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Effects of delay in visiting a specialist doctor in type 2 diabetic patients on glycemic control: a retrospective cohort study with a 4-year follow-up

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A – Study Design, **B** – Data Collection, **C** – Statistical Analysis, **D** – Data Interpretation, **E** – Manuscript Preparation, **F** – Literature Search, **G** – Funds Collection

Summary **Background.** Diabetic patients' delay in visiting a specialist doctor can have significant effects on blood sugar factors. The present study aimed to determine the effects of delay in visiting a specialist doctor in type 2 diabetic patients on glycaemic factors.
Material and methods. The patients' demographic and clinical information included in medical records of 209 type 2 diabetic patients referred to diabetes clinics in Shiraz city, south of Iran, were analysed using logistic mix-model regression. Due to the occurrence of COVID-19 during the follow-up period, data analyses were done separately before and after the pandemic.
Results. The mean age of the patients was 63.47 ± 8.89 years, and 67.94% of the type 2 diabetic patients were female. After COVID-19, haemoglobin A_{1C} (HBA_{1C}) of the patients who had delays of < 3, 3–6 and > 6 months in referring to a specialist increased by 1.81 (OR: 1.12–2.93), 2.56 (OR: 1.81–5.56) and 3.69 (OR: 1.79–7.63), respectively, compared to the group without delays. In this period, 2-hour Postprandial Glucose (2-hpp) of the patients with delays of 3–6 and > 6 months and the Fasting Blood Sugar (FBS) of the patients with delays of > 6 months had a significant increase of 1.92 (OR: 1.01–3.65), 2.14 (OR: 1.09–4.21) and 2.36 (confidence interval of 95%: 1.27–4.39), respectively, compared to the patients without delays in visits. The above trends had a non-significant increase before COVID-19, though.
Conclusions. Healthcare providers should ensure the continuity of providing services to diabetes patients, especially during health crises, by taking appropriate measures.
Key words: diabetes mellitus, type 2, glycaemic control, COVID-19.

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Background

The increasing prevalence of diabetes in all countries has imposed a huge economic burden on societies [1, 2]. It is predicted that the prevalence of diabetes in the Middle East region will increase significantly by 2030. In Iran, as in all other [3] countries, diabetes has become one of the most common non-communicable diseases, and it is estimated that the annual growth rate of diabetes in Iran will reach third place in the region after Pakistan and Egypt by 2030 [4].

Due to the nature of diabetes, it is very important for diabetic patients to visit service providers regularly to prevent serious complications of the disease [5, 6]. In other words, reduced visits of type 2 diabetic patients raises many concerns about the future negative consequences of poor control or delayed treatment [7]. For example, according to the study by Mendenhall et al., new diabetic patients who had poor blood sugar control often delayed their treatment [8]. In their study, Gavan et al. reported that a delay of over 1 month in seeing a doctor would lead to an increase in neuropathy and diabetic foot ulcers [9]. Another study showed that the patients who visited a doctor or health centre with a delay of more than 3 months were twice as likely to have uncontrolled diabetes compared to those who did not delay [10]. In fact, delays in health-seeking behaviours of diabetic patients will lead to delays in treatment, late diagnosis of the disease, poor health outcomes and increased healthcare costs of the patients [11]. On the other hand, unexpected conditions such as COVID-19 may affect the health behaviours of patients, especially regular visits to specialist doctors.

Following the social distancing measures during the COVID-19 pandemic, people with chronic diseases, especially diabetics, faced many challenges in managing the disease and making necessary lifestyle changes [12]. These extensive restrictions reduced the usual visits of the patients to clinics, reduced their physical activities, changed their eating habits and negatively affected their mental health [13]. Many diabetic patients refused or delayed seeing a doctor for non-COVID-19 problems due to the fear of COVID-19 [14].

Numerous studies have been conducted on the impact of COVID-19 on the conditions of type 2 diabetes patients. For example, a study in Brazil showed that 59.4% of diabetic patients experienced an increase, a decrease or large changes in glucose levels; 38.4% of patients delayed their medical appointments and/or routine examinations, and 59.5% reduced their physical activities [15]. In their research, Biamonte et al. found that the quarantine caused by the COVID-19 pandemic had a negative effect on weight and glucose control in patients with type 2 diabetes, especially those treated with insulin [16]. According to a study, the blood sugar control index of diabetic patients decreased by 21.2% in 2020 compared to 2019 [17]. Furthermore, Falcetta et al. showed in their study that at the beginning of the pandemic, blood sugar control (HBA_{1C} > 5%) in elderly patients and insulin patients worsened compared to the pre-pandemic period [18]. In general, various studies suggested that management of caring for diabetic patients and their access to care providers and, as a result, diabetes complications had been affected by the COVID-19 pandemic [19–21].

Considering the importance of regular visits of type 2 diabetic patients to service providers and the effect of timely treatment on reducing diabetes complications and their treatment costs, the present study aimed to determine the effect of delayed visits of type 2 diabetic patients on their glycaemic control in southern Iran, Shiraz city.

Material and methods

Study type and settings

This retrospective cohort study was conducted in three diabetes clinics in southern Iran, Shiraz city. The follow-up of these patients was a 4-year period, which was divided into two 2-year intervals (Feb. 2018–Feb. 2020 vs Feb. 2020–Feb. 2022) due to the occurrence of COVID-19.

Inclusion and exclusion criteria

In this research, the data available in the clinics that had active files starting 2 years before the outbreak of COVID-19 and had registered the data of the patients was collected and analysed. The inclusion criteria were > 18 years of age, a history of type 2 diabetes for at least 2 years before the outbreak of COVID-19, a history of visiting the clinic at least twice before the outbreak of the pandemic and consent to participate in the study. The exclusion criteria included suffering from mental disorders (such as schizophrenia, bipolar disorder and other disorders that affected the validity of the results) and having a history of alcohol and drug abuse.

Sampling

Three of the seventeen diabetes clinics in Shiraz met the inclusion criteria for entering the study. To determine the sample size, a pilot study was conducted using the formula of two means paired before and after, based on which the sample size of 209 patients was calculated, and the required number of patients was selected from each clinic proportionate to the total number of the patients in the studied clinics. In each clinic, random sampling was done, and the patients who met the inclusion criteria were selected. The sample size was calculated through the following formula with an alpha (α) error of 0.05 and a power of statistical test of 90%.

$$n = \frac{2\left(Z_{1-\alpha/2} + Z_{1-\beta}\right)^2}{\left(\delta_{Difference} / \sigma_{Difference}\right)^2} + \frac{Z^2{}_{1-\alpha/2}}{2} = 209.$$

Exposure and confounding variables and results

The study population was classified into 2 groups based on exposure status (delay in visiting a specialist doctor before and after COVID-19), and their clinical tests were defined as the primary outcome. The demographic data (age, gender, education, marital status, occupation, type of treatment, insurance, history of diabetes, body mass index, place of residence and history of smoking) were controlled as confounding variables. The number of delayed days was calculated based on the dates of the next visits specified by the specialist doctor at each visit. The delays were categorised into 4 groups: no delay, < 3 months, 3–6 months and > 6 months.

Data collection

A checklist was used to collect the data from the patients' files. The data included age, gender, education, marital status, occupation, type of treatment, insurance, history of diabetes, date of patient visit, body mass index, place of residence, history of smoking and clinical tests. The type 2 diabetic patients were followed up for 4 years. All data was collected retrospectively in 2022. Due to the occurrence of the COVID-19 pandemic during this period, the patients' clinical data was categorised into two groups of before and after the pandemic (17 February 2018 to 18 February 2020 vs 19 February 2020 to 20 February 2022).

Data analysis

Mean and standard deviation, as well as median and interquartile range, were used to describe the quantitative variables. On the other hand, frequency and percentage were used to describe the qualitative variables, and logistic mix-model regression was applied to analyse the data. If the confidence interval did not include odds ratios (OR) equal to 1, the analysis was not considered significant. Stata 14 software was also used to describe and analyse the data.

Ethics approval and consent to participate

The study protocol was approved by ethics committee of Shiraz University of Medical Sciences under the code IR.SUMS.NUMIMG.REC.1400.066. All methods were according to the ethical standards of the Helsinki Declaration.

Results

The mean age of the participants in this research was 63.47 ± 8.89 years, 67.94% were female, and the remaining were male. The mean duration of diabetes was 13.42 ± 5.70 years. The median of visiting a specialist doctor before the outbreak of COVID-19 was 6(5–8), and after, this was 5(3–7). The status of the patients' demographic variables is presented in Table 1.

As a result of COVID-19, HBA_{1C}, FBS and 2-hpp tests in all four categories increased. This study found an interaction effect between the delay in the visit and the occurrence of COVID-19 on HBA_{1C}, FBS and 2-hpp tests (Table 2). We investigated the effect of delay in visits on the mentioned tests before and after outbreak separately (Table 3, 4 and 5).

After COVID-19, the adjusted odds ratios of HBA_{1C} for the patients with < 3 months, 3–6 months and > 6 months delays in visiting a specialist doctor were 1.81 (OR: 1.12–2.94), 2.55 (OR: 1.17–5.55) and 3.68 (OR: 1.78–7.59) times, respectively, compared to the patients with no delay in visits. However, this increase was insignificant before COVID-19. According to the intraclass correlation coefficient (ICC), 37% of the HBA_{1C} variations that could not be explained by the current model variables were due to interpersonal variations (Table 3).

After COVID-19, the adjusted odds ratios of 2-hpp in the patients with delays of < 3, 3–6 and > 6 months were 0.93 (OR: 0.58–1.47), 1.92 (OR: 1.01–3.65) and 2.14 (OR: 1.09–4.21), respectively, that of the patients who did not have a delay in visits. These delays were not significant before COVID-19, though. The internal correlation coefficient of 2-hpp was 35%, showing that

Table 1. Basic characteristics of participants		
Variables		Diabetic patients ($n = 209$)
Age (mean ± SD*)		63.47 ± 8.89
BMI (kg/m^2)		29.18 ± 4.71
Duration of diabetes (mean ± SD, year)		13.42 ± 5.70
Gender, *n* (%)	male	67 (32.06)
	female	142 (67.94)
Marital status *n* (%)	married	193 (92.34)
	widowed	16 (7.65)
Education level *n* (%)	illiterate	48 (22.97)
	under high school	114 (54.55)
	diploma	32 (15.31)
	college	15 (7.18)
Occupation *n* (%)	government employed	31 (14.38)
	self-employed	36 (17.22)
	housewife	135 (64.59)
	retired	7 (3.34)
Insurance	social security	117 (55.98)
	health insurance	71 (33.97)
	other	21 (10.05)
Treatment type	oral hypoglycaemic drug	152 (72.73)
	both	57 (27.27)
Location	large city	160 (76.56)
	small city	49 (23.44)
Smoking history *n* (%)	yes	44 (21.05)
	No	165 (78.95)
HBA_{1C} (mean ± SD)**		7.30 ± 1.82
2-hpp (mean ± SD)**		211.23 ± 80.18
FBS (mean ± SD)**		153.60 ± 57.49

*SD – standard deviation; BMI – body mass index; HbA_{1c} – haemoglobin A_{1C}; FBS – Fasting blood sugar; 2-hpp – postprandial glucose; **These values are related to the first recorded visit of the patient in the analysed data.

Table 2. Descriptive information of clinical test of type 2 diabetes patients based on delay and non-delay in visits before and after COVID-19 outbreak								
	Before outbreak ($n = 209$)				After outbreak ($n = 209$)			
Variable	No delay	Delay < 3 month	3 ≤ delay < 6 month	Delay ≥ 6 month	No delay	Delay < 3 month	3 ≤ delay < 6 month	Delay ≥ 6 month
HBA_{1C} (mean ± SD)	7.30 ± 1.82	7.93 ± 2.93	7.35 ± 1.47	7.86 ± 1.38	7.49 ± 1.79	7.66 ± 2.75	8.13 ± 5.05	8.13 ± 2.22
2-hpp (mean ± SD)	200.99 ± 69.41	206.04 ± 52.10	213.65 ± 85.03	234 ± 94.70	196.67 ± 56.13	197.07 ± 62.15	216.99 ± 70.77	241.31 ± 105.21
FBS (mean ± SD)	146.23 ± 43.84	144.37 ± 36.91	153.46 ± 53.07	157.6 ± 47.83	145.42 ± 33.70	146.95 ± 44.34	155.98 ± 49.04	176.14 ± 87.70

Table 3. Odds ratio of HBA_{1C} based on delay in visits of participants before and after COVID-19 outbreak						
HBA_{1C}	Before outbreak			After outbreak		
Variable	OR	95% CI	*p*	OR	95% CI	*p*
No delay (references)	–	–	–	–	–	–
Delay < 3 month	1.28	0.92–1.78	0.14	1.81	1.12–2.93	0.016
3 ≤ delay < 6 month	0.90	0.45–1.81	0.78	2.55	1.18–5.56	0.018
Delay ≥ 6 month	NA**	NA**	NA**	3.68	1.79–7.63	0.000
ICC*	0.53			0.37		

*OR – adjusted for Age, Gender, BMI, Work, Education, Marital Status, Duration of Diabetes, Insurance, Treatment Type, Tobacco, Location and Clinic; **The sample size is small.

Table 4. Odds ratio of 2-hpp based on delay in visits of participants before and after COVID-19 outbreak

2-hpp	Before outbreak			After outbreak		
Variable	OR	95% CI	*p*	OR	95% CI	*p*
No delay (references)	–	–	–	–	–	–
Delay < 3 month	1.15	0.84–1.56	0.38	0.93	0.58–1.45	0.73
3 ≤ delay < 6 month	0.96	0.54–1.70	0.89	1.92	1.01–3.65	0.04
Delay ≥ 6 month	1.15	0.33–4.02	0.82	2.14	1.09–4.21	0.02
ICC*	0.36			0.35		

*OR adjusted for Age, Gender, BMI, Work, Education, Marital Status, Duration of Diabetes, Insurance, Treatment Type, Tobacco, Location and Clinic.

Table 5. Odds ratio of FBS based on delay in visits of participants before and after COVID-19 outbreak

FBS	Before outbreak			After outbreak		
Variable	OR	95% CI	*p*	OR	95% CI	*p*
No delay (references)	–	–	–	–	–	–
Delay < 3 month	0.89	0.64–1.24	0.47	1.29	0.87–1.92	0.20
3 ≤ Delay < 6 month	1.08	0.62–1.88	0.79	1.80	0.95–3.37	0.06
Delay ≥ 6 month	1.13	0.31–4.07	0.85	2.36	1.27–4.39	0.006
ICC*	0.42			0.38		

*OR adjusted for Age, Gender, BMI, Work, Education, Marital Status, Duration of Diabetes, Insurance, Treatment Type, Tobacco, Location and Clinic.

some factors other than the studied variables were important in the model, and the changes were related to interpersonal differences (Table 4).

The adjusted odds ratios of FBS after COVID-19 for the patients with delays of < 3 months, 3–6 months and > 6 months were 1.30 (OR: 0.87–1.94), 1.80 (95% confidence interval: 0.95–3.37) and 2.36 (95% confidence interval: 1.27–4.39) times, respectively, that of the patients with no delay in visits. However, these values did not increase significantly before COVID-19. The intraclass correlation coefficient for FBS was 38%, showing that 38% of the changes in the model were due to interpersonal factors (Table 5).

Discussion

The present study investigated the consequences of delay in the regular visits of type 2 diabetic patients to specialist doctors during a 4-year period. To the knowledge of the researchers, this is one of the first studies that examined patients' glycaemic tests over a long period of time (2 years before and 2 years after COVID-19 outbreak) when taking into account the delays in visiting specialist doctors.

The results of this study showed that the average visit to specialist doctors decreased during COVID-19. Other studies also reported disruptions in the regular visits of diabetic patients to service providers during the pandemic. For example, the results of the study by Coma showed that during COVID-19, patients' visits to primary care doctors decreased by 50% [17], the reasons for which could be the change in the patients' health behaviour due to the fear of contracting COVID-19 and the social distancing measures that caused barriers to access to clinics. According to the study by Abidi, COVID-19 had a negative impact on continuous in-person examinations of diabetic patients [22]. Another study conducted in Canada showed that in-person visits to specialist doctors decreased by 7.7% during the pandemic [23]. Studies indicated that the restrictions on patients' visits and the quarantines during COVID-19 caused changes in the health behaviours of diabetic patients. Considering the need of diabetic patients for regular care, any delay in their visits could be harmful. Unhealthy diets, reduced physical activities, stress and delaying health care due to the fear of contracting COVID-19 were among the reasons that affected the continuous care of diabetic patients [24–27].

The findings of this study suggested that although the delay in visits before COVID-19 increased the number of the patients' glycaemic tests, this was not significant. After COVID-19, however, the delay in visits caused a significant increase in the patients' glycaemic tests. According to the results, HBA_{1C} of the patients with delays of < 3, 3–6 and > 6 months in visiting a specialist doctor during COVID-19 were 1.83, 2.37 and 3.72 times, respectively, that of the patients with no delay. This indicates that the delay in receiving care had a great impact on HBA_{1C}. According to Moin et al., the HBA_{1C} tests decreased by 18.9% during the COVID-19 pandemic [23].

In their study, Sun et al. found that HBA_{1C} testing was performed 3 months later than the recommended time, and cancellation of referrals was more common during COVID-19 than before. In addition, fewer referrals of diabetic patients was not a reason for poor blood sugar control [28]. However, the present study concluded that the delay in visiting a specialist doctor could cause an increase in HBA_{1C}. Another study showed that the percentage of patients who had fewer visits to specialists and whose HBA_{1C} was > 10 increased during COVID-19. It seems that the change in the health behaviour of the patients had caused an increase in their blood sugar [17]. Other studies reported similar findings as well [16, 29–31]. Ghosal et al. reported that the duration of quarantine had a direct relationship with the worsening of HBA_{1c} [32]. This could be due to the decrease in the patients' physical activities and the high use of snacks and sweet foods during the pandemic [33]. On the other hand, increased economic and social problems caused the use of low-quality and fattening foods [34]. Nevertheless, some studies showed that although the HBA_{1C} of patients increased before and during COVID-19, the increase was not significant [35–37]. In the study by Ludwig et al., HBA_{1C} decreased during COVID-19 [30]. The findings of another study showed that after COVID-19, the HBA_{1C} levels decreased significantly [38]. The reason for such a difference could be the better lifestyle of the patients, their lower stress and diabetes self-management education of the patients in these studies.

Our study also showed that during COVID-19, 2-hpp increased in the patients who had a delay of > 3 months. Other studies also showed that 2-hpp increased during the COVID-19 quarantines [39, 40]. Ghesquière et al. stated that 2-hpp was significantly less controlled in 2020 than in 2019 [41], the reasons for which could be the changes in the amounts and types of their food, reduced physical activities, stress and changes in their sleep. According to Önmez et al., 2-hpp increased after COVID-19, but the difference was not significant [36]. On the other hand, Rastogi et al. suggested that 2-hpp decreased during the pandemic [42]. The dispersion in the results of the studies might be due to the differences in the participants, including the differences in their self-care and diets. Differences in the personal, social and economic characteristics of the patients and their blood sugar status in different societies could be other reasons for these contradictory results.

The present study also showed that after the spread of COVID-19, FBS increased in the patients who had a delay of < 6 months in seeing a specialist doctor, but the increase was not significant; however, FBS significantly increased in the patients with a delay of > 6 months. The study by Biancalana et al. showed that during the COVID-19 quarantines, FBS increased in the patients whose diabetes was not controlled [29]. This could be due to lifestyle changes, discontinuation of treatment due to the stress caused by infection and inability to refer to hospitals and pharmacies [13], high consumption of carbohydrates, extensive psychological stress, reduced access to healthcare services and medications [32] and decreased sleep [39]. According to the findings of some other studies, the FBS of diabetic patients was higher during the pandemic than before, but the difference was not significant [36, 39, 43]. Meanwhile, another study indicated that FBS decreased during the pandemic [3]. The dispersion in the findings of different studies could be due to the demographic conditions of the participants, their lifestyle during COVID-19, the difference in their self-care skills and the difference in the management of the pandemic in different societies.

Strengths and limitations of the study

This study has many strengths, one of which is that the recorded data of the patients was analysed over a 4-year period. In addition, the effect of diabetic patients' delay in visiting a specialist and the impact of the COVID-19 pandemic on their clinical conditions were analysed as well. Therefore, this study has policymaking and management applications. However, it had some limitations, as follows. In this study, it was not possible to examine some variables confounding the delay in visiting a specialist doctor and the clinical conditions of the patients, such as diabetic complications, socio-economic status, lifestyle, mental health and physical activity.

Conclusions

The present study showed that during COVID-19, diabetic patients' visits to specialist doctors decreased. In addition, the increase in the number of days delayed was associated with an increase in glycaemic factors. Considering the importance of regular visits to doctors and its impact on the patients' glycaemic control and quality of life, it is necessary to plan to identify and follow up the patients whose last visits had been a long time before. This way, possible complications of diabetes and the number of people with uncontrolled diabetes can be reduced. During the outbreak of the COVID-19 pandemic, many patients avoided visiting their specialist doctors regularly due to the fear of contracting COVID-19 and transferring it to other family members. This may have several negative consequences for the patients and the health system. Thus, providing suitable conditions to reduce the patients' waiting time in clinics, especially high-risk patients, can greatly help reduce their worries. Furthermore, expanding the use of telehealth technologies, teaching self-care to patients, recommending increasing mobility and cutting down on high-calorie foods are suggested as strategies for managing diabetic patients' disease during crises.

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