B. Pirooz, G. Moradi, B. Nouri, A.M. Bolbanabad, H. Safari, Catastrophic health expenditure after the implementation of health sector evolution plan: a case study in the west of Iran, *Int. J. Health Pol. Manag.* 5 (7) (2016) 417.