Prevalence of and Sociodemographic Disparities in Influenza Vaccination Among Adults with Diabetes in the United States

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ABSTRACT

National estimates describing the overall prevalence of and disparities in influenza vaccination among patients with diabetes mellitus (DM) in United States are not well described. Therefore, we analyzed the prevalence of influenza vaccination among adults with DM, overall and by sociodemographic characteristics, using the Medical Expenditure Panel Survey database from 2008 to 2016. Associations between sociodemographic factors and lack of vaccination were examined using adjusted logistic regression. Among adults with DM, 36% lacked influenza vaccination. Independent predictors of lack of influenza vaccination included age 18-39 years (odds ratio [OR] 2.54; 95% CI, 2.14-3.00), Black race/ethnicity (OR 1.29; 95% CI, 1.14-1.46), uninsured status (OR 1.88; 95% CI, 1.59-2.21), and no usual source of care (OR 1.61; 95% CI, 1.39-1.85). Nearly 64% individuals with ≥4 high-risk characteristics reported lack of influenza vaccination (OR 3.50; 95% CI 2.79-4.39). One-third of adults with DM in the U.S. lack influenza vaccination, with lower age, Black race, and lower socioeconomic status serving as strong predictors. These findings highlight the continued need for focused public health interventions to increase vaccine coverage and utilization among vulnerable patients and populations.
INTRODUCTION

The Centers for Disease Control and Prevention (CDC) estimates 959,000 hospitalizations and 79,400 deaths from influenza infection occurred in the United States during the 2017-2018 season.¹ There is substantial evidence that those with DM face serious adverse consequences from influenza infection including increased likelihood of hospital admission for acute cardiovascular and respiratory diseases and all-cause mortality.²⁻⁵

Therefore, the Advisory Committee on Immunization Practices (ACIP) and American Diabetic Association recommend seasonal influenza vaccination for patients with DM irrespective of age.⁶ To date, national estimates of influenza vaccination among individuals with DM in the US are not well described. In the current study, among a nationally representative sample of adults with DM, we report estimates of influenza vaccination, characterizing sociodemographic groups, both individually and in combination, that were at particularly high risk of lacking vaccination.

RESEARCH DESIGN AND METHODS

Data Source

We included adults ≥18 years with DM using pooled Medical Expenditure Panel Survey (MEPS) data from 2008-2016. MEPS is administered by the Agency for Healthcare Research and Quality and provides comprehensive national data on health care utilization, expenditures and insurance coverage for US civilian noninstitutionalized population.⁷ A new panel of households, consisting of 5 rounds of surveys spanning throughout 2 years’ time, are enrolled on a continual basis every year. They represent a subsample of households that participated in the National Health Interview Survey (NHIS) six months to one year earlier. For NHIS participant
recruitment, the sampling design follows an area probability framework that enables representative sampling of households and noninstitutional groups quarters where clusters of addresses are defined within each state. Since MEPS data is de-identified and publicly available, it was exempt from purview of the institutional review board committee.

**Study Variables**

Adults with DM were identified using self-reported and/or ICD-9/10 diagnosis codes of diabetes mellitus, both type I and II. Individuals were ascertained to have had influenza vaccination if they answered yes to having received the vaccination in the 12 months prior to survey completion. Other covariates in the study included age (18-39, 40-64 and ≥ 65 years), sex, ethnicity (non-Hispanic White, non-Hispanic Black, non-Hispanic Asian, and Hispanic), family income (as a proportion of federal poverty limit; high/middle-income [≥200%] and low-income [<200%]), insurance status (insured and uninsured), education level (≥ some college education and ≤ high school), and presence/absence of usual source of care.

**Statistical Analysis**

We used the person-level sampling weights which were obtained after adjusting for nonresponse, age, sex, and ethnicity (based on population estimates from the US Census Bureau) to obtain nationally representative results. We compared the survey-weighted proportions of influenza vaccination across different sociodemographic characteristics using Rao-Scott $\chi^2$ analysis. We assessed the association of sociodemographic characteristics with influenza vaccination using multivariable survey-specific logistic regression adjusting for covariates and known confounders (listed in Table 1 as footnote) and reported the adjusted odds ratios (OR)
with 95% confidence intervals (CI). To analyze the cumulative associations between these characteristics and influenza vaccination, we developed a composite model of increasing number of high-risk sociodemographic characteristics including the following 6 variables; 18-39 years of age, non-Hispanic black race/ethnicity, uninsured status, lack of usual source of care, low-income level, and low education level (i.e. ≤ high school). All analyses were performed using Stata version 14.0 (StataCorp, College Station, TX).

RESULTS

Nearly 11% of adults in MEPS (n = 25,396) had DM, corresponding to 24.9 million US adults annually. Overall, 35.6% (95% CI 34.4%-36.8%) of total patients with DM, representing about 8.6 million adults, did not receive influenza vaccination in the previous 12 months. In adjusted analyses, the odds of missing influenza vaccination were highest in adults of age 18 to 39 years (OR 2.54, 95% CI 2.14-3.00), non-Hispanic Black population (OR 1.29, 95% CI 1.14-1.46), adults lacking insurance coverage (OR 1.88, 95% CI 1.59-2.21), those with no usual source of care (OR 1.61, 95% CI 1.39-1.85), adults from low income (OR 1.10, 95% CI 1.01-1.20), and those with level of education equal to or less than high school diploma (OR 1.19, 95% CI 1.06-1.33). There was no difference in receipt of vaccination based on gender or geographic location (Table 1).

On further analysis of the association of these characteristics (from now on, “high-risk characteristics”) with influenza vaccination, when compared with the reference group without any high-risk characteristic (non-Hispanic White individuals, of ≥65 years of age, with middle to high family income, with health insurance, with usual source of care, and higher education level), those with 1 (34%), 2 (38%), 3 (48%), and ≥4 (64%) high-risk characteristics had a
stepwise increase in the prevalence of those who lacked influenza vaccination (Figure 1). Adjusting for sex, geographic region, cardiovascular risk factors, and co-morbidities, we found that adults with ≥4 high-risk characteristics had 3.5-fold higher odds (OR 3.50; 95% CI 2.79-4.39) of lacking vaccination when compared with individuals without any high-risk characteristic (Figure 2).

**DISCUSSION**

We assessed differences in influenza vaccination in various sociodemographic groups in a nationally representative sample of US adults with DM. More than one-third of adults with DM aged ≥18 years did not receive influenza vaccination in the prior 12 months, translating to nearly 9 million individuals. Furthermore, vaccination rates were significantly lower in certain groups including younger adults (18-64 years), non-Hispanic Blacks, individuals without insurance, those from low-income families, and individuals lacking access to usual care, vaccination disparities similar to those reported in the general population. Adults with a greater number of the above mentioned characteristics were found to have lower rates of influenza vaccination, with nearly two-thirds (64%) of those with four or more of these sociodemographic characteristics lacking influenza vaccination. These insights will be critical for health systems and policy makers to develop targeted interventions for these “missed opportunities” to vaccinate. These findings are particularly relevant in the current COVID-19 pandemic, given risk of adverse outcomes in patients with comorbid DM and/or co-infection with influenza.

Limitations of our study include the cross-sectional nature of the MEPS data which limits the determination of causal relationships and the potential recall bias associated with self-reported influenza vaccination information in this database which may underestimate or
overestimate the true prevalence of influenza vaccination. However, the overall high quality of the MEPS data, its representativeness of the US population, the comprehensive adjustment for potential confounders conducted in the regression analyses, and the large sample size lend credibility to our report and make these results valuable for economic and health-policy making.

In conclusion, nationally nearly one-third of adults with DM lacked influenza vaccination with disproportionately higher rates among vulnerable sociodemographic groups. These results underscore the importance of focused public health interventions to address these underlying factors to improve influenza vaccination rates and limit downstream preventable adverse outcomes in patients with DM.
AUTHOR CONTRIBUTIONS

P.B., R.M., J.V.E, and K.N. and designed the current study

J.V.E. performed the statistical analysis, interpreted the data, and wrote the initial draft

R.M., G.R.G., S.S.V., M.G.A., F.S.V., S.O., and K.N. supervised and contributed support for data analyses, interpretation of findings, and critical revision of the article.

All authors reviewed and approved the final version of the article submitted for publication. K.N. initiated the study.

K.N. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
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### Tables

**Table 1.** Weighted prevalence and odds ratios representing lack of influenza vaccination by participant characteristics among adults with diabetes mellitus in the United States

|                          | Weighted Prevalence | Estimated US Population | OR* (95% CI)          |
|--------------------------|---------------------|-------------------------|-----------------------|
| **Total Population**     | 35.6 (34.4, 36.8)   | 8,643,242               | N/A                   |
| **Age Category**         |                     |                         |                       |
| ≥ 65 years               | 24.1 (22.6, 25.6)   | 2,486,029               | Reference             |
| 40-64 years              | 42.5 (41.0, 44.1)   | 5,173,199               | 1.94 (1.75, 2.15)     |
| 18-39 years              | 54.7 (51.5, 57.9)   | 984,014                 | 2.54 (2.14, 3.00)     |
| **Sex**                  |                     |                         |                       |
| Female                   | 35.0 (33.6, 36.4)   | 4,346,815               | Reference             |
| Male                     | 36.2 (34.6, 37.8)   | 4,296,427               | 1.05 (0.96, 1.15)     |
| **Race/Ethnicity**       |                     |                         |                       |
| Non-Hispanic White       | 32.9 (31.2, 34.6)   | 4,933,720               | Reference             |
| Non-Hispanic Black       | 43.2 (40.9, 45.4)   | 1,581,587               | 1.29 (1.14, 1.46)     |
| Non-Hispanic Asian       | 33.0 (29.3, 36.8)   | 394,958                 | 0.81 (0.67, 0.98)     |
| Hispanic                 | 39.6 (37.7, 41.4)   | 1,451,433               | 0.89 (0.79, 1.02)     |
| **Family Income**        |                     |                         |                       |
| Middle/High-Income       | 34.4 (33.0, 35.9)   | 5,286,696               | Reference             |
| Low-Income               | 37.6 (36.1, 39.1)   | 3,357,146               | 1.10 (1.01, 1.20)     |
| **Insurance Status**     |                     |                         |                       |
| Insured                  | 33.6 (32.3, 34.9)   | 7,556,343               | Reference             |
| Uninsured                | 60.6 (56.9, 64.4)   | 1,086,899               | 1.88 (1.59, 2.21)     |
| **Education Level**      |                     |                         |                       |
| Some College or Higher   | 33.7 (31.9, 35.5)   | 3,678,436               | Reference             |
| HS/GED or Less than HS   | 37.2 (35.7, 38.7)   | 4,903,713               | 1.19 (1.06, 1.33)     |
| **Usual Source of Care** |                     |                         |                       |
| Yes                      | 34.0 (32.8, 35.3)   | 941,359                 | Reference             |
| No                       | 55.5 (52.4, 58.6)   | 7,633,547               | 1.61 (1.39, 1.85)     |
| **Region**               |                     |                         |                       |
| Northeast                | 32.7 (29.2, 36.1)   | 1,376,978               | Reference             |
| Midwest                  | 34.7 (32.4, 36.9)   | 1,811,918               | 1.06 (0.87, 1.28)     |
| South                    | 37.5 (35.4, 39.6)   | 3,714,647               | 1.10 (0.92, 1.31)     |
| West                     | 35.2 (33.2, 37.3)   | 1,739,698               | 1.03 (0.86, 1.24)     |

Results reported as % (95% confidence interval).
Abbreviations: ASCVD, atherosclerotic cardiovascular disease; US, United States; HS, high school; GED, General Equivalency Diploma; CRF, Cardiovascular Risk Factor
* Model adjusted for age, sex, race/ethnicity, family income, insurance status, education, geographic region, usual source of care, cardiovascular risk factors, and comorbidities
**FIGURE LEGENDS**

**Figure 1.** Weighted proportions for lack of influenza vaccination among individuals with diabetes mellitus by number of high-risk sociodemographic characteristics, from Medical Expenditure Panel Survey, 2008-2016

* High-risk sociodemographic characteristics include younger age, non-Hispanic Black race/ethnicity, lack of insurance coverage, no usual source of care, low-income, and lower level of completed education

**Figure 2.** National estimates and odds ratios of lacking influenza vaccination among adults with diabetes and high-risk sociodemographic characteristics.

* High-risk sociodemographic characteristics include younger age, non-Hispanic Black race/ethnicity, lack of insurance coverage, no usual source of care, low-income, and lower level of completed education
Figure 2.

| No. High-Risk Characteristics | OR (95% CI)       | Estimated US Pop. |
|-------------------------------|-------------------|-------------------|
| 0 (n = 1,247)                 | reference         | 1,807,414         |
| 1 (n = 2,506)                 | 1.34 (1.17 - 1.52)| 2,671,012         |
| 2 (n = 2,892)                 | 1.58 (1.39 - 1.81)| 2,432,306         |
| 3 (n = 1,804)                 | 2.23 (1.93 - 2.57)| 1,064,062         |
| ≥4 (n = 811)                  | 3.50 (2.79 - 4.39)| 447,818           |