



# Evaluation of Influenza, Pneumococcus, Zoster, Measles, Diphtheria, and Pertussis Vaccination Rates in Patients with Type 1 and Type 2 Diabetes Mellitus; a Single-Center Experience from Turkey

Diabetes Mellitus Tanılı Hastalarda İnfluenza, Pnömonokok, Zoster, Kızamık, Difteri ve Boğmaca Aşılama Oranlarının Değerlendirilmesi; Türkiye'den Tek Merkez Deneyimi

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## Abstract

**Objective:** Several vaccines have been recommended for adults with diabetes. This study aimed to determine the rates of uptake of recommended vaccines in diabetic adults and estimate their association with sociodemographic and clinical factors. **Material and Methods:** This was a cross-sectional study conducted on patients with either type 1 or type 2 diabetes, who had attended the outpatient clinics of internal medicine and endocrinology. The patients were inquired about their immunization status against influenza, pneumococcus, zoster, measles, pertussis, and diphtheria. **Results:** Among the 350 diabetic patients, 38 (10.8%) had received a vaccine against pneumococcus, 90 (26%) against seasonal influenza, and only one patient had been administered the zoster vaccine. None of the patients had been vaccinated against measles, diphtheria, and pertussis. The rate of pneumococcal vaccination (PV) increased with age (65.5±9.7 vs. 57±9.1 [OR 2.9 (95% CI=14.3-2.67), p=0.005], although there was no such association between influenza vaccination (IV) and age (p=0.456). The rate of PV increased with the number of routine follow-up visits per year (10/38 vs. 28/38 [OR 4 (95% CI=0.994-16.096), (p=0.039)]. The rates of PV and IV were significantly higher in diabetic patients with chronic pulmonary disease (21/38 vs. 14/312 [OR 52.80 (95% CI 8.4-333.1), p=0.005 and 31/90 vs. 4/260 [OR 29.15 (95% CI 3.37-252.28), p=0.001] respectively. The rates of IV in diabetic patients with chronic renal failure were also significantly different from those without (27/90 vs. 8/260, [OR 14.28 95% CI 1.51-133.74], p=0.013). **Conclusion:** We observed low rates of vaccination against influenza, pneumococcus, and zoster in patients with diabetes, which were below the targets recommended by the World Health Organization.

**Keywords:** Diabetes; vaccination; influenza; pneumococcal vaccines; zoster; pertussis

## Özet

**Amaç:** Diyabetik hastalarda çeşitli aşılama oranları önerilmektedir. Bu çalışmada diyabetik hastalarda aşılama oranlarının belirlenmesi ve sosyodemografik ve klinik faktörlerle ilişkilerinin saptanması amaçlanmaktadır. **Gereç ve Yöntemler:** Çalışma, İç Hastalıkları ve Endokrinoloji Kliniğine başvuran tip 1 ve tip 2 DM'li hastalar üzerinde kesitsel-gözlemsel olarak yapıldı. Hastaların influenza, pnömonokok, zoster, kızamık, boğmaca ve difteri enfeksiyonlarına karşı aşılama durumları sorgulandı. **Bulgular:** Çalışmaya tip 1 ve tip 2 diabetli, toplam 350 hasta dahil edildi. Hastaların 38 (%10,8)'i pnömonokok, 90 (%26) mevsimsel grip ve sadece bir hasta zoster enfeksiyonuna karşı aşılanmıştı. Hastaların hiçbirinde kızamık, diphtheria ve boğmaca aşısı yapılmamıştı. Pnömonokok aşılama (PA) oranı yaşla birlikte artmış bulundu (65,5±9,7 vs 57±9,1 [OR 2,9 (%95 CI-14,3-2,67), p=0,005]. Ancak influenza aşısı (IA) ile yaş arasında böyle bir ilişki saptanmadı (p=0,456). PA oranı, yıllık rutin poliklinik ziyaret sayısı ile ilişkili olarak artmış görüldü (10/38 vs 28/38 [OR 4 (%95 CI -0,994-16,096), (p=0,039). PA ve IA oranları kronik akciğer hastalığı olan diabetes mellituslu hastalarda anlamlı olarak daha yüksekti (sırasıyla 21/38 vs 14/312 [veya 52,80 (%95 CI 8,4-333,1), p=0,005 ve 31/90 vs 4/260 [veya 29,15 (%95 CI 3,37-252,28), p=0,001]. Kronik böbrek yetmezliği olan ve olmayan diyabetik hastalarda IV oranları arasında istatistiksel olarak anlamlı bir fark saptandı (27/90 vs 8/260, [OR14,28 %95 CI 1,51-133,74], p=0,013). **Sonuç:** Diyabetik hastalarda influenza, pnömonokok ve zona aşılama oranları Dünya Sağlık Örgütü tarafından belirlenen hedeflerin altında saptandı.

**Anahtar kelimeler:** Diabetes mellitus; aşılama; influenza; pnömonokok; zoster; boğmaca

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## Introduction

Diabetes Mellitus (DM) is an important systemic disease with increasing incidence, complications, and economic burden on society (1). Patients with DM show a higher prevalence of comorbidities and are more susceptible to infectious disease, which in turn leads to increased morbidity and mortality risk via several mechanisms (2,3). Influenza runs a more severe course (e.g., higher incidence of complications such as cardiovascular events) in diabetic patients, with a 2–4-fold increased risk of pneumonia-related hospitalization and mortality, compared to non-diabetics (3–5). Numerous studies show an increased risk of pneumococcal pneumonia and invasive pneumococcal disease (IPD) in diabetic patients, with increased rates of mortality (6,7). Diabetics are also at higher risk of herpes zoster infection, including the risk of ophthalmic nerve involvement and/or debilitating post-herpetic neuralgia (8). Although the risk of infection in diabetics is similar to that in a healthy population, diseases such as measles, diphtheria, and pertussis have a more serious course in diabetic patients. Therefore, vaccination in patients with DM is essential. The reported immune responses to vaccines in people with diabetes are variable. However, it is generally considered that immunization against influenza and pneumococcus in this risk group yields favorable results overall (9–13). Herpes zoster vaccine lowers the risk of disease by 51% and post-herpetic neuralgia by 67% in immunocompetent individuals aged 60 and above (14). In pertussis, diphtheria, tetanus, and measles, which are known for their high incidence and contagiousness, natural or vaccination-induced immunity does not provide lifelong protection. Recent outbreaks of measles and pertussis in adult populations have suggested an epidemiological shift of such infections to an older age, where the initiating cause is unvaccinated people or those who have lost their immunity. Therefore, childhood vaccines for preventable diseases should also be administered in adults (15).

The approach of international and national organizations to vaccination may differ in the type of recommended vaccine, patient's age, and the presence of chronic illness. All

the organizations suggest the administration of IV annually before the flu season begins and PV for patients with diabetes of all ages, with some differences in vaccination regimens according to the age (16–19). A single dose of zoster vaccine (ZV) for all diabetic adults aged 60 years and above is recommended by the Advisory Committee on Immunization Practices (ACIP) and the Infectious Diseases and Clinical Microbiology Speciality Society of Turkey (EKMUD) (17,19). Pertussis-containing vaccines have recently been started to be used for adults (15). Some organizations recommend that all adults should get a single dose of the tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine followed by Td booster every ten years, and at least one dose of MMR vaccine for adults born during or after 1957 who have no evidence of immunity (15,19).

Studies investigating the uptake of and response to recommended vaccines in adults with chronic diseases in Turkey are limited. Moreover, local epidemiological changes, the rise of immigration over the past years, along with an increased risk of re-emerging epidemics, and the aging of the population associated with an increased risk of comorbidities, require a systematic approach to vaccination and updating the immunization schedules. This study aimed to investigate the uptake of influenza, pneumococcus, zoster, measles, diphtheria, and pertussis vaccination in diabetic patients, in the context of proposed changes in vaccination and lack of consensus on the applicability of childhood vaccination in adults. Furthermore, we aimed to explore the clinical attributes associated with the actual vaccination rates (VR).

## Material and Methods

This was a cross-sectional study conducted between January and August 2019 at the Istanbul Prof. Dr. Cemil Taşcıoğlu State Hospital, Department of Internal Medicine, Istanbul, Turkey.

## Participants

Patients with type 1 and type 2 DM aged over 18-years-old, who attending the internal medicine and endocrinology outpatient clinics, gave informed consent for data col-

lection, and had no contraindications to vaccination were consecutively included in the study. The exclusion criteria were age below 18 years and inability to provide reliable information regarding vaccination.

### Study design

Sociodemographic data, comorbid diseases, current medication, type of diabetes, disease duration, and the number of outpatient clinic visits during the previous years were recorded for all the patients included in the study. Medication data were obtained from the patient charts. The comorbid diseases recorded were hypertension (HT), asthma, chronic obstructive pulmonary disease (COPD), chronic kidney damage (CKD), coronary artery disease (CAD), and cirrhosis. Although asthma and COPD were treated as distinct diseases, we recorded them under the title "chronic pulmonary disease (CPD)". According to regular follow-up visits during the previous five years, we divided the patients into two groups: those with a maximum of two annual follow-up visits and those with at least three. Since the guidelines on diabetes management recommended patients to have their routine follow-up at least twice a year but with an optimal frequency of four times a year, we divided the patients into the above-defined groups, highlighting the patients' adherence to the diabetes management plan (18). History of vaccination against influenza, pneumococcus, zoster, Tdap, and measles of all the enrolled patients for the past five years was obtained from the physicians' records and/or based on the patient's statement. We attempted to ascertain the timing of the vaccination as much as possible. For seasonal IV, patients were categorized as 1) vaccinated during the previous year, 2) at least once in the last five years, and 3) annually for the last five years. For pneumococcus, pertussis-containing (Tdap/Td) combinations, and measles, we inquired about the time of vaccination in the past. The trade names of vaccines were not recorded since our objective was only to confirm the uptake and not the efficiency of vaccination.

### Ethics statement

This study was conducted following the Declaration of Helsinki. The study was approved

by the institutional ethics committee (07.02.2017/48670771) of the Health Sciences University, Okmeydani Training and Research Hospital. All patients and/or their caregivers were informed about the study, and their informed consent was obtained.

### Statistical Analysis

The sociodemographic and clinical data were summarized using appropriate summary statistics. We used the Student's t-test to compare the continuous variables and the Chi-square test to compare the categorical variables. Continuous values were presented as mean  $\pm$  SD. Spearman's correlation was used to assess the relationship between vaccination statuses (yes/no) and factors probably able to affect the VR. A p-value  $<0.05$  was considered statistically significant. All the data were analyzed using the statistical software SPSS for Windows, version 15.0 (SPSS Inc, Chicago, IL).

### Results

A total of 350 diabetic patients who fulfilled the inclusion criteria were enrolled in the study. The population in the study consisted of type 1 ( $n=35$ ) and type 2 ( $n=315$ ) diabetic patients. The demographic and clinical characteristics of all patients were recorded, as shown in [Table 1](#).

Thirty-eight (10.8%) of the patients received pneumococcal vaccine all in the previous five years. Twenty-four (63%) of the patients receiving PV were 65 years of age or older. The number of older patients ( $\geq 65$  years,  $n=103$ ) receiving PV was higher than younger ones ( $<65$  years) ( $p<0.005$ ) ([Table 2](#)). No patient with type 1 DM received pneumococcal vaccine.

Analysis of distribution of influenza vaccination over the past five years for all patients revealed that 90 (26%) patients received an influenza vaccine during the last year, 108 (31%) had received it at least once during the last five years, and 60 (17%) had received IV annually. The seasonal IV rate of 65 years or older diabetic patients during the last year was 30%. The distribution of vaccination in type 1 DM patients was as follows: 10 (2.8%) patients had received an influenza vaccine during the last year, 16 (4.5%) had received it at least once during the last five years, and 3 (0.8%) had received IV annually.

**Table 1.** The demographic and clinical characteristics of the patients.

Variables	Patients n=350
Age (mean±SD; year)	57,9±10,7
Age of T1DM*	48,5±6,3
Age of T2DM**	58,9±9,3
Number of the patient over the age of 65 (n; %)	103 (29%)
Gender male/female (n)	97/253
Education status	
No education	142 (41%)
Primary school	165 (47%)
High school	42 (12%)
University	0
Diabetes duration (years; mean±SD)	8,9±6,7
Diabetes duration of T1DM*	17,8±7,9
Diabetes duration of T2DM**	7,9±5,4
Comorbidities (n; %)	
HT+ (n=232)	232 (66%)
CAD++ (n=59)	59 (17%)
CKD+++ (n=35)	35 (10%)
CPD++++ (n=35)	35 (10%)
Treatment options (n; %)	
Only diet	9 (3%)
OAD <sup>a</sup>	180 (51%)
OAD+basal Insulin	43 (12%)
Intensive insulin therapy	118 (34%)
Number of follow up visits per year (n; %)	
Less than one visit per year	43 (12%)
One regular visit per year	59 (17%)
Two regular visits per year	132 (37%)
Three regular visits per year	62 (18%)
Four and more regular visit per year	90 (26%)

T1DM\*: Type 1 diabetes mellitus; T2DM\*\*: Type 2 diabetes mellitus; HT+: Hypertension; CAD++: Coronary artery disease; CKD+++ : Chronic kidney damage; CPD++++: Chronic pulmonary disease; OAD<sup>a</sup>: Oral antidiabetic drugs.

Only one patient with type 2 DM had been vaccinated against herpes zoster. No patient was vaccinated against measles, diphtheria, or pertussis.

The rates of PV and IV were similar between genders. We observed that the rate of PV (65.5±9.7 vs. 57±9.1 [OR 2.9 (95% CI-14.3 -2.67)]; p=0.005) increased with increasing age, whereas there was no such association between IV and age (Table-2). IV and PV rates increased with an increase in the number of regular DM follow-up visits, but it was only statistically significant for PV (10/38 vs. 28/38 [OR 4 (95% CI -0.994 -

16.096], (p=0.039) (Table 2). The rates of PV and IV were higher in diabetic patients with CPD with a high statistical significance (21/38 vs. 14/312 [OR 52.80 (95% CI 8.4-333,1], p=0.005 and 31/90 vs. 4/260 [OR 29.15 (95% CI 3.37-252.28], p=0.001), respectively. There was also a statistically significant difference between the rates of IV in diabetic patients with CKD than those without (27/90 vs. 8/260 [OR 14.28 95% CI 1.51-133.74], p=0.013). Although the rate of PV was higher in diabetic patients with CKD, we did not find a significant difference in the rate of PV between patients with CKD and without CKD (Table 2). Of the 38 patients who were vaccinated against pneumococcus, 34 also received influenza vaccination. There was a significant association between the rates of two vaccinations (P<0.001). Patient with zoster vaccine uptake had been simultaneously vaccinated against pneumococcus and influenza. There were no statistical differences between the rates of IV and PV regarding education status, treatment characteristics, duration of diabetes, HT, and CAD (Table 2).

## Discussion

In this study, we observed lower rates of IV, PV, and ZV in type 1 and type 2 diabetic patients, which were below the targets recommended by the World Health Organization (WHO) (20,21). Childhood vaccines required to protect public health were not administered at all.

VRs, both in general and diabetic populations, vary depending on age, socio-economic status, or regional development. A seven-year retrospective study on the rates of IV among 124,503 diabetic patients in the United States, as an example of a developed country, has demonstrated that IV rates vary between 63% and 69% annually. Vaccinated diabetics were older and had more comorbidities than the non-vaccinated ones (11). According to the National Center for Health Statistics (NCHS) data of the last four years, the rates of IV and PV were 62% and 53%, respectively, with no variation between the years. The rates of both IV and PV in diabetic patients have been demonstrated to increase with income status and age and vary by race and ethnicity (22). In a Canadian study, the rate and trend of IV between 2006/07 and

Table 2. Association of influenza and pneumococcal vaccinations with demographic and clinical factors.

Variables	Influenza vaccination			Pneumococcal vaccination		
	Vaccinated (n=90)	Non vaccinated (n=260)	P value	Vaccinated (n=38)	Non vaccinated (n=312)	P value
Age	59.7±10.1	57.3±9.3	0.288	65.5±9.7	57±9.1	<b>0.005</b>
Age						
<65 (n=247)	59 (17%)	188 (54%)		14 (4%)	233 (67%)	
≥65 (n=103)	31(9%)	72 (20%)	0.456	24 (7%)	79 (22%)	0.015
Gender						
Male (n=97)	35 (10%)	62 (18%)		17 (5%)	80 (23%)	
Female (n=253)	55 (16%)	199 (57%)	0.118	21(6%)	232 (66%)	0.150
Education status						
No education	35 (10%)	107(31%)		14 (4%)	128 (36%)	
Primary school	48 (14%)	117 (33%)		20 (6%)	146 (42%)	
High school	7 (2%)	36 (10%)	0.326	4 (1%)	38 (11%)	0.877
University	-	-		-	-	
Diabetes duration (years; mean±SD)	10.4±6.5	8.4±6.3	0.184	8.2±4.9	9±6.5	0.708
Comorbidities (n;%)						
HT* (n=232)	69 (20%)	163(47%)	0.143	31 (9%)	201(57%)	0.212
CAD** (n=59)	20 (6%)	39 (11%)	0.085	10 (3%)	49 (14%)	0.390
CKD*** (n=35)	27 (8%)	8 (2%)	<b>0.013</b>	12 (3%)	23(7%)	0.090
CPD**** (n=35)	31 (9%)	4 (1%)	<b>0.001</b>	21(6%)	14 (4%)	<b>0.005</b>
Treatment options						
Only diet (n=9)	2 (0.5%)	7 (2.5%)		0	9 (3%)	
OAD& (n=180)	34 (10%)	146 (42%)		24 (7%)	156 (45%)	
OAD+basal	14 (4%)	29 (8%)		7(2%)	36 (10%)	
Insulin (n=43)						
Intensive insulin therapy (n=118)	40 (11%)	78 (22%)	0.363	7(2%)	111 (32%)	0.570
Number of follow up visits per year						
Twice or less	36 (10%)	162 (46%)		10 (3%)	187 (53%)	
More than twice	54 (15%)	98 (28%)	0.056	28 (8%)	125 (36%)	<b>0.039</b>

HT\*: Hypertension; \*\*CAD: Coronary artery disease; \*\*\*CKD: Chronic kidney damage; \*\*\*\* CPD: Chronic pulmonary disease.

2013/14 were relatively stable, with an average rate of 40% (23).

Data from European countries have demonstrated that the rates of IV vary between 10-86% (24-28). Some member states of the WHO European Region have reported an increase in vaccination coverage rates in this population, while others have reported a decrease over time (26,28). Among these countries, the Netherlands (>75%) consistently had the highest coverage in the diabetic group, fol-

lowed by England and Belarus (24,26). Greece had the lowest IV coverage in the diabetic group. Although there was a substantial gap in data on vaccination coverage, it was observed that IV coverage in diabetic patients differed considerably among European countries (25,26,28). The proportion of diabetic patients administered PV varied between 2% and 23% and was much lower than that of IV in these countries (29,30). Turkey is a developing country and a member state of the WHO



European Region. The IV rates observed in our study were lower compared to those in some developed countries such as the United States, Netherlands, and Canada. Similarly, some of the European countries had also reported unsatisfactory outcomes. Our rates of PV were lower in diabetic patients, as in most European developed countries.

However, most of the European countries are developed and have national policies for IV/PV, which allows for a predominant payment mechanism for the coverage of recommended vaccinations by national health insurance (26,31). Thus, differences in VRs among these countries cannot be explained only by financial reasons. They are also influenced by a lack of awareness that infectious diseases may trigger serious complications, inadequate vaccination recommendations by physicians, and community perception that vaccination is unnecessary (24).

In developing countries, data for uptake of the recommended vaccines in diabetic patients is insufficient. Rates of IV were reported to vary between 0.4% and 28%, and rates of PV varied between 0.7 and 26% (32-35). The rates of IV and PV in our study were slightly higher compared to the study results from other developing countries, including China, India, Morocco, and Thailand. In contrast to developed countries, the unsatisfactory results of vaccination in developing countries are due to a lack of access to vaccination services, absence of a national vaccination policy incorporating health insurance coverage, and insufficient investment in vaccine manufacturing (36).

Turkish healthcare organizations have precise recommendations for vaccinations in diabetic patients as adopted in developed countries. Although the payment for vaccination is covered by the national health insurance system, the decision on the vaccine uptake is the choice of the diabetic patient. The low VRs observed in our study are probably due to similar reasons, such as low awareness of vaccination-related benefits, which was indirectly supported by the fact that the VR increased with an increase in the number of regular follow-up visits. On the other hand, most of our patients who

were vaccinated against one of the infectious agents were observed to have received other recommended vaccines, implying an enhancement in awareness for vaccination. Our observations on the associations between previous IV and PV, and more findings of several studies on prior PV and current PV, indicate that the patients who had received any kind of vaccination were likely to be more vigilant about disease prevention (37,38). The VRs in developed countries increased with the presence of CPD, a higher number of regular follow-up visits, and a longer duration of diabetes (25,38). Our findings regarding the relationship between comorbidities and vaccination status were consistent with the literature. A higher number of follow-up visits affected the PV rates in our population but did not affect the rates of IV. No relationship was observed between the duration of diabetes and VR. Older age was the most predictable factor for vaccination in most studies, although the strength of this association was variable. In our study, only the rate of PV increased with age. Achieving a relatively higher rate of IV than PV without any difference between the age groups could be partially explained by the recurrent influenza outbreaks, which caused an impact on increasing awareness on this infection, as well as encouraging vaccination in almost all age groups in Turkey in recent years. Development of geriatric medicine and initiation of a vaccination program for elderly patients, as part of a preventive arrangement, may have contributed to an increase in rates of PV in the elderly diabetic population, as observed in our study. The rates of IV and PV did not differ across educational level in contrast to the findings of other studies (39,40). The discrepancy between our results and those of others may be explained by the fact that much of our cohort comprised patients without or having a low level of education; thus, preventing a possible comparison.

In Turkey, data on the VRs of diabetic patients are also variable. In elderly diabetic patients living in the Izmir region ( $n=274$ ; mean age= $72\pm$ six years), rates of IV and PV were 38.1% and 13.4%, respectively, which were observed to be significantly higher than those in diabetic patients in

general (41). In a study from Antalya (2006, n=1494) revealed that only 111 (7.4%) patients had received influenza vaccine. Of those vaccinated, 13.4% were DM patients (42). Another study from Ankara (n=318; type 1 DM=6.9% and type 2 DM=93.1%; average age=54.7 years) reported that the rates for IV and PV were 14.6% and 3.8%, respectively, which were lower than our results. Similar to our results, there was no relationship between educational status and VRs (43). In a recent study (n=293) from Istanbul, the rates of IV and PV in diabetic patients were 34.1% and 9.9%, respectively (44). In 2013, a large (n=5682) study conducted by Satman reported the rates of IV and PV in Turkish diabetic patients as 27% and 9.8%, respectively (45). The age of patients and duration of diabetes of our cohort were similar to those in Satman's study that characterized the profile of the diabetic population in Turkey. The rates of IV and PV observed in our study were similar to those reported in other studies. In our study, regular follow-up visits were observed to positively influence PV, which was not observed in Satman's study. In Satman's study, diabetics with more severe health conditions were reported to be less likely to be vaccinated, whereas, in our study, certain diseases such as CPD and CKD were positively associated with VRs. Although we had a smaller cohort that represented a limited range of vaccination practice in diabetic patients in Turkey, when we compare our results with those in Satman's study, several important findings were highlighted. Firstly, although our work was conducted eight years after Satman's study, the rates of IV and PV in patients with diabetes were similar to the baseline data from this epidemiological study coming from 2013 (data collection in 2011). This suggested that the VRs did not significantly increase over time. In the referred study, explaining the importance of vaccination to the patients resulted in an increase in IV and PV rates from 27% to 63% and from 9.8% to 41%, respectively. Given the low VRs in our study, physicians who seemed to be the most important factors to enhance the rates of vaccination have not been actively involved in vaccination promotion initiatives over time. Finally, in Sat-

man's study, diabetic patients with more comorbidities and/or familial risk factors had a lower rate of IV and PV uptake at the baseline. Our study revealed increased VRs in diabetic patients with certain conditions such as CPD and CKD, compared to those without such conditions. This finding probably indicated an enhancement in the concern about the preventive measures in diabetic patients with comorbidities and showed an improvement in the multidisciplinary approach in preventive measures in high-risk patients.

There are little data on VRs on zona, measles, diphtheria, and pertussis, where the vaccines have been recommended in the context of community protection in patients with diabetes. According to the data from NCHS, the rate of diabetic patients over 60 years of age vaccinated against herpes zoster was 27.9% and 27.2%, respectively. Low uptake of herpes zoster vaccination (4%) was generally observed, with variations based on age, race, and low-income levels. Data on vaccination in diabetic adults against tetanus toxoid, reduced diphtheria toxoid, Tdap, and measles are lacking, but have been reported to range between 8 and 28% in all adult populations during the period from 2012 to 2016 (46). In a Brazilian study addressing immunization against measles, mumps, and rubella associated with younger patients, 14.9% of the patients with DM had been reported to have undertaken at least one dose of MMR. But Td vaccine in those diabetic patients was administered at a high rate of 65.5% (47). There were no data on vaccination against measles and Tdap/Td in Turkish diabetic adults.

The limitations of this study were the cross-sectional design and collection of the data based on self-reports, which may pose a challenge in recalling whether or when the vaccination was administered, especially in older patients.

## Conclusion

Vaccination rates among adults with DM were below the targets recommended by the WHO. Specific policies are needed to improve the vaccination rates in this risk group of patients.

## Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

## Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

## Authorship Contributions

Idea/Concept: Müge Bilge, Aylia Yeşilova, Neslihan Özsoy; Design: Aylia Yeşilova, Müge Bilge, Neslihan Özsoy; Mine Adaş; Control/Supervision: Aylia Yeşilova, Müge Bilge, Mine Adaş; Data Collection and/or Processing: Neslihan Özsoy, Aylia Yeşilova, Müge Bilge; Analysis and/or Interpretation: Aylia Yeşilova, Müge Bilge, Mine Adaş, Neslihan Özsoy; Literature Review: Aylia Yeşilova, Müge Bilge, Mine Adaş; Writing the Article: Aylia Yeşilova, Müge Bilge, Mine Adaş; Critical Review: Mine Adaş, Müge Bilge, Aylia Yeşilova; References and Fundings: Müge Bilge, Aylia Yeşilova, Neslihan Özsoy; Materials: Neslihan Özsoy, Müge Bilge, Aylia Yeşilova.

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