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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. We used Joinpoint regression to identify trends in the data from 2008 - 2019. 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 2019, the proportion of adults reporting having received at least three of six recommended practices decreased from 71.0% in 2008 to 67.3%, although this trend was not significant. No significant changes were seen for most subgroups. Most individual practices examined also were flat or decreased over the study period, with the exception of the receipt of 2 or more A1C tests in year, which increased.

**Conclusions:** The trend in the percentage of adults over the age of 18 diagnosed with diabetes that self-report receiving less preventive care in 2019 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.

In this study, we report the proportion of and trends in the receipt of six of the preventive care practices recommended by the ADA overall and among subgroups. These data are valuable for identifying groups that may be underutilizing 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. We chose 2008 to 2020 due to changes in MEPS and the availability of particular questions. Respondents were from a subsample of households that participated in the National Health Interview Survey (NHIS). Data used from MEPS were collected through a combination of computer assisted personal interviewing and pencil-and-paper surveys. 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 self-reported receipt in the past year of the following ADA annual care recommendations7: ≥1 dental examination, a dilated eye examination, a foot examination, ≥2 A1C tests, a cholesterol test, and a flu vaccine. We also 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 throughout have been direct age-adjusted, standardized to the 2000 US standard population grouped by ages 18 - 44, 45 - 64, 65 - 74, and older than 75. 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 calculate estimates8,9.

Medical care utilization decreased as a result of the COVID-19 pandemic starting in 202010. We report the estimated proportions for 2020 in Table 1 and as points in [Figure 1](#fig-exams) and [Figure 2](#fig-tests), but 2020 was excluded from trend analysis. Trends 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 ≥ 3 preventive care practices received

Overall, there was no change in the percentage of adults receiving three or more recommended preventive care practices over the 2008 to 2019 time period (Table 1). Additionally, few groups exhibited significant changes in this trend over the same time period (Table 1). For adults age 75 and greater, the percentage receiving three or more of the recommended care practices was flat until 2015 (1.0 [-0.2, 2.2]), and after 2015 was decreasing (-3.1 [-5.7, -0.4]). The AAPC for adults 75 and older was -0.5 [-1.5, 0.5]. Adults with less than a high school education had a flat trend until 2012 (4.5 [-1.3, 10.6]) which was followed by an APC in the second period of -3.5 (-5.8, -1.2). The AAPC for this group was not significantly different from zero.

Both males and females showed decreasing percentages of adults receiving three or more recommended preventive care practices. The AAPC for females was -0.7 (-1.2, -0.1) over the entire analyzed period, whereas the trend for males was flat until 2015 (1.4 [-0.2, 3.1]), at which point it began to decrease (-4.1 [-7.7, -0.3]). Among the different insurance groups, adults with private insurance and adults on Medicaid both changed by -0.7 (-1.4, 0.0) and -1.6 (-3.1, -0.2), respectively. The percentage of adults in the highest earning group receiving three or more recommended care practices increased annual by 7.1 (0.0, 14.6) and was flat after 2010 (-0.5 [-1.1, 0.1]). Adults earning just above the poverty line that received three or more of the recommended practices decreased by -2.2 (-4.1, -0.3).

## Trends for each preventive care practice

Trends for all adults with diabetes receiving an eye exam with dilation, while the trend for adults visiting the dentist at least once increased slightly after 2016 and adults receiving a foot exam increased until 2011 when the trend began to decrease ([Figure 1](#fig-exams)). The percent of adults getting a flu vaccine increased until 2013 then began to decrease ([Figure 2](#fig-tests)). Cholesterol testing dropped slightly over the studied time period, while the only preventive practice to increase over this entire 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 receiving an eye examination with dilation was flat over 2008 to 2019. Within the income poverty ratio subgroups, only those in the highest poverty income ratio group (> 400%) deviate from this flat trend ([Figure 1](#fig-exams)).

# Discussion

Despite the recovery from the Great Recession in 2008 and the passing of the Affordable Care Act (ACA) in 2010, there was no change overall and for many subgroups in the percentage of people receiving at least three recommended preventive care services, while a few subgroups showed decreasing percentages. While the passing of the ACA led to an increase in the number of adults with diagnosed and undiagnosed diabetes that have health insurance and an increase in their use of health care services14,15, detecting changes in the receipt of preventive care has proved more elusive. Two studies, both of which used data from the Behavioral Risk Factor Surveillance System (BRFSS), found no changes overall in the utilization of preventive care for adults with diabetes and adults in the general population, respectively15,16. It may be difficult to detect changes in any single preventive care practice or aggregate count of preventive care, especially if other factors are presenting stronger barriers to care. For example, depression has been shown to decrease adherence to medical, diet, and exercise recommendations among adults with diabetes17,18.

Other studies on the trends in preventive care using different data sources report different 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 doctor19. Another study that reported on data from NHANES, the National Health Interview Survey, and (BRFSS) found that foot exams, flu vaccinations, and A1C testing increased from 1999 - 2016, although eye exams stayed roughly constant20. 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 39.5% in 2019 and 27.6% in 2020. Furthermore, we were unable to distinguish between type 1 and type 2 diabetes in these data.

# Conclusions

In summary, receipt of preventive care for diabetes has was flat from 2008 to 2019 overall and for many subgroups. Decreasing trends in preventive care percentages were seen in adults with diabetes over the age of 74, adults with less than a high school educations, males and females, and adults with private insurance only or Medicaid.

# Acknowledgements

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# Tables

Table : Age-adjusted trends in proportions of US adults with diabetes that report receiving at least three of six recommended care practices - at least one dental visit, one eye exam with dilation, one foot exam, two or more A1C tests, cholesterol level tested, and receiving a flu vaccine. Estimates for Percent Change, APC, and AAPC do not include data from 2020.

|  | 2008 (SE) | 2009 (SE) | 2010 (SE) | 2011 (SE) | 2012 (SE) | 2013 (SE) | 2014 (SE) | 2015 (SE) | 2016 (SE) | 2017 (SE) | 2018 (SE) | 2019 (SE) | 2020 (SE) | Percent Change (95% CI) | Joinpoint Year | APC Period 1 (95% CI) | APC Period 2 (95% CI) | AAPC (95% CI) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Overall | | | | | | | | | | | | | | | | | | |
| - | 71.0 (2.1) | 70.8 (2.1) | 72.3 (2.1) | 76.1 (1.9) | 74.3 (1.9) | 73.4 (2.1) | 73.6 (1.9) | 74.3 (1.9) | 72.5 (2.1) | 66.3 (1.9) | 70.3 (2.4) | 67.3 (2.7) | 65.1 (2.5) | -5.2 (-14.5, 4.1) |  | -0.5 (-1.2, 0.2) |  | -0.5 (-1.2, 0.2) |
| Age | | | | | | | | | | | | | | | | | | |
| 18 to 44 | 61.9 (3.8) | 63.0 (3.8) | 64.3 (3.6) | 69.7 (3.3) | 67.5 (3.4) | 65.6 (3.9) | 64.8 (3.3) | 65.5 (3.5) | 63.1 (3.7) | 56.6 (3.5) | 63.3 (4.4) | 57.4 (5.0) | 56.4 (4.8) | -7.2 (-26.6, 12.2) |  | -0.8 (-1.8, 0.2) |  | -0.8 (-1.8, 0.2) |
| 45 to 64 | 79.5 (1.7) | 76.1 (1.6) | 77.8 (1.5) | 80.9 (1.5) | 79.1 (1.6) | 78.5 (1.5) | 79.5 (1.7) | 80.6 (1.7) | 78.7 (1.7) | 74.2 (1.8) | 75.4 (1.8) | 74.7 (2.0) | 71.1 (2.4) | -6.1 (-12.4, 0.2) |  | -0.4 (-0.9, 0.1) |  | -0.4 (-0.9, 0.1) |
| 65 to 74 | 84.9 (1.9) | 86.0 (1.9) | 86.8 (2.1) | 86.2 (1.7) | 85.6 (1.8) | 87.8 (1.7) | 89.0 (1.7) | 89.8 (1.6) | 91.5 (1.5) | 83.1 (1.8) | 84.7 (1.5) | 87.1 (1.7) | 83.1 (2.0) | 2.7 (-3.3, 8.6) |  | 0.1 (-0.4, 0.6) |  | 0.1 (-0.4, 0.6) |
| 75+ | 84.6 (2.6) | 86.0 (2.1) | 88.3 (1.9) | 89.9 (1.8) | 88.3 (2.3) | 89.1 (2.1) | 92.2 (1.6) | 91.7 (1.5) | 90.5 (1.8) | 82.0 (2.4) | 81.9 (2.3) | 83.4 (2.6) | 79.5 (2.9) | -1.4 (-9.7, 7.0) | 2015 | 1.0 (-0.2, 2.2) | -3.1 (-5.7, -0.4) | -0.5 (-1.5, 0.5) |
| Highest degree earned | | | | | | | | | | | | | | | | | | |
| Less than high school | 60.7 (4.2) | 64.2 (3.8) | 60.7 (4.0) | 74.5 (3.1) | 70.7 (4.5) | 66.1 (3.0) | 66.7 (3.4) | 67.4 (5.3) | 65.5 (3.2) | 58.5 (3.8) | 56.8 (5.0) | 55.8 (5.2) | 44.3 (6.0) | -8.0 (-28.9, 13.0) | 2012 | 4.5 (-1.3, 10.6) | -3.5 (-5.8, -1.2) | -0.7 (-2.8, 1.5) |
| High school | 68.9 (3.2) | 70.3 (3.1) | 73.6 (2.9) | 72.0 (3.0) | 75.6 (3.2) | 74.5 (3.7) | 75.1 (3.2) | 64.8 (5.0) | 73.6 (3.3) | 64.4 (3.1) | 69.0 (4.0) | 68.2 (3.7) | 64.5 (4.1) | -1.0 (-14.9, 12.9) |  | -0.5 (-1.5, 0.5) |  | -0.5 (-1.5, 0.5) |
| Greater than high school | 84.3 (2.9) | 78.2 (4.0) | 79.3 (3.4) | 85.5 (2.8) | 82.2 (4.8) | 77.9 (4.1) | 76.4 (5.0) | 86.1 (3.8) | 76.7 (4.6) | 75.2 (3.3) | 81.0 (2.8) | 75.2 (4.3) | 75.9 (3.9) | -10.8 (-22.5, 0.8) |  | -0.6 (-1.5, 0.2) |  | -0.6 (-1.5, 0.2) |
| Race/Ethnicity | | | | | | | | | | | | | | | | | | |
| Hispanic | 62.6 (12.1) | 60.5 (12.3) | 36.7 (15.3) | 62.4 (18.8) | 61.3 (3.4) | 64.2 (3.6) | 70.8 (3.6) | 71.6 (3.4) | 64.1 (3.5) | 58.3 (4.2) | 62.9 (5.7) | 60.7 (5.8) | 50.3 (6.7) | -3.0 (-44.0, 38.1) |  | 1.4 (-1.8, 4.6) |  | 1.4 (-1.8, 4.6) |
| Black/Not Hispanic | 59.1 (4.3) | 69.9 (4.0) | 64.6 (4.5) | 72.4 (3.4) | 64.7 (3.7) | 72.6 (3.2) | 73.5 (3.7) | 68.9 (4.6) | 62.9 (4.2) | 59.6 (4.6) | 63.8 (5.5) | 60.1 (6.0) | 66.8 (7.1) | 1.7 (-22.9, 26.3) |  | -0.6 (-2.1, 0.9) |  | -0.6 (-2.1, 0.9) |
| Asian/Not Hispanic | 74.6 (10.9) | 62.6 (8.5) | 71.6 (11.1) | 68.6 (9.1) | 78.2 (7.3) | 78.0 (5.7) | 75.3 (6.4) | 62.2 (10.2) | 72.5 (8.4) | 69.5 (8.5) | 77.8 (7.2) | 64.4 (15.5) | 56.8 (14.2) | -13.7 (-61.4, 34.1) |  | -0.1 (-1.7, 1.5) |  | -0.1 (-1.7, 1.5) |
| White/Not Hispanic | 74.0 (2.5) | 71.7 (2.6) | 74.5 (2.3) | 77.7 (2.2) | 83.1 (2.7) | 77.8 (3.3) | 74.8 (3.1) | 77.2 (3.1) | 78.8 (3.0) | 72.5 (2.9) | 76.5 (2.9) | 73.4 (3.5) | 70.8 (3.2) | -0.9 (-12.2, 10.5) |  | 0.0 (-0.8, 0.8) |  | 0.0 (-0.8, 0.8) |
| Sex | | | | | | | | | | | | | | | | | | |
| Male | 67.7 (3.0) | 68.9 (3.1) | 70.0 (3.2) | 76.8 (2.5) | 71.5 (2.7) | 72.6 (3.1) | 74.7 (2.6) | 76.3 (2.6) | 73.2 (2.6) | 66.0 (2.9) | 69.0 (3.3) | 64.3 (3.8) | 64.9 (4.0) | -5.0 (-18.8, 8.7) | 2015 | 1.4 (-0.2, 3.1) | -4.1 (-7.7, -0.3) | -0.6 (-2.0, 0.8) |
| Female | 74.0 (2.6) | 72.4 (2.7) | 74.4 (2.4) | 75.5 (2.6) | 77.1 (2.4) | 74.1 (2.8) | 72.6 (3.1) | 72.5 (2.9) | 71.9 (2.8) | 66.5 (2.4) | 71.6 (3.1) | 70.5 (3.1) | 65.3 (3.4) | -4.8 (-15.3, 5.8) |  | -0.7 (-1.2, -0.1) |  | -0.7 (-1.2, -0.1) |
| Insurance coverage | | | | | | | | | | | | | | | | | | |
| Private only | 74.6 (2.9) | 75.6 (2.8) | 78.4 (3.0) | 78.7 (3.0) | 78.8 (3.0) | 81.2 (3.0) | 72.4 (3.3) | 73.8 (3.1) | 75.2 (2.9) | 71.1 (3.1) | 73.2 (3.6) | 70.8 (3.6) | 68.1 (3.5) | -5.1 (-17.0, 6.8) |  | -0.7 (-1.4, 0.0) |  | -0.7 (-1.4, 0.0) |
| Medicare only | 83.6 (2.1) | 81.5 (2.7) | 85.4 (2.1) | 86.8 (2.1) | 88.4 (1.7) | 89.9 (1.4) | 90.2 (1.7) | 89.2 (1.8) | 89.2 (1.7) | 78.1 (2.4) | 81.4 (1.9) | 86.3 (1.6) | 83.1 (2.1) | 3.3 (-3.1, 9.7) |  | 0.0 (-0.9, 0.9) |  | 0.0 (-0.9, 0.9) |
| Medicaid | 68.2 (4.6) | 70.6 (4.5) | 66.5 (4.9) | 77.0 (3.7) | 73.3 (4.0) | 65.4 (4.8) | 70.6 (4.2) | 74.4 (4.5) | 60.9 (4.8) | 59.1 (3.9) | 65.8 (4.0) | 55.6 (5.6) | 54.7 (5.2) | -18.4 (-37.8, 0.9) |  | -1.6 (-3.1, -0.2) |  | -1.6 (-3.1, -0.2) |
| Uninsured | 40.3 (6.6) | 42.6 (6.4) | 43.2 (5.1) | 48.5 (4.9) | 39.7 (4.7) | 33.8 (5.3) | 56.8 (6.5) | 48.0 (8.9) | 56.1 (7.5) | 38.8 (8.3) | 30.7 (9.5) | 36.9 (12.6) | 39.5 (11.6) | -8.5 (-76.5, 59.6) |  | -1.0 (-4.5, 2.6) |  | -1.0 (-4.5, 2.6) |
| Poverty income ratio | | | | | | | | | | | | | | | | | | |
| > 400% | 76.6 (3.9) | 76.9 (4.5) | 86.6 (2.9) | 85.1 (2.9) | 84.9 (2.9) | 86.8 (2.9) | 86.8 (3.3) | 81.8 (3.7) | 82.1 (3.2) | 82.7 (3.2) | 84.4 (2.2) | 80.9 (3.3) | 79.7 (4.0) | 5.6 (-8.0, 19.2) | 2010 | 7.1 (0.0, 14.6) | -0.5 (-1.1, 0.1) | 0.8 (-0.3, 2.0) |
| 200% - 399% | 74.9 (3.3) | 70.5 (3.8) | 66.2 (3.5) | 74.9 (3.2) | 73.7 (4.1) | 69.6 (4.2) | 70.1 (4.3) | 73.5 (3.6) | 60.6 (4.3) | 68.2 (4.1) | 72.4 (4.4) | 65.1 (5.1) | 60.8 (5.3) | -13.2 (-28.5, 2.2) |  | -0.8 (-1.9, 0.4) |  | -0.8 (-1.9, 0.4) |
| 100% - 199% | 69.2 (3.7) | 68.3 (4.4) | 74.0 (3.3) | 76.7 (3.0) | 70.4 (4.1) | 78.9 (2.9) | 63.0 (4.4) | 67.6 (3.5) | 75.9 (2.8) | 53.0 (4.4) | 57.9 (5.0) | 56.7 (6.3) | 49.8 (6.5) | -18.1 (-38.0, 1.7) |  | -2.2 (-4.1, -0.3) |  | -2.2 (-4.1, -0.3) |
| < 100% | 55.0 (5.3) | 64.6 (4.0) | 58.8 (4.5) | 61.1 (4.5) | 64.6 (4.0) | 56.1 (5.4) | 72.6 (4.4) | 71.1 (4.4) | 68.2 (4.6) | 53.1 (4.6) | 61.8 (4.6) | 61.5 (4.5) | 58.9 (6.3) | 11.8 (-14.6, 38.2) |  | 0.4 (-1.5, 2.4) |  | 0.4 (-1.5, 2.4) |

# Figures

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| Background pattern  Description automatically generated  Fig 1: Age-adjusted trends in proportions of US adults with diabetes who reported receiving recommended medical examinations from 2008 - 2019. The dashed black line is the overall trend, while dots represent percentages for 2020. Data from 2020 was not included in the trend analysis. |

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| Background pattern  Description automatically generated with medium confidence  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, while dots represent percentages for 2020. Data from 2020 was not included in the trend analysis. |

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