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**Trends in Preventive Care Practices among US Adults with Diabetes, 2008-2020**

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# Abstract

**Introduction:** Preventive care practices are important for managing complications associated with diabetes. We report on trends in receipt of six American Diabetes Associated recommended preventive care practices during 2008 - 2020.

**Methods:** We used 2008 - 2020 data from the Medical Expenditures Panel Survey to calculate the proportion of adults diagnosed with diabetes 18 years of age and older that reported receiving preventive care practices overall and for subpopulations. The six practices we have data for were at least one dental examination, an eye examination that includes dilation, a foot examination, at least two A1C tests, a cholesterol test, and the receipt of a flu vaccine.

**Results:** From 2008 to 2020, the proportion of adults reporting having received at least three of six recommended practices decreased from 73.9% in 2008 to 65.1%. Decreases or no change were seen for all subgroups. Most individual practices examined also decreased or were flat over the study period, with the exception of the receipt of 2 or more A1C tests in year, which increased.

**Conclusions:** The number of adults over the age of 18 diagnosed with diabetes self-report receiving less preventive care in 2020 than in 2008. These data are important as a decrease in the receipt of preventive care may lead to increases in the burden of diabetes due to increasing complications.

# Introduction

Diabetes is a chronic disease that affects 11.3% of the adult population, or 37.1 million adults, in the United States1. Diabetes is also costly: total direct and indirect costs associated with diabetes are estimated at $327 billion2. Incidence of diabetes peaked in the US at 8.5 cases per 1,000 in 2008 and 2009 and has fallen since to 5.1 cases per 1,0003,4. Despite this decrease in the incidence of diabetes, rates of hospitalization with diabetes as the primary diagnosis have been increasing since the year 2000 by about 2.5% per year5. The prevalence of diabetes in the US is expected to increase to 60.6 million adults by the year 20606. Access to preventive services health care will be important to reduce the rate of hospitalizations and complications due to diabetes.

The American Diabetes Association (ADA) releases *Standards of Medical Care* which provides guidance on health-care services for individuals with diabetes, including preventive practices7. A recent reports on the trends of preventive care practices found that overall prevalence of receipt of recommended preventive care practices increased from 2005 to 2018, driven largely by the increasing receipt of care among adults 65 years and older8. However, the proportions and trends in preventive practices among other groups of adults with diabetes has not been reported. In this study, we report the proportion of and trends in the receipt of five of the preventive care practices recommended by the ADA overall and among subgroups. These data are valuable for identifying groups that may be under utilizing health care services, examining any effects the COVID-19 pandemic may have had on the receipt of these practices, and providing benchmarks for future studies to compare against.

# Methods

## Data Source

We used data from the Medical Expenditure Panel Survey (MEPS) from the years 2008 - 2020 to evaluate trends in preventive care practices in US adults 18 years or older with self-reported diagnosed diabetes. Respondents were from a subsample of households that participated in the National Health Interview Survey (NHIS). The average number of individual respondents over this 13 year period was 32,170. MEPS targets the civilian noninstitutionalized population in the US and provides national and regional estimates of health care use, expenditures, sources of payment and health insurance coverage. This survey also contains information on patient demographics, socioeconomic, and, via the Diabetes Care Survey (DCS), information on diabetes preventive care practices. The DCS is a self-administered paper-and-pencil questionnaire that is provided to MEPS respondents who indicate that they have been told by a doctor or health professional that they have diabetes. The data we used comes from the full-year consolidated file from MEPS for the 13 year time span of our report.

## Outcomes

We selected six outcome variables that were readily available in the data from 2008 - 2020 and that are based on ADA annual care recommendations7. These six recommendations include at least one dental examination, an eye examination that includes dilation, a foot examination, at least two A1C tests, a cholesterol test, and the receipt of a flu vaccine. The number of total dentist visits in a year is available in the MEPS data and was used to determine which adults had one or more dentist visits in a year. Respondents were also asked if they had an eye examination, a foot examination, a flu vaccine, or a cholesterol test in a given year of the survey. The number of A1C tests received by a respondent was recorded and we grouped respondents into those that had two or more A1C tests in a year and those that had less than two. Using the binary outcomes for each of these six measures, we created a binary variable classifying adults as having received at least three of those recommended care practices or not.

## Analysis

Our analysis accounts for the complex survey design used, including clustering and stratification. Reported values for the percentages of the population receiving recommended preventive care practices are direct age-adjusted estimates. These estimates are presented for the overall population, as well as stratified by age, sex, race and ethnicity, highest degree of education obtained, type of insurance, and the ratio of family income to the poverty line (income poverty ratio). Estimates provided are followed by 95% confidence intervals.

We used the package gtsummary in R Statistical Software (v4.2.1) to perform all analyses9,10. Trends in preventive care practices were analyzed using Joinpoint Command Line Software11 with R via the R package nih.joinpoint12. Joinpoint regression uses permutation tests to detect statistically significant changes at a pre-specified alpha of 0.05 in direction or magnitude of trends13. The Joinpoint software also provided estimates of the annual percent change (APC) for each trend segment and the average annual percent change (AAPC) for the entire trend.

# Results

## Trends in the number of preventive care practices received

For the entire population of adults diagnosed with diabetes in the US there was a significant percent decrease of -11.9 (-20.3, -3.6) of people receiving at least three of the recommended practices from 2008 to 2020 (Table 1). The percent change observed among subgroups were either decreasing or showed no change (the 95% confidence intervals for percent change overlap with zero) (Table 1). The largest negative percent change was in the income poverty ratio group between 100% and 199% at -33.5 (-51.6, -15.5). There was also a -20.6 (-35.7, -5.5) percent change in the income poverty ratio group between 200% and 399% and a -31.6 (-51.9, -11.3) percent change seen in those with no high school diploma (Table 1). Other groups that had significant percent decreases include a -13.2 (-19.6, -6.8) percent change in adults aged 45 to 64, a -15.3 (-25.5, -5.1) percent change for adult females, a -12.2 (-21.5, -2.9) percent change for adults with any private insurance, and a -16.4 (-28.9, -3.9) percent change for adults with only public insurance.

While the overall percent change from 2008 to 2020 was a significant decrease, the overall AAPC was not. In general this pattern held true for subgroups as well; fewer of the AAPC values were significantly different from zero than values for percent change over the entire time period. The significant AAPC values were -2.4 (-4.4, -0.4) in adults with less than a high school degree, -0.7 (-1.4, 0.0) adults with more than a high school degree, -3.1 (-4.9, -1.3) adults with an income poverty ratio between 100% and 199%, and -1.3 (-2.4, -0.2) in adults with an income poverty ratio between 200% and 399% (Table 1). While the percent change and AAPC for nearly all groups were negative or flat, some groups had APC values that were initially flat in the first period but became negative in the second period (Table 1). The year in which Joinpoint regression identified statistically significant changes in the slope of the trend ranged from 2010 - 2015 (Table 1). Hispanic adults had an APC in period one of 4.5 (0.4, 8.8), which was the only group to have a positive APC (Table 1).

## Trends for each preventive care practice

Trends for all adults with diabetes receiving an eye exam with dilation or a foot examination were flat, while the trend for adults visiting the dentist at least once increased slightly until 2015, then began to decrease ([Figure 1](#fig-exams)). The percent of adults getting a flu vaccine and their cholesterol tested also increased slightly until 2013 and 2015, respectively, and then began to decrease ([Figure 2](#fig-tests)). The only preventive practice to increase over the examined time period was the percentage of adults with diabetes receiving at least two A1C tests each year ([Figure 2](#fig-tests)). The shape of the trends in subgroups tend to mirror the overall trend for each practice, although the year at which trend values change may differ among these subgroups. The trend in some subgroups for each preventive practice do not always follow the shape of the overall trend, however. For example, the overall trend in the percentage of adults with diabetes visiting the dentist increased until 2015, when it begins to decrease. Within the income poverty ratio subgroups, only those in the lowest poverty income ratio group (< 100%) and those in the 200% - 399% group follow a similar trend. Both the high income (> 400%) and 100% - 199% group trends decrease in this percentage over the 13 year survey period ([Figure 1](#fig-exams)).

# Discussion

The increase in preventive care we report from 2008 to approximately 2016 may be due in part to the recovery of the economy following the Great Recession in 2008 and to the passing of Affordable Care Act (ACA) in 2010. The passing of the ACA led to an increase in the number of adults with diagnosed and undiagnosed diabetes that have health insurance and increasing their use of health care services14–16. The decreasing trend observed after 2016 may be due in large part to the large decrease in health care utilization during the onset of the COVID-19 pandemic17,18.

Other studies on the trends in preventive care appear to support these findings. A study using data from the National Health and Nutrition Examination Survey (NHANES) found increases in the proportion of adults with diabetes that reported having a primary care doctor, received an annual check-up with a physician, had at least two A1C tests in a year, had their cholesterol levels tested, and had an annual foot exam by a doctor8. Another study that reported on data from NHANES, the National Health Interview Survey, and the Behavioral Risk Factor Surveillance System found that foot exams, flu vaccinations, and A1C testing increased from 1999 - 2016, although eye exams stayed roughly constant19. Declining trends in preventive care may lead to increasing complications due to diabetes, increasing the burden of diabetes.

## Limitations

This report is not without limitations. The data from MEPS are self-report only and the study group is cross-sectional. Additionally, there has been a steadily declining response rate for this survey from a peak during the studied time period of 59.3% in 2008 to 27.6% in 2020. Furthermore, we were unable to distinguish between type 1 and type 2 diabetes in this data.

# Conclusions

In summary, receipt of preventive care for diabetes has decreased from 2008 to 2020 although the magnitude of change varies with different subgroups and for different care practices. This decrease may be linked, in part, to the COVID-19 pandemic. This study highlights those groups that may be most likely to receive substandard preventive care.

# Acknowledgements

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# Tables

|  | 2008 (SE) | 2010 (SE) | 2012 (SE) | 2014 (SE) | 2016 (SE) | 2018 (SE) | 2020 (SE) | Percent Change (95% CI) | Joinpoint Year | APC Period 1 (95% CI) | APC Period 2 (95% CI) | AAPC (95% CI) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Overall | | | | | | | | | | | | |
| - | 73.9 (2.2) | 74.6 (2.0) | 76.7 (1.8) | 77.0 (2.0) | 78.0 (2.1) | 70.3 (2.4) | 65.1 (2.5) | -11.9 (-20.3, -3.6) | 2015 | 0.7 (-0.9, 2.4) | -3.8 (-6.5, -1.1) | -1.2 (-2.5, 0.1) |
| Age | | | | | | | | | | | | |
| 18 to 44 | 65.3 (3.9) | 66.7 (3.5) | 71.1 (3.2) | 69.4 (3.4) | 70.3 (3.7) | 63.3 (4.4) | 56.4 (4.8) | -13.6 (-31.2, 3.9) | 2013 | 2.3 (-1.9, 6.7) | -3.8 (-6.1, -1.3) | -1.3 (-3.2, 0.7) |
| 45 to 64 | 81.9 (1.4) | 80.5 (1.4) | 80.3 (1.6) | 82.4 (1.6) | 83.6 (1.5) | 75.4 (1.8) | 71.1 (2.4) | -13.2 (-19.6, -6.8) | 2015 | 0.5 (-0.8, 1.9) | -2.9 (-5.0, -0.7) | -0.9 (-1.9, 0.1) |
| 65 to 74 | 86.7 (1.9) | 89.1 (1.7) | 87.2 (1.7) | 90.1 (1.8) | 93.0 (1.4) | 84.7 (1.5) | 83.1 (2.0) | -4.1 (-10.2, 2.0) |  | -0.2 (-0.7, 0.4) |  | -0.2 (-0.7, 0.4) |
| 75+ | 86.1 (2.4) | 88.9 (1.9) | 88.2 (2.3) | 92.8 (1.5) | 91.5 (1.8) | 81.9 (2.3) | 79.5 (2.9) | -7.6 (-15.8, 0.7) | 2015 | 0.9 (-0.3, 2.0) | -3.1 (-4.9, -1.2) | -0.8 (-1.7, 0.1) |
| Highest degree earned | | | | | | | | | | | | |
| Less than high school | 64.8 (4.4) | 63.6 (4.1) | 73.5 (4.4) | 71.5 (3.2) | 69.2 (3.2) | 56.8 (5.0) | 44.3 (6.0) | -31.6 (-51.9, -11.3) | 2014 | 2.6 (-0.8, 6.2) | -7.3 (-10.4, -4.0) | -2.4 (-4.4, -0.4) |
| High school | 72.2 (3.3) | 76.1 (2.7) | 79.3 (2.9) | 78.3 (3.1) | 80.6 (3.0) | 69.0 (4.0) | 64.5 (4.1) | -10.7 (-24.6, 3.2) | 2012 | 3.0 (-2.4, 8.6) | -2.6 (-4.4, -0.8) | -0.8 (-2.6, 1.0) |
| Greater than high school | 85.0 (2.9) | 80.8 (3.3) | 83.2 (4.8) | 79.1 (4.9) | 80.9 (4.6) | 81.0 (2.8) | 75.9 (3.9) | -10.7 (-21.6, 0.1) |  | -0.7 (-1.4, 0.0) |  | -0.7 (-1.4, 0.0) |
| Race/Ethnicity | | | | | | | | | | | | |
| Hispanic | 62.6 (12.) | 51.5 (18.) | 68.8 (3.5) | 75.4 (3.1) | 74.0 (3.1) | 62.9 (5.7) | 50.3 (6.7) | -19.5 (-56.6, 17.5) | 2015 | 4.5 (0.4, 8.8) | -7.1 (-13.2, -0.7) | -0.5 (-3.5, 2.7) |
| Black/Not Hispanic | 65.2 (4.7) | 71.3 (4.0) | 68.0 (3.5) | 82.8 (2.8) | 76.5 (3.6) | 63.8 (5.5) | 66.8 (7.1) | 2.4 (-23.3, 28.2) |  | -1.0 (-2.5, 0.6) |  | -1.0 (-2.5, 0.6) |
| Asian/Not Hispanic | 85.0 (5.6) | 72.0 (11.) | 86.9 (5.7) | 76.6 (6.4) | 75.3 (8.5) | 77.8 (7.2) | 56.8 (14.) | -33.3 (-67.0, 0.5) |  | -1.5 (-3.4, 0.5) |  | -1.5 (-3.4, 0.5) |
| White/Not Hispanic | 75.6 (2.7) | 75.9 (2.3) | 82.7 (2.7) | 76.1 (3.3) | 80.7 (3.0) | 76.5 (2.9) | 70.8 (3.2) | -6.4 (-17.0, 4.3) | 2012 | 2.8 (-0.8, 6.6) | -1.6 (-2.9, -0.4) | -0.2 (-1.4, 1.1) |
| Sex | | | | | | | | | | | | |
| Male | 70.4 (3.4) | 71.9 (3.0) | 74.7 (2.6) | 78.4 (2.6) | 79.0 (2.6) | 69.0 (3.3) | 64.9 (4.0) | -7.8 (-21.9, 6.2) | 2015 | 1.6 (-0.3, 3.6) | -4.6 (-7.6, -1.5) | -1.0 (-2.5, 0.5) |
| Female | 77.1 (2.5) | 77.2 (2.4) | 78.8 (2.4) | 75.8 (3.1) | 77.1 (2.8) | 71.6 (3.1) | 65.3 (3.4) | -15.3 (-25.5, -5.1) | 2013 | 0.8 (-2.0, 3.7) | -2.5 (-4.1, -0.8) | -1.1 (-2.4, 0.2) |
| Insurance coverage | | | | | | | | | | | | |
| Any private | 79.7 (2.5) | 82.3 (2.6) | 83.1 (2.5) | 78.9 (3.1) | 83.9 (2.3) | 75.5 (3.0) | 70.0 (3.1) | -12.2 (-21.5, -2.9) | 2013 | 1.2 (-1.4, 3.8) | -2.5 (-4.0, -1.0) | -1.0 (-2.2, 0.2) |
| Public only | 73.9 (3.3) | 71.8 (3.6) | 78.0 (3.1) | 78.1 (3.2) | 73.3 (3.9) | 69.5 (2.9) | 61.8 (3.8) | -16.4 (-28.9, -3.9) | 2015 | 0.6 (-1.6, 2.9) | -4.8 (-8.3, -1.2) | -1.7 (-3.3, 0.0) |
| Uninsured | 45.7 (7.0) | 48.1 (5.3) | 45.1 (4.9) | 60.4 (6.6) | 55.7 (7.3) | 30.7 (9.5) | 39.5 (12.) | -13.6 (-69.6, 42.4) |  | -2.0 (-4.7, 0.9) |  | -2.0 (-4.7, 0.9) |
| Poverty income ratio | | | | | | | | | | | | |
| > 400% | 79.3 (4.0) | 89.4 (2.2) | 86.2 (2.8) | 88.4 (3.3) | 87.2 (2.6) | 84.4 (2.2) | 79.7 (4.0) | 0.4 (-13.6, 14.5) | 2010 | 6.6 (-0.8, 14.6) | -0.8 (-1.4, -0.3) | 0.4 (-0.7, 1.5) |
| 100% - 199% | 74.9 (3.4) | 76.9 (3.4) | 72.6 (4.1) | 66.5 (4.5) | 78.9 (2.8) | 57.9 (5.0) | 49.8 (6.5) | -33.5 (-51.6, -15.5) |  | -3.1 (-4.9, -1.3) |  | -3.1 (-4.9, -1.3) |
| 200% - 399% | 76.6 (3.2) | 68.3 (3.6) | 77.5 (4.0) | 75.6 (4.2) | 68.3 (4.5) | 72.4 (4.4) | 60.8 (5.3) | -20.6 (-35.7, -5.5) |  | -1.3 (-2.4, -0.2) |  | -1.3 (-2.4, -0.2) |
| < 100% | 56.4 (5.3) | 59.8 (4.6) | 66.8 (3.9) | 75.7 (4.3) | 74.4 (4.4) | 61.8 (4.6) | 58.9 (6.3) | 4.3 (-24.8, 33.5) | 2014 | -0.2 (-3.2, 3.0) |  | -0.2 (-3.2, 3.0) |

# Figures

|  |
| --- |
| Background pattern  Description automatically generated  Fig 1: Age-adjusted trends in proportions of US adults with diabetes who reported receiving recommended medical examinations. The dashed black line is the overall trend. |

|  |
| --- |
| Background pattern  Description automatically generated  Fig 2: Age-adjusted trends in proportions of US adults with diabetes who reported receiving recommended lab tests and vaccinations. The dashed black line is the overall trend. |

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