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Recent Vaccination Rates in Diabetic Patients

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ABSTRACT

Introduction: This study aimed to determine vaccination rates, attitudes toward vaccination, and factors influencing influenza, pneumococcal, hepatitis B, and coronavirus disease-2019 (COVID-19) vaccination among patients diagnosed with diabetes mellitus (DM) after the COVID-19 pandemic.

Methods: Vaccination rates for influenza, pneumococcus, hepatitis B, and COVID-19 among newly diagnosed patients with DM were analyzed using Stepwise Multivariate Logistic Regression models to identify influencing parameters.

Results: The study included 442 (88.4%) patients with type 2 DM and 58 (11.6%) patients with type 1 DM. The median diabetes duration was 10 (5-19) years. Diabetes follow-up was conducted for 275 (55%) patients in Internal Medicine, 156 (31.2%) in endocrinology, and 46 (9.2%) in family medicine, with 23 (4.6%) patients having no regular follow-up. Vaccination rates were influenza 28.2%, pneumococcus 23.6%, hepatitis B 9.6%, and COVID-19 91.2%. Patients who were informed about vaccines had significantly higher vaccination rates ($p<0.001$). The distribution of information sources for COVID-19 and other vaccines differed significantly ($p<0.001$). Patients received more COVID-19 vaccine information from TV, Ministry of Health messages, and social media, while information about other vaccines was obtained mainly from the family medicine and internal medicine departments. Influenza vaccination rates were higher among older age groups, those with higher education levels, longer diabetes duration, and regular diabetes follow-up ($p<0.05$). Pneumococcus vaccination rates were higher among older age groups, those with longer diabetes duration, and those with regular diabetes follow-up ($p<0.05$). Hepatitis B vaccination rates were higher among those with higher education levels ($p<0.05$). No significant differences in COVID-19 vaccination rates were observed across the factors examined.

Conclusion: Knowledge regarding vaccination necessity and actual vaccination rates among patients with diabetes is significantly low. Educating patients about vaccination is crucial. The COVID-19 pandemic has highlighted the importance of vaccination for patients with diabetes. Although COVID-19 vaccination rates are expected to be higher due to the pandemic, utilizing Ministry of Health messages, TV, and social media to inform diabetic patients about influenza, pneumococcal, and hepatitis B vaccinations could enhance vaccination rates. It is essential for all patients with diabetes to be fully vaccinated against these infections, regardless of age.

Keywords: Vaccination, diabetes, hepatitis B, influenza, pneumococcus, COVID-19

Introduction

Diabetes mellitus (DM), one of the major health issues of our time, increases susceptibility to infectious diseases and remains a significant cause of mortality and morbidity among patients (1). One of the most effective ways to protect diabetic patients from infectious agents is encouraging vaccination and ensuring complete vaccination (2). It is well known that vaccination against influenza, pneumococcus, and hepatitis B significantly reduces mortality and morbidity associated with these diseases in patients with diabetes (2-5). National and international authorities recommend influenza, pneumococcal, and hepatitis B vaccinations for patients with diabetes without age distinction (2,6,7). In addition, the recent coronavirus disease-2019 (COVID-19) pandemic has affected our country as well, highlighting diabetic patients as a high-risk group for COVID-19 infection and emphasizing the necessity for all diabetic patients to receive COVID-19 vaccination (8-10). This underscores once again that vaccination is one of the most important ways to protect patients with diabetes from infections, increasing awareness among both physicians and patients with diabetes regarding vaccination. Despite these efforts, studies conducted in Turkey in recent years have shown

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lower vaccination rates among patients with diabetes compared with developed countries (2,11-13). In our study, following the COVID-19 pandemic that affected our country, as in the rest of the world, we aimed to determine the vaccination rates against influenza, pneumococcus, hepatitis B, and COVID-19 among patients with diabetes who presented to our clinic for the first time, as well as their vaccination attitudes and the factors influencing these.

Methods

After obtaining consent from patients presenting to our clinic for the first time with type 1 and type 2 DM, vaccination rates against influenza, pneumococcus, hepatitis B, and COVID-19 were assessed, along with an examination of where patients received information about these vaccinations. Vaccination statuses of patients were documented individually through the e-Nabız system after obtaining consent from all patients. Hemoglobin A1c (HbA1C) levels, indicating diabetic regulation, were also documented. Patients with HbA1C levels ≤7% in the last 3 months were categorized as having controlled DM, whereas those with HbA1C levels >7% were categorized as having uncontrolled DM.

Factors influencing patients' vaccination rates (demographic characteristics, type of diabetes, duration of diabetes, control of diabetes, regularity of diabetes follow-up, location of follow-up visits, awareness of the necessity of vaccinations among patients, whether they knew about the vaccinations, sources of information if known, presence of comorbidities) were analyzed.

This study was approved by the University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital Ethical Committee (approval number: 421, date: 13.09.2023).

Statistical Analysis

Statistical analyses were conducted using the Statistical Package for the Social Sciences software version 21.0 (IBM Corp, Armonk, NY). Descriptive statistics for continuous data are presented as medians with minimum-maximum values, whereas categorical data are expressed as numbers and percentages. Fisher's exact test or Pearson's chi-square test was used to assess differences in categorical data. A significance level of $p<0.05$ was considered statistically significant. Multivariable logistic regression analyses were performed to identify factors associated with self-reported pneumococcal, influenza, hepatitis B, and COVID-19 vaccination status.

Results

A total of 500 patients were included in the study, comprising 58 (11.6%) diagnosed with type 1 DM and 442 (88.4%) diagnosed with type 2 DM. The median duration of diabetes was 10 (5-19) years. The mean age of the patients was 52.6±17.5 years. The distribution of patients' sociodemographic and clinical characteristics is presented in Table 1.

Clinics for diabetes follow-up are presented in Table 1. Among patients diagnosed with type 1 DM, 77.6% were under follow-up care at the endocrinology department. Notably, patients followed by the endocrinology department had significantly higher rates of high school and university education compared with those followed by other clinics ($p<0.001$). There were no significant differences in other demographic characteristics among the clinics.

In our study, 70.8% (n=354) of the patients had comorbid conditions. The most common comorbidities were hypertension [52.2% (n=261)] and coronary artery disease [27% (n=137)].

The patients' average HbA1c levels was 9.1±2.4. Fifty-six percent of patients developed diabetes-related complications. Among the patients, 44% had diabetic nephropathy, 37% had diabetic retinopathy, 28% had diabetic neuropathy, and 34% had macrovascular complications. There was no statistically significant difference in vaccination rates between patients with and without diabetes-related complications (p=0.125).

The vaccination rates for the overall patient population were as follows: influenza, 28.2%; pneumococcal, 23.6%; hepatitis B, 9.6%; and COVID-19, 91.2% (at least two doses of BioNTech, Sinovac, or Turkovac). Among the patients who received the COVID-19 vaccine, 61.4% received Sinovac, with 55.9% having two doses; 81.1% received BioNTech, with 56.1% having two doses; and 3.9% received Turkovac, all with a single dose.

When examining vaccination rates according to the type of DM, the hepatitis B vaccination rate was significantly higher in patients diagnosed with type 1 DM than in those diagnosed with type 2 DM ($p<0.001$). However, there was no significant difference in the rates of other vaccinations.

The relationship between vaccination knowledge and vaccination rates is presented in Table 2.

Table 1. Distribution of the sociodemographic and clinical characteristics of the patients

	n (%)
Gender	
Female	274 (54.8)
Male	226 (45.2)
Marital status	
Married	433 (86.6)
Single	67 (13.4)
Educational status	
Illiterate	76 (15.2)
Primary school	258 (51.6)
Middle school	28 (5.6)
High school	79 (15.8)
University	59 (11.8)
Diabetes type	
Type 1	58 (11.6)
Type 2	442 (88.4)
Diabetes regulation	
Controlled	160 (32)
Uncontrolled	340 (68)
Clinic for diabetes follow-up	
Internal medicine	275 (55)
Endocrinology	156 (31.2)
Family medicine	46 (9.2)
Not followed	23 (4.6)

Upon examining where patients received their vaccination information, we found that the sources of information for the COVID-19 vaccine and other vaccines differed significantly (p<0.001). Patients reported obtaining information about COVID-19 vaccination more frequently from television, Ministry of Health messages, and social media, whereas information about other vaccines was generally obtained from physicians (Figure 1). Among healthcare providers, family medicine and internal medicine departments were the most common sources of vaccination information. It was noted that none of the patients followed in the endocrinology department received vaccination information from their endocrinology clinic.

Table 2. Relationship between vaccination knowledge and vaccination rate

	The vaccine	There is no vaccine	p
Influenza vaccine			
Informed	87 (61.7)	3 (0.8)	**<0.001**
Not Informed	54 (38.3)	356 (99.2)	
Pneumococcal vaccine			
Informed	50 (42.4)	3 (0.8)	**<0.001**
Not Informed	68 (57.6)	379 (99.2)	
Hepatitis B vaccine			
Informed	17 (35.4)	5 (1.1)	**<0.001**
Not Informed	31 (64.6)	447 (98.9)	
COVID-19 vaccine			
Informed	363 (79.6)	5 (11.4)	**<0.001**
Not Informed	93 (20.4)	39 (88.6)	

The p-value was obtained from the Pearson's chi-square test. COVID-19: Coronavirus disease-2019

When examining vaccination rates by age, we found that the rates of all vaccines differed significantly between individuals over and under the age of 65 (p<0.05). A comparison of vaccination rates by age in patients with diabetes is shown in Table 3.

The follow-up of patients at different clinics affected their vaccination status. The vaccination rates and clinics where patients were followed up for diabetes are shown in Table 4.

When factors that could influence vaccination were examined using multiple logistic regression analysis, influenza vaccination rates were found to be significantly higher among individuals of advanced age, with a high level of education, with diabetes duration over 10 years, and with regular diabetes follow-up (p<0.05). Pneumococcal vaccination rates were also significantly higher among patients of advanced age, those with diabetes duration >10 years, and those with regular diabetes follow-up (p<0.05). Hepatitis B vaccination rates were significantly higher among those with a high level of education (p<0.05). There were no significant differences in COVID-19 vaccination rates according to the factors examined (Table 5).

Table 3. Comparison of vaccination rates according to age among patients with diabetes

	Age <65, (n=339)	Age >65, (n=161)	p
	n (%)	n (%)	
Influenza vaccine	82 (24.2)	59 (36.6)	**0.004**
Pneumococus vaccine	58 (17.1)	60 (37.3)	**<0.001**
Hepatitis B vaccine	40 (11.8)	8 (5)	**0.015**
COVID-19 vaccine	302 (89.1)	154 (95.7)	**0.015**

The p-value was obtained using the Pearson's chi-squared test. COVID-19: Coronavirus disease-2019

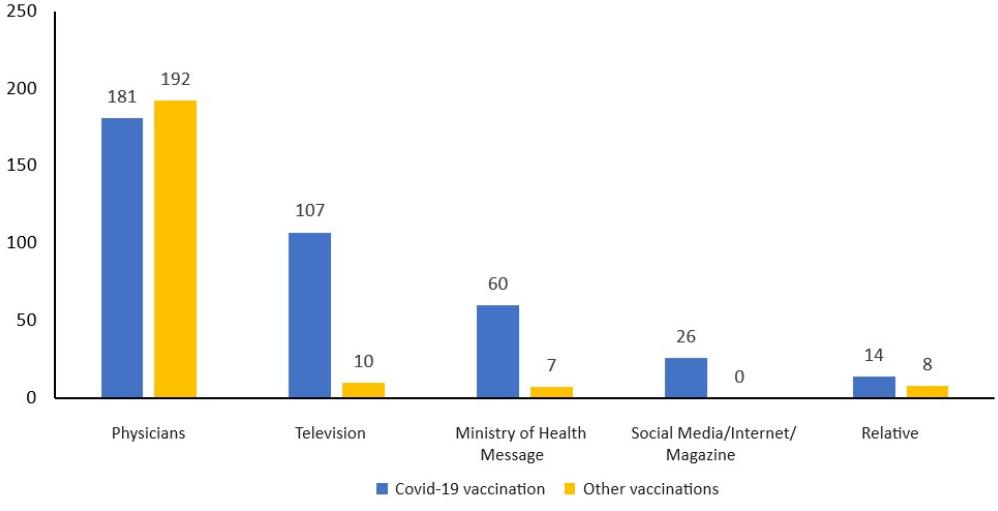

Figure 1. Bar graph showing the sources of information for COVID-19 and non-COVID-19 vaccinations
COVID-19: Coronavirus disease-2019

Table 4. Vaccination rates and clinics where patients are followed up for diabetes

	Clinic for diabetes follow-up			
	Family medicine, n (%)	Internal medicine, n (%)	Endocrinology, n (%)	p
Influenza vaccine				
Present	10 (21.7)	65 (23.6)	60 (38.5)	**0.003**
Not present	36 (78.3)	210 (76.4)	96 (61.5)	
Pneumococus vaccine				
Present	13 (28.3)	58 (21.1)	44 (28.2)	0.199
Not present	33 (71.7)	217 (78.9)	112 (71.8)	
Hepatit B vaccine				
Present	3 (6.5)	16 (5.8)	27 (17.3)	**<0.001**
Not present	43 (93.5)	259 (94.2)	129 (82.7)	
COVID-19 vaccine				
Present	46 (100)	251 (91.3)	139 (89.1)	0.068
Not present	0 (0)	24 (8.7)	17 (10.9)	

The p-value was obtained from the Pearson's chi-square test. COVID-19: Coronavirus disease-2019

Table 5. Examination of the variables affecting vaccination rates

	Influenza		Pneumococcal		Hepatitis B		COVID-19	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Gender (male)	0.723 (0.470-1,114)	0.142	0.83 (0.52-1.32)	0.429	1.74 (0.89-3.38)	0.105	0.49 (0.24-1)	0.051
Age (<65 years)	1,740 (1,094-2,768)	**0.019**	2.62 (1.61-4.25)	<0.001	0.58 (0.25-1.37)	0.213	2.31 (0.94-5.69)	0.069
Marital status (single)	1,196 (0.639-2,236)	0.576	1.67 (0.8-3.49)	0.174	2.58 (0.85-7.89)	0.096	1.88 (0.85-4.14)	0.118
Education (illiterate)								
Primary school	2,220 (1,090-4,522)	**0.028**	0.84 (0.44-1.63)	0.609	3.42 (0.76-15.28)	0.108	1.87 (0.77-4.56)	0.170
Secondary school	3,866 (1,363-10,962)	**0.011**	1.72 (0.6-4.89)	0.312	4.12 (0.61-27.66)	0.145	1.14 (0.27-4.9)	0.861
High school	3,207 (1,326-7,753)	**0.010**	1.53 (0.64-3.65)	0.339	5.66 (1.1-29.04)	**0.038**	1.14 (0.38-3.48)	0.814
University	2,880 (1,150-7,211)	**0.024**	1.86 (0.76-4.53)	0.172	8.43 (1.67-42.53)	**0.010**	1.45 (0.42-5)	0.552
Diabetes (uncontrolled)	0.919 (0.611-1,560)	0.919	1.08 (0.66-1.78)	0.754	1.07 (0.54-2.12)	0.853	1.42 (0.65-3.09)	0.377
The type of diabetes (type 1)	0.647 (0.309-1,351)	0.246	0.52 (0.22-1.22)	0.134	1.85 (0.78-4.39)	0.162	0.84 (0.32-2.22)	0.732
Duration of diabetes (<10 years)	2,290 (1,451-3,614)	**<0.001**	2.48 (1.5-4.1)	**<0.001**	1.2 (0.63-2.3)	0.583	1.41 (0.73-2.73)	0.304
Diabetes follow-up (none)	1,773 (1,111-2,830)	**0.016**	1.71 (1.04-2.81)	**0.035**	1.18 (0.57-2.45)	0.662	1.07 (0.52-2.18)	0.863

The reference categories for variables are indicated in parentheses. OR: Odds ratio, CI: Confidence Interval, COVID-19: Coronavirus disease-2019

Discussion

Vaccination against hepatitis B, influenza, pneumococcus, and COVID-19 in patients with diabetes is a critical factor in reducing hospitalization, mortality, morbidity, and healthcare costs in this patient group. The COVID-19 pandemic has once again highlighted the importance of effectively protecting patients with diabetes through vaccination. In our study, the influenza, pneumococcus, hepatitis B virus (HBV), and COVID-19 vaccination rates in patients diagnosed with DM during follow-up after the COVID-19 pandemic were 28.2%, 23.6%, 9.6%, and 91.2%, respectively. Vaccination rates for influenza, pneumococcus, and COVID-19 were significantly lower in individuals under 65 years of age than in those over 65 years of age, whereas the hepatitis B vaccination rate was higher among younger individuals. Vaccination rates were also higher in patients who were knowledgeable about vaccines. Patients reported receiving information about COVID-19 vaccination more frequently from TV, Ministry of Health messages, and social media, while information about other vaccines was often obtained from physicians (mainly from family physicians). Influenza vaccination rates were significantly higher in patients of advanced age, with a high education level, with a long duration of diabetes, and with regular diabetes follow-up. Pneumococcal vaccination rates were significantly higher in patients of advanced age, those with long-lived diabetes, and those with regular diabetes follow-up. Hepatitis B vaccination rates were significantly higher among patients with high education levels. There were no significant differences in COVID-19 vaccination rates according to the factors examined.

Vaccination rates for patients with diabetes in Turkey are significantly lower than those in developed countries (2,14). In a study conducted on patients with DM in Spain, the influenza, pneumococcal, and HBV vaccination rates were 55%, 18%, and 17%, respectively (15). In a prospective study by Tacken et al. (16), the influenza vaccination rates among patients with diabetes were reported to vary between 75% and

85%. In Turkey, a study by Apaydın et al. (12) on 504 patients with DM found influenza, pneumococcal, and HBV vaccination rates of 10%, 5%, and 6.9%, respectively. Another study by Arslan et al. (4) on patients with DM reported vaccination rates of 14.5%, 3.8%, and 15.5%, respectively, indicating relatively low levels.

In previous vaccination studies conducted in Turkey, data were generally obtained through surveys based on patient self-reports, and vaccination rates were determined accordingly (4,11-13). However, in our study, vaccination levels were accessed through individual entries for each patient in the E-health system. Although the influenza and pneumococcal vaccination rates in our study were lower than those of developed countries, they were higher than those reported in other studies conducted in Turkey. It is important to note that these studies in Turkey were conducted before the pandemic period (4,11-13,14,17). We believe that the higher rates of pneumococcal and influenza vaccination among patients with diabetes in our study are due to the pandemic. As is well known, during the pandemic period, all health authorities and the Ministry of Health recommended that patients with DM be fully vaccinated against influenza and pneumococcus, in addition to COVID-19, to reduce mortality rates. Patients were also informed about these recommendations during COVID-19 vaccination.

According to data from the Ministry of Health in Turkey, the COVID-19 vaccination rate in Istanbul is 77.8% (at least two doses) (18). The COVID-19 vaccination rate among patients with diabetes was 91.2%. We believe that the higher COVID-19 vaccination rate among patients with diabetes in our study compared with the general population in Istanbul is due to the Ministry of Health mandating vaccinations for patients with diabetes and conducting effective campaigns in this regard, as has been done worldwide. In a study conducted by Eren et al. (19) in Şanlıurfa on diabetic patients, the COVID-19 vaccination rate was 87.4%. The higher COVID-19 vaccination rate in our study may be attributed to the differences in socioeconomic status and education level, which influence vaccination rates, as highlighted in the TEMD vaccination study (20).

In our study, when examining vaccination rates according to the type of DM, there was no significant difference in vaccination rates, except for hepatitis B vaccination rates among patients with type 1 DM. This result is consistent with the TEMD vaccination study (20). Additionally, hepatitis B vaccination rates were significantly higher in individuals under 65 years of age than in those over 65. Since hepatitis B vaccination has been administered to the entire population during childhood in Turkey since 1998, we believe that the higher vaccination rates among the younger group of patients with type 1 DM can be explained by this. Given that the current adult population is not vaccinated during childhood and that hepatitis B is a significant infection risk for diabetics, many guidelines recommend hepatitis B vaccination for diabetics (2,7). However, similar to other studies conducted in Turkey and globally, our study also found that hepatitis B vaccination rates among patients with DM were quite low (4,11-13,15). This result highlights once again that adequate importance is not given to immunizing DM patients against HBV. Nevertheless, many guidelines recommend routine administration of the HBV vaccine three times for all diabetic patients aged 19-59 and for those aged 60 and above if there are additional risk factors for HBV (2,21).

Similar to the study by Arslan et al. (4), our study also found that influenza and pneumococcal vaccination rates were significantly higher in individuals over 65 years of age. While it is known that comorbidities and the potential for increased mortality and morbidity due to pneumonia are higher in patients over 65, both national and international authorities recommend immunization through vaccination for young patients with diabetes without age discrimination (2,7). In our study, contrary to the recommendations in the guidelines, we observed once again that immunization of young patients with diabetes through vaccination is being neglected. Therefore, we believe that additional support and information campaigns targeting the vaccination and immunization of young patients with diabetes in our country.

In a prospective study conducted by Satman et al. (14), factors that could affect vaccination status were examined, and it was found that the parameters increasing the rates of influenza and pneumonia vaccinations were advanced age and long duration of diabetes. We obtained results similar to those of Satman. However, unlike Satman's study, we observed that the presence of additional comorbidities and other illnesses did not affect the vaccination rates in our study. Similar to the results of the TEMD vaccination study, we found that these two vaccination rates were higher in patients with regular diabetes follow-up (20). We believe that this result is due to the close contact and information exchange between the patients, physicians, and healthcare institutions. In our study, similar to the results of Demirci's multicenter cross-sectional TEMD vaccination study, influenza vaccination rates were higher in those with higher education levels, whereas, unlike Demirci et al.'s (20) study, there was no such relationship for pneumococcal vaccination rates. As in Lu et al.'s (22) study in the United States evaluating hepatitis B vaccination rates in patients with diabetes, we also found that hepatitis B vaccination rates were significantly higher in those with higher education levels. In our study, COVID-19 vaccination rates were not affected by factors that could influence vaccination, as was the case in Eren et al.'s (19) study. Given the different dynamic nature of the COVID-19 pandemic, its higher mortality rates, and the inclusion of all patients with diabetes in the mandatory vaccination program, as recommended by health authorities, this is expected. The diagnosis of diabetes itself was the most significant reason for COVID-19 vaccination, independent of all other parameters.

In our study, we observed that the follow-up of patients with diabetes by different clinical units affected their vaccination rates. The influenza and hepatitis B vaccination rates of patients followed by the endocrinology department were statistically significantly higher compared with those followed by other clinical units, whereas there was no significant difference in other vaccination rates. However, we also found that the education level of patients followed by the endocrinology department was higher than that of patients followed by other clinical units. We believe that this difference in vaccination rates may be related to this disparity in education levels. Similar to previous studies, we observed that influenza and hepatitis B vaccination rates were associated with higher education levels in our study (4).

Consistent with previous studies, our study found that patients who received information about vaccines had higher vaccination rates (11,14,17). In our study, we observed that patients frequently obtained information about COVID-19 vaccination from TV, Ministry of Health messages, and social media, whereas they primarily received information about other vaccines from physicians. Although we consider the differences in COVID-19 vaccination rates and vaccination information compared to other vaccines and vaccination attitudes as a natural consequence of the pandemic, we believe that the effective use of social media, TV, and the Ministry of Health's vaccination information messages for informing diabetic patients about influenza, pneumococcal, and hepatitis B vaccines could significantly contribute to increasing their vaccination rates.

In our study, we observed that similar to the findings of the study by Kırık et al. (11), information about vaccinations other than COVID-19 was primarily provided by physicians. The diaVAX study, a multicenter prospective study conducted by Satman et al. (14), found that a 4-month physician training program resulted in an average increase of 2.5 and 4 times in influenza and pneumonia vaccination rates. Ensuring the education of physicians at all levels regarding the vaccination of patients with diabetes and maintaining the continuity of this education are crucial for bringing the vaccination rates among patients with diabetes in Turkey to the desired levels. In our study, we found that vaccination information was mostly provided by family physicians and internal medicine departments, similar to the findings of Arslan et al. (4). Contrary to Arslan et al.'s (4) study, it is striking that none of the patients followed by the endocrinology department in our study received vaccination information from the endocrinology clinic. We believe that the importance given to vaccination immunization in endocrinology clinics, where diabetic patients are referred as the last step, should be increased, and that information should be provided meticulously. It is concerning that, as shown in the studies by Arslan et al. (4) and Eren et al. (19), the vaccination rates in endocrinology clinics remain significantly below the expected levels for patients with diabetes even after the pandemic period (20).

Study Limitations

This study was limited by its retrospective design. Although the study included a significant number of patients, further research involving larger and more diverse populations would be beneficial to confirm and expand upon these findings.

Conclusion

Although there has been a slight increase in pneumococcal and influenza vaccination rates following the pandemic period, knowledge regarding the necessity of vaccination and the actual vaccination rates among patients with diabetes remain significantly below the desired levels. The COVID-19 pandemic has once again highlighted the importance of effectively protecting patients with diabetes through vaccination. Although it is expected that COVID-19 vaccination rates will be higher than other vaccinations due to the pandemic, we believe that the effective use of Ministry of Health vaccination information messages, TV, and social media to inform diabetic patients about influenza, pneumococcal, and hepatitis B vaccinations would be beneficial in increasing vaccination rates. Furthermore, regardless of age group, it should be remembered that all patients with DM, whether type 1 or type 2 DM, are at increased risk of infections, and it is essential to ensure that influenza, pneumococcal, and hepatitis B vaccinations are completed without fail.

Ethics Committee Approval: This study was approved by the University of Health Sciences Turkey, Başakşehir Çam and Sakura City Hospital Ethical Committee (approval number: 421, date: 13.09.2023).

Informed Consent: It was obtained.

Authorship Contributions: Concept - Ö.P.K.; Design - Ö.P.K.; Data Collection or Processing - D.A., M.G.G., K.Ş., Ö.B.G., M.N.; Analysis or Interpretation - Ö.P.K., M.N., E.Ş.H.; Literature Search - Ö.P.K.; Writing - Ö.P.K.

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