



Self-reported receipt of preventive practices and its associated factors among adults with diabetes in the United States

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ABSTRACT

Previous studies indicated that a high proportion of adults with diabetes do not receive recommended preventive care in the United States. Nevertheless, a comprehensive evaluation of the factors associated with the receipt of most recommended preventive care measures collectively is lacking. Therefore, this study describes the utilization of multiple preventive care measures collectively. Moreover, this paper aims to identify factors associated with receiving the recommended preventive care. A cross-sectional study design was implemented using data from multiple panels (2009–2015) of the Medical Expenditure Panel Survey. The sample included adults aged 21 years or older with diabetes ($n = 8415$). The outcome for this study was either receiving five selected preventive care measures (HbA1c tests, cholesterol tests, foot examinations, dilated eye examinations, and influenza vaccines) collectively or not. Multivariable logistic regressions were performed among all adults with diabetes, those with multimorbidity, chronic kidney disease (CKD) or eye complications. Adults with diabetes were poorly adherent to receiving the five preventive care measures collectively (15.6%). Among all adults with diabetes, factors associated with receiving all the selected preventive practices included age, education, health insurance, prescription drug coverage, duration of diabetes, number of chronic conditions and smoking status. Similar results were observed among adults with multimorbidity. Among adults with CKD, those with private insurance and drug prescription coverage were more likely to receive the recommended practices. The findings suggest low adherence to receiving all five recommended practices. It is crucial to increase the awareness about the need for all the recommended practices among adults with diabetes.

1. Introduction

In the United States (US), 30.2 million individuals were living with diabetes (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017) in 2016. The financial burden of diabetes and its complications is found to be high, and 25% of the US health care expenditures are for individuals with diabetes (American Diabetes Association, 2018a; Deshpande et al., 2008). Among adults with Type 2 diabetes, those with any degree of the eye or renal complications had higher healthcare expenditures than those without (Li et al., 2013). Diabetes is also associated with negative health consequences (American Diabetes Association, 2018a; Deshpande et al., 2008). Diabetes was the seventh leading cause of death in 2016 (Centers for Disease Control and, 2016). Adults with diabetes are at higher risk of serious health complications (Deshpande et al., 2008) including heart disease, advanced diabetic retinopathy and lower-limb amputations

(Centers for Disease Control and Prevention, 2011). Individuals with diabetes can better manage their health and prevent diabetes-related complications by receiving preventive care, including HbA1c testing, cholesterol tests, foot examinations, dilated eye examinations, and influenza vaccines (American Diabetes Association, 2012; American Diabetes Association, 2018b).

According to the Standards of Medical Care in Diabetes by the American Diabetes Association (ADA), it is recommended that adults with diabetes receive two or more HbA1c tests annually (American Diabetes Association, 2012; American Diabetes Association, 2018b). In addition, it is recommended that they annually receive one cholesterol test, a foot examination, a dilated eye examination, and an influenza vaccine (American Diabetes Association, 2012; American Diabetes Association, 2018b). Based on the data from the United States Diabetes Surveillance System and National Health Interview Survey, the proportions of adults with diabetes who received some of those

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recommended preventive care practices increased from 2011 to 2015 (Centers for Disease Control and Prevention. Diabetes Report Card, 2017). Numerous studies have examined the relationships between several demographic and economic factors and the receipt of some preventive care practices among adults with diabetes in the US. These studies found that factors including race, socioeconomic status, and health insurance are associated with receiving that care (Pu and Chewing, 2013; Tran et al., 2017; Gibson, 2017; Centers for Disease Control and Prevention, 2005; Hu et al., 2014; Li et al., 2010; Luo et al., 2018).

Nevertheless, previous studies focused on receiving some of the preventive care measures at a time and did not include other factors that may affect receiving that care, such as other chronic physical and mental diseases. Additionally, with exception of two studies (Centers for Disease Control and Prevention, 2005; Li et al., 2010), previous studies focused on the relationships between several factors and each preventive care measure individually. ADA (American Diabetes Association, 2012; American Diabetes Association, 2018b) and Centers For Disease Control and Prevention (CDC) (Centers for Disease Control and Prevention. Diabetes Report Card, 2017) both recommend multiple preventive care practices and a multidisciplinary approach to care for individuals with diabetes. Therefore, a comprehensive evaluation of the most probable factors associated with receiving the most recommended preventive care practices collectively is required to tailor health programs that target adults who are less likely to follow the recommendations. Furthermore, the relationships between demographic, economic and personal factors and receipt of preventive practices among subgroups of adults with diabetes including those with renal or eye complications is still lacking. As a result, the main objective of the current study was to identify the factors associated with receiving the recommended preventive care measures collectively among adults with diabetes in the US. A second objective of this study was to identify the aforementioned factors among subgroups of adults with diabetes.

2. Materials and methods

2.1. Study design

A cross-sectional study design was implemented using data from multiple panels (2009–2015) of the Medical Expenditure Panel Survey (MEPS).

2.2. Data source

For this study, households, diabetes care surveys, and medical conditions files from the MEPS were used (<https://meps.ahrq.gov/mepsweb/>, n.d.). The MEPS is an annual household survey of the non-institutionalized civilian population (<https://meps.ahrq.gov/mepsweb/>, n.d.). The MEPS uses a probability weighted complex multistage survey design with primary sampling units, strata and person level sampling weights. Therefore, The MEPS sample is a nationally representative sample of non-institutionalized persons in the US. In order to increase the sample size, data from four years (2009, 2011, 2013, and 2015) were combined. This study utilized alternate years to avoid duplicate observations of the same participant following the recommendations of the Agency for Healthcare Research and Quality (Sommers, 2006).

Information regarding surveyed patients' mental and physical health, demographic and socioeconomic characteristics, employment, access to care, and satisfaction with healthcare were extracted from the household component of the survey (Anon, 2017a). In the survey, individuals with diabetes are identified as those who responded positively to the question, "Have you ever been told by a doctor or health professional that you have diabetes?". Those individuals were sent a diabetes care survey, which gathered information on diabetes management and recommended preventive care. Medical conditions reported by the

participants were available either in the household file or the medical conditions file (Anon, 2017b).

2.3. Study sample

The study sample consists of adults aged 21 years or older, who are alive and with diabetes. Subgroup analyses were performed separately among adults with multimorbidity (at least one additional chronic physical condition), chronic kidney disease (CKD) or eye complications.

2.4. Measures

2.4.1. Outcomes

Five recommended preventive care measures were included in this study: HbA1c tests, cholesterol tests, foot examinations, dilated eye examinations, and influenza vaccines. Adults with diabetes who received ≥ 2 HbA1c tests during preceding year were identified as following the recommendations. In addition, adults with diabetes who received an annual cholesterol test, dilated eye examinations, foot examinations, and an annual influenza vaccine for two consecutive years were identified as following the recommendations for those practices. Participants were asked to report cholesterol tests, dilated eye examinations, foot examinations, and influenza vaccines they received for two consecutive years (during the survey year and the preceding year). Participants were asked to report the number of HbA1c tests they had during the previous year. The outcome for this study was a categorical variable with two levels (using the five recommended preventive practices or less than five).

2.4.2. Independent variables

The selection of the independent variables was guided by the expanded Andersen Healthcare Utilization Model (Andersen and Newman, 2005). Based on this model, healthcare use may be influenced by five domains: predisposing factors (e.g., age and sex), enabling factors (e.g., education level and health insurance), need factors (e.g., physical and mental health), personal health practices (e.g., smoking status), and external environmental factors.

Predisposing factors included age (21–39 years, 40–49 years, 50–64 years, and 65 years and older), sex, and race/ethnicity (White, African American, Latino, and others). Enabling factors included marital status (married, separated/divorced, widow, and never married), education (less than high school, high school, and greater than high school), poverty status ($< 100\%$ of the federal poverty line), near poor (100% to $< 200\%$), middle income (200% to $< 400\%$), and high income (greater than or equal to 400%), health insurance coverage (private, public, uninsured) and prescription drug coverage (yes or no). Need factors included perceived health status (excellent/very good, good, and fair/poor), presence of other co-occurring physical conditions [asthma, arthritis, cancer, gastroesophageal reflux disease (GERD), heart diseases, hypertension, osteoporosis, thyroid, and chronic obstructive pulmonary disease], the presence of other co-occurring mental conditions (depression and/or anxiety) and other diabetes factors (number of years since diagnosis and having kidney or eye complications). Personal health practices comprised smoking status (current smoker or other), heavy physical exercise (three times per week or other), and body mass index (BMI). BMI categories were sorted into three classifications (underweight/normal ($< 25.0\text{kg/m}^2$), overweight (25.0–30.0 kg/m^2), and obese (30.0–40.0 kg/m^2)). All independent variables were measured during the year of the survey.

2.5. Statistical techniques

Cross-tabulation was used to calculate prevalence estimates. Multivariable logistic regressions were used to assess the relationships between the independent variables and receiving all of preventive practices. In adjusted models using all adults with diabetes, those with

Table 1
Descriptive statistics of adults with diabetes (N = 8415).
Medical Expenditure Panel Survey (2009, 2011, 2013 and 2015).

Predisposing factors	
Sex N (%)	
Female	4735 (50.7)
Male	3800 (49.3)
Age N (%)	
21–39	630 (6.5)
40–49	1227 (12.9)
50–64	3311 (37.9)
65 +	3367 (42.7)
Race N (%)	
White	3348 (61.3)
African American	2165 (15.4)
Latino	2230 (15.2)
Other	7,92 (8.1)
Enabling factors	
Marital status N (%)	
Married	4472 (57.4)
Separated/divorced	1229 (13.7)
Widow	1710 (18.1)
Never married	1124 (10.8)
Education N (%)	
Less than high school	2530 (20.8)
High school	2719 (34.0)
More than high school	3195 (45.2)
Poverty status N (%)	
Poor	1857 (14.4)
Near poor	2180 (22.2)
Middle income	2524 (31.0)
High income	1974 (32.4)
Health insurance N (%)	
Private	4179 (58.2)
Public	3465 (34.4)
Uninsured	891 (7.5)
Prescription drug coverage N (%)	
Yes	7685 (92.2)
No	850 (7.8)
Need factors	
Chronic physical conditions number N (%)	
No physical condition	1171 (11.8)
1–2	4235 (48.7)
3–4	2443 (30.8)
≥ 5	686 (8.7)
Chronic mental conditions number N (%)	
No mental condition	7449 (86.2)
≥ 1	1086 (13.8)
Perceived health status N (%)	
Excellent/very good	3984 (50.0)
Good	3061 (34.6)
Fair/poor	1490 (15.4)
Number of years since diagnosis Mean(SE)	10.78 (0.2)
Have chronic kidney disease	
Yes	969 (11.2)
No	7446 (88.8)
Have eye complications	
Yes	1849 (18.9)
No	6571 (81.1)
Personal health practices	
Body mass index N (%)	
Underweight/Normal	1246 (14.1)
Overweight	2538 (29.8)
Obese	4606 (54.6)
Missing	145 (1.6)
Smoking status N (%)	
Current smoker	1232 (14.6)
Other	7069 (85.4)
Heavy physical exercise N (%)	
Heavy physical exercise	3119 (36.7)

Table 1 (continued)

Predisposing factors	
No	5395 (63.3)

Note: Based on 8415 adults aged 21 years or older, alive during the calendar years, and reported having diabetes, Medical Expenditure Panel Survey (2009, 2011, 2013, 2015).

Poor: < 100% of the federal poverty line, near poor (100% to < 200%), middle income (200% to < 400%), and high income (greater than or equal to 400%). Chronic physical conditions included [asthma, arthritis, cancer, gastroesophageal reflux disease (GERD), heart diseases, hypertension, osteoporosis, thyroid, and chronic obstructive pulmonary disease]. Mental chronic conditions included depression and/or anxiety. Heavy physical exercise: three times per week.

CKD, or adults with eye complications, the following variables are controlled for: age, sex, race/ethnicity, marital status, education, poverty status, health insurance coverage, prescription drug coverage, perceived health status, presence of other co-occurring physical conditions, the presence of other co-occurring mental conditions, number of years since diabetes diagnosis, smoking status, heavy physical exercise and BMI. In the adjusted model using adults with multimorbidity, we controlled for all the above factors except the presence of other co-occurring physical conditions. All analyses were conducted using survey procedures in the Statistical Analysis System (SAS®) version 9.4. Diabetes care survey weights were used in the analyses. These weights adjust for diabetes care surveys nonresponse and weights to the number of the individuals with diabetes in the U.S. civilian noninstitutionalized population in a given year (Anon, 2017a).

3. Results

3.1. Description of the study sample

Table 1 summarizes the characteristics of the studied adults with diabetes. The study sample consists of 8415 adults with diabetes. Most of the study sample were females (50.7%), white (61.3%), married (57.4%), and obese (54.6%). Additionally, most of the study sample had one additional chronic physical condition or more (88.2%). Furthermore, the majority of the study sample had private health insurance (58.2%) and prescription drug coverage (92.2%). Of the study sample, 11.2% had CKD, and 18.9% had eye complications.

Most of the adults with diabetes received the recommended HbA1c (59.4%) and cholesterol tests (62.6%). Nevertheless, most of them did not follow the recommendations for foot examinations (No, 51%), dilated eye examinations (No, 60.2%), and influenza vaccinations (No, 55.7%). Among all adults with diabetes, only 15.6% received all the five recommended practices collectively. Likewise, 16.8% of the adults with multimorbidity received the five recommended preventive practices. However, 22.4% of adults with CKD and 22.7% of the adults with eye complications received the all recommended preventive practices under study. When measuring the receipt of preventive practices across years (Appendix A), the percentages of adherence were steady across years. Across years of the study, a small proportion of the sample received all five recommended strategies (14%–17%).

3.2. Factors associated with adherence to recommended preventive practices among adults with diabetes

3.2.1. Predisposing factors

Table 2 displays adjusted ORs and their 95% confidence intervals (95% CI) for preventive practices from multivariable logistic regressions. *All adults with diabetes:* Older adults (≥ 65 years) with diabetes were more likely to receive all the five recommended practices (OR = 2.13; 95% CI = 1.36, 3.34) as compared to young adults

Table 2

Adjusted odds ratio and 95% confidence intervals for preventive practices from separate logistic regressions. Adults with Diabetes ($N = 8415$). Medical Expenditure Panel Survey (2009, 2011, 2013, 2015).

		Overall ($N = 8415$)	Multimorbidity ($N = 7364$)	CKD ($N = 969$)	Eye complications ($N = 1849$)
Predisposing factors					
Sex	Male	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Female	0.93[0.77, 1.11]	0.9[0.75, 1.07]	0.59[0.38, 0.92]*	0.8[0.57, 1.11]
Age	21–39	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	40–49	1.04[0.59, 1.81]	1.43[0.72, 2.85]	0.99[0.20, 5.04]	1.74[0.60, 5.02]
	50–64	1.63[1.04, 2.54]*	2.34[1.36, 4.05]**	3.29[0.92, 11.74]	3.39[1.32, 8.68]*
	65, +	2.13[1.36, 3.34]**	3.23[1.87, 5.57]***	3.3[0.85, 12.80]	3.92[1.47, 10.50]**
Race	White	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	African American	0.83[0.66, 1.05]	0.84[0.66, 1.07]	0.97[0.60, 1.57]	0.72[0.49, 1.06]
	Latino	0.88[0.71, 1.08]	0.85[0.68, 1.07]	0.88[0.48, 1.61]	0.68[0.45, 1.05]
	Other	0.92[0.65, 1.31]	0.97[0.69, 1.36]	0.67[0.31, 1.45]	0.63[0.33, 1.19]
Enabling factors					
Marital status	Married	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Separated/Divorced	0.91[0.70, 1.17]	0.91[0.70, 1.19]	0.99[0.55, 1.77]	1.13[0.75, 1.71]
	Widow	0.77[0.62, 0.94]*	0.78[0.64, 0.96]*	0.87[0.47, 1.61]	0.85[0.53, 1.36]
	Never Married	0.81[0.59, 1.12]	0.8[0.58, 1.12]	1.03[0.50, 2.15]	0.93[0.52, 1.64]
Education	> High School	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	High School	0.68[0.54, 0.85]***	0.7[0.56, 0.88]**	0.8[0.42, 1.52]	0.7[0.48, 1.01]
	Less than High School	0.54[0.41, 0.72]***	0.56[0.42, 0.73]***	0.72[0.41, 1.24]	0.82[0.50, 1.35]
Poverty status	High Income	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Middle Income	0.83[0.67, 1.03]	0.84[0.67, 1.04]	0.97[0.56, 1.68]	1.00[0.58, 1.71]
	Near Poor	0.68[0.52, 0.88]**	0.71[0.54, 0.94]*	0.84[0.43, 1.62]	0.76[0.42, 1.39]
	Poor	0.76[0.56, 1.03]	0.77[0.57, 1.06]	0.98[0.47, 2.08]	0.76[0.42, 1.36]
Health insurance	Public	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Private	1.28[1.02, 1.61]*	1.28[1.02, 1.61]*	2.15[1.29, 3.59]**	1.68[1.05, 2.68]*
	Uninsured	0.51[0.34, 0.77]**	0.45[0.27, 0.74]**	0.47[0.16, 1.39]	0.58[0.26, 1.27]
Prescription drug coverage	Yes	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	No	0.46[0.28, 0.76]**	0.44[0.24, 0.82]**	0.11[0.02, 0.68]*	0.74[0.30, 1.80]
Need factors					
Chronic physical conditions	No Chronic Physical Conditions	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	1–2	1.2[0.84, 1.70]	–	0.42[0.14, 1.21]	1.16[0.52, 2.60]
	3–4	1.65[1.14, 2.38]**	–	0.64[0.20, 2.04]	1.86[0.79, 4.38]
	≥ 5	1.62[1.03, 2.56]*	–	0.52[0.15, 1.81]	1.06[0.42, 2.69]
Chronic mental conditions	No Chronic Mental Conditions	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	≥ 1	1.12[0.88, 1.44]	1.15[0.89, 1.49]	1.22[0.66, 2.26]	0.84[0.54, 1.30]
Perceived health status	Excellent/Vgood	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Good	0.9[0.73, 1.10]	0.87[0.70, 1.08]	0.7[0.38, 1.30]	1.24[0.77, 2.00]
	Fair/Poor	0.8[0.63, 1.00]	0.84[0.67, 1.06]	0.67[0.38, 1.19]	1.12[0.70, 1.79]
Number of years since diagnosis		1.04[1.03, 1.05]***	1.04[1.03, 1.05]***	1.04[1.02, 1.06]***	1.03[1.01, 1.04]***
Have chronic kidney disease	No	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Yes	1.44[1.11, 1.88]**	1.43[1.09, 1.86]**	–	1.35[0.91, 2.01]
Personal health practices					
Body Mass Index	Underweight/Normal	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Overweight	0.83[0.64, 1.09]	0.84[0.64, 1.12]	0.84[0.43, 1.64]	0.89[0.53, 1.49]
	Obese	0.95[0.72, 1.25]	1.02[0.77, 1.35]	0.89[0.46, 1.71]	0.85[0.52, 1.39]
	Missing	0.49[0.20, 1.18]	0.5[0.20, 1.24]	0.21[0.01, 3.50]	0.35[0.04, 2.76]
Smoking status	Other	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	Current smoker	0.54[0.41, 0.71]***	0.57[0.43, 0.75]***	0.47[0.20, 1.13]	0.44[0.25, 0.78]**
Heavy physical exercise	3/wk	Reference (Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2017)			
	No	0.94[0.80, 1.11]	0.94[0.79, 1.11]	0.78[0.47, 1.30]	0.92[0.67, 1.26]

Note: Based on 8415 adults aged 21 years or older, alive during the calendar years, and reported having diabetes.

Poor: < 100% of the federal poverty line, near poor (100% to < 200%), middle income (200% to < 400%), and high income (greater than or equal to 400%). Chronic physical conditions included [asthma, arthritis, cancer, gastroesophageal reflux disease (GERD), heart diseases, hypertension, osteoporosis, thyroid, and chronic obstructive pulmonary disease]. Mental chronic conditions included depression and/or anxiety. Heavy physical exercise: three times per week.

*** $P < 0.001$.

** $0.001 \leq P < 0.01$.

* $0.01 \leq P < 0.05$.

(21–39 years). However, there were no relationships between sex, race and receiving the five recommended practices. **Adults with multimorbidity:** among adults with at least one additional chronic physical disease, older age groups (50–60 years and ≥ 65 years) were more likely to receive all recommended practices than young adults (21–39 years). **Adults with CKD:** Females were less likely than males to receive all the five recommended practices (OR = 0.59; 95% CI = 0.38, 0.92). **Adults with eye complications:** older age groups (50–60 years and ≥ 65 years) were more likely to receive the five recommended practices than young adults (21–39 years).

3.2.2. Enabling factors

All adults with diabetes: Among all adults with diabetes, widows were less likely than married to receive all five practices (OR = 0.77; 95% CI = 0.62, 0.94). Additionally, there was a significant relationship between education and receiving the five recommended practices collectively. Adults with less education (\leq high school) were less likely to receive all the five recommended practices than those with > high school. Moreover, adults with private insurance were more likely to receive all five recommended practices (OR = 1.28; 95% CI = 1.02, 1.61) than those with public insurance. On the other, hand, uninsured adults were less likely to receive all five practices than those with public

insurance (OR = 0.51; 95% CI = 0.34, 0.77). Adults without prescription drug coverage were less likely to receive all the five practices (OR = 0.46; 95% CI = 0.28, 0.76) than those with drug prescription coverage. Adults with multimorbidity: The results for adults with multimorbidity were similar to those for the overall sample. Adults with CKD: Among adults with CKD, those who have private insurance were more likely to receive all practices (OR = 2.15; 95% CI = 1.29, 3.59) than those with public insurance. However, there was no statistical difference between uninsured adults and those with public insurance in receiving all recommended practices. Adults without prescription drug coverage were less likely to receive the five practices (OR = 0.11; 95% CI = 0.02, 0.68) than those with prescription drug coverage. Adults with eye complications: Adults with private insurance were more likely to receive the five recommended practices than those with public insurance (OR = 1.68; 95% CI = 1.05, 2.68). There were no relationships between the other enabling factors and receiving the recommended practices among adults with eye complications.

3.2.3. Need factors

All adults with diabetes: Adults with higher numbers of physical chronic conditions were more likely to receive the five recommended practices than those without chronic physical conditions. Furthermore, the number of years since the diabetes diagnosis was positively associated with receiving all recommended preventive practices. Additionally, having chronic kidney disease was also associated with receiving the recommended practice (OR = 1.44; 95% CI = 1.11, 1.88). Adults with multimorbidity: Among adults with at least one additional chronic physical condition, the number of years since the diabetes diagnosis was positively associated with receiving the five recommended preventive practices (OR = 1.43, 95% CI = 1.09, 1.86). On the other hand, only the number of years since the diabetes diagnosis was positively associated with the outcome among adults with CKD and adults with eye complications.

3.2.4. Personal health practices

Of the personal health practices, only smoking status was associated with receiving the five recommended practices among all adults with diabetes. In fact, current smokers were less likely to receive all recommended practices (OR = 0.54; 95% CI = 0.41, 0.71) than those who do not smoke or quit smoking. Likewise, among adults with multimorbidity, current smokers were less likely to receive all five practices (OR = 0.57; 95% CI = 0.43, 0.75). Among adults with CKD, there were no relationships between all personal health practices and receiving all five recommended practices. Conversely, current smokers were less likely to receive the recommended practices (OR = 0.44; 95% CI = 0.25, 0.78) among adults with eye complications.

4. Discussion

The aim of the current study was to describe the adherence to five recommended preventive care measures among adults with diabetes in the US, and also to identify factors associated with that adherence. Our results suggest that low proportion of adults with diabetes are adherent to the five selected preventive strategies collectively. Unfortunately, literature on adherence to multiple preventive practices collectively is scarce. Li et al. found that sex, race, education and years since diagnosis of diabetes were associated with receiving annual eye exams, annual foot exams and performing daily self-monitoring of blood glucose (Li et al., 2010). Furthermore, a population based study by CDC found that age, education, health insurance, duration of diabetes and smoking status are associated with receiving multiple preventive care services (eye examinations, foot examinations, and HbA1c tests) during the preceding year (Centers for Disease Control and Prevention, 2005), consistent with our estimates. Our results suggest that adults with diabetes can be adherent to selected preventive practices but not all practices collectively. Further research is required to identify whether

the adherence to preventive practices differ due to personal or health-care variations and preferences.

Among all adults with diabetes and those with additional one or more physical chronic conditions, those with lower education were less likely to receive the five recommended preventive care. Previous reports have found that diabetes is more prevalent among adults with less than a high school or high school education as compared to those with more than a high school education (Centers for Disease Control and Prevention. Diabetes Report Card, 2017; Borrell et al., 2006). Additionally, having some form of health insurance was associated with higher odds of receiving all of the preventive practices collectively, which is consistent with prior research (Pu and Cheung, 2013; Tran et al., 2017; Centers for Disease Control and Prevention, 2005). However, adults with private insurance were more likely to receive all the recommended preventative measures as compared to those with public insurance among all adults with diabetes and all subgroups. These results highlight the fact that uninsured adults with diabetes had lower access to high healthcare quality, consistent with previous studies (Michael, 2009; Zhang et al., 2012; Bailey et al., 2015). Bailey et al. found that uninsured adults with diabetes were less likely to receive recommended preventive care (Bailey et al., 2015). As a result, the findings of this study add to the body of evidence about the importance of having insurance in the US to increase the quality of care and access to preventive medicine especially among adults with diabetes. Moreover, the results also highlight the differences between adults with public insurance and those with private insurance in the use of preventive care.

Our findings also emphasize the importance of having prescription drug coverage, as adults without coverage were less likely to receive recommended preventive care practices. Chu et al. found that having prescription drug coverage is positively associated with Hepatitis B screening among Asian Americans in primary care (Chu et al., 2013). Although having prescription drug coverage is not directly related to preventive practices, one could speculate that individuals without prescription drug coverage may be less adherent because they worry about the need for treatment after preventive practices or regular check. Furthermore, Kesselheim et al. found that adults with prescription drug coverage had better health outcomes in comparison with those without (Kesselheim et al., 2015). Therefore, it is crucial to expand drug coverage to all adults with diabetes in the US.

In terms of need factors, adults with higher numbers of chronic physical conditions were more likely to receive the five preventive practices among all adults with diabetes. Furthermore, the number of years since diagnosis was positively associated with receiving all recommended preventive practices. Likewise, having chronic kidney disease or eye complications was also associated with most of the preventive care practices. These results suggest that, as adults with diabetes become more aware of complications, they tend to become more adherent to preventive practices.

Current smokers were also less likely to receive the five preventive practices collectively than their counterparts who do not smoke among all adults with diabetes and those with multimorbidity or eye complications. This finding is consistent with the findings of the study by Murchison, et al., who found in a sample of adults in one hospital, that smoking status is a risk factor for not receiving eye care (Murchison et al., 2017). It is also consistent with a previous report in which the estimates showed that current smoking was negatively associated with receiving multiple preventive practices among adults with diabetes (Centers for Disease Control and Prevention, 2005). It is not clear why smoking status is associated with the lower likelihood of receiving diabetes preventive care; however, smoking is a risk factor of diabetes-related complications, and health programs should be implemented to increase the adherence of diabetes preventive care among smokers.

In spite of its several strengths, this study has some limitations as well. To the best of the authors' knowledge, this is the first study of its kind to measure adherence to the most common preventive care

measures collectively among subgroups of adults with diabetes in the US. In this study, we used a nationally representative sample of adults with diabetes in the US. In addition, the selection of the possible factors associated with adherence was guided by a validated framework. However, all information on diabetes diagnosis and adherence to preventive care is self-reported and are subject to recall bias. Additionally, we did not address access to primary care and utilization patterns which may affect the receipt of preventive care. Furthermore, in the analyses, we did not differentiate between Type 1 and Type 2 diabetes, as this information is not available in MEPS. Also, this is a cross-sectional study; hence, it is not possible to determine the temporal relationships between the factors under study and the outcome. Finally, although we included a comprehensive list of factors and preventive care measures, we did not include all predisposing factors and all the preventive care measures in our analyses.

5. Conclusion

Preventive care practice may decrease the risk of diabetes-related

Appendix A. Percentages of the adults with diabetes who reported receiving recommended preventive care practices, adults with diabetes. Medical Expenditure Panel Survey (2009, 2011, 2013, 2015)

2009 (N = 2049)	2011 (N = 2117)	2013 (N = 2216)	2015 (N = 2177)
HbA1c 58.80[55.96, 61.63]	58.01[55.44, 60.59]	57.91[55.37, 60.45]	62.63[59.86, 65.41]
Cholesterol test 59.51[56.92, 62.11]	66.86[64.30, 69.40]	62.80[59.95, 65.65]	61.09[58.18, 64.00]
Foot examination 46.74[43.99, 49.50]	52.28[49.43, 55.13]	50.88[48.13, 53.63]	46.34[43.27, 49.41]
Dilated eye examination 36.04[33.45, 38.63]	42.81[40.14, 45.48]	40.27[37.26, 43.29]	39.59[37.04, 42.14]
Influenza vaccination 40.87[38.21, 43.53]	47.11[44.22, 49.99]	45.32[42.55, 48.09]	43.79[40.54, 47.03]
Receipt all five recommended strategies 14.33[12.39, 16.28]	16.01[14.03, 17.99]	16.94[14.76, 19.12]	15.67[13.44, 17.91]

Note: Based on 8415 adults aged 21 years or older, alive during the calendar years, and reported having diabetes.

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complications. The results suggest that a high proportion of adults with diabetes do not receive all recommended preventive practices collectively in the same year. Individuals with diabetes need multiple preventive care practices and a multidisciplinary approach to care. Therefore, it is crucial to increase the awareness about the need for all the recommended practices among adults with diabetes.

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