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

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# Abstract

# Introduction

Intro – peak incidence in 2008/2009, increasing rates of some major complications + projections of diabetes numbers; previous reports of preventive care practices

Diabetes is a chronic disease that affects XX people in the USA.

# 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 individuals 18 years or older with diabetes in the USA. Participants in this survey are a subsample of households that participate in the National Health Interview Survey (NHIS). The MEP survey 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 12 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 American Diabetes Association annual care recommendations. 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 individuals 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 further classified individuals as having received at least three of those recommended care practices and those that received less than three of these practices.

## Analysis

Our analysis is adjusted 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 income to poverty line.

We used R Statistical Software (v4.2.1)1 to perform all analyses. The package gtsummary was used to account for the complex survey design and age-adjust estimates2. Trends in preventive care practices were analyzed using Joinpoint Command Line Software3 with R via the R package nih.joinpoint4. Joinpoint regression uses permutation tests to detect statistically significant changes at a pre-specified alpha of 0.05 in direction and/or magnitude of trends5. 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

For the entire population of individuals diagnosed with diabetes in the USA there was a decrease in the percentage of people receiving at least three of the recommended practices from 2008 to 2020 (Table 1). This negative percent change in the amount of preventive care practices received held true for all groups, with the exception of individuals with an income to poverty line ratio greater than 400% and those with an income to poverty line ratio less than 100%, which saw percent changes of 1.322% and 1.373%, respectively (Table 1). The largest decreases in the percentage of individuals receiving at least three preventive care practices were seen in those with no high school diploma (-31.09%), Asian/Not Hispanic (-31.15%), the uninsured (-31.63%), and those with an income to poverty line ratio between 100% and 199% (-34.29%) (Table 1).

While the percent change and AAPC for nearly all groups were negative, some groups had APC values that were initially flat (i.e. the 95% CI overlapped 0) 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). Only individuals in the highest poverty to income ratio category (>400%) had an initial APC that was positive at 7.3 (0.38, 15.)% (Table 1).

Overall trends in each of the individual preventive practices decreased from 2008 to 2020, with the exception of the percentage of people receiving two or more A1C tests in one year, which increased from 53.7% to 59.3% ([Figure 1](#fig-exams) & [Figure 2](#fig-tests)). Trends in the percentages of people getting an eye exam with dilation and one or more dentist visits tended to be close to flat or decreasing, with a few exceptions where percentages first increased until the mid 2010s and then began to decrease (e.g., see the eye exam graph for the poverty income ratio stratifier and dentist visits for race and ethnicity stratifier, [Figure 1](#fig-exams)). The overall trend for foot exams initially increased and then started to decrease in 2012, and many of the stratifier-specific groups follow a similar trend ([Figure 1](#fig-exams)). The trend overall and among our stratifying variables for cholesterol testing and receiving a flu vaccine also generally follow the trend of increasing until between 2013 - 2015, where they begin to decrease, although a few specific stratifying groups only decrease over the examined time period ([Figure 2](#fig-tests)). The percentage of the population receiving two or more A1C tests in a year only increased overall and for all groups ([Figure 2](#fig-tests)).

# Discussion

Discussion – ACA and recovery from Great Recession as context for increasing trends after 2008 until 2016 (then what happened?); compare to BRFSS state estimates; impact of COVID on receipt of PCP; speculation about future burden of complications due to suboptimal preventive care

BRFSS estimates - Median state eye exam is roughly flat - individual states bounce all over - Median foot exam is flat/maybe increasing? - Median state A1c tests - also flattish/maybe increasing? hard to say - Median state flu vaccine - bounces around a bit more. Overall line would probably be flat though? Nationally though the estimate is pretty clearly increasing overall and for all available stratifiers - No cholesterol or dentist info from BRFSS? Not on dashboard anyway.

Limitations – cross-sectional, self-report only, declining response rate

# References

1. R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing; 2022. <https://www.R-project.org/>

2. Sjoberg DD, Whiting K, Curry M, Lavery JA, Larmarange J. Reproducible summary tables with the gtsummary package. *The R Journal*. 2021;13:570-580. doi:[10.32614/RJ-2021-053](https://doi.org/10.32614/RJ-2021-053)

3. Statistical Methodology and Applications Branch, Surveillance Research Program, National Cancer Institute. *Joinpoint Regression Program*.; 2022.

4. Chaltiel D. *Nih.joinpoint: R Interface for NIH’s Joinpoint Regression Software*.; 2022. <https://github.com/DanChaltiel/nih.joinpoint/>

5. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Statistics in medicine*. 2000;19(3):335-351.

# Tables

|  | 2008 (SE) | 2010 (SE) | 2012 (SE) | 2014 (SE) | 2016 (SE) | 2018 (SE) | 2020 (SE) | Percent Change | Joinpoint Year | APC Period 1 (95% CI) | APC Period 2 (95% CI) | AAPC (95% CI) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Overall |
| - | 73.88 (0.028) | 74.60 (0.028) | 76.71 (0.030) | 77.02 (0.028) | 78.01 (0.028) | 70.34 (0.025) | 65.08 (0.023) | -11.92 | 2015 | 0.74 (-0.93, 2.4) | -3.8 (-6.5, -1.1) | -1.2 (-2.5, 0.10) |
| Age |
| 18 to 44 | 65.34 (0.039) | 66.66 (0.035) | 71.12 (0.032) | 69.38 (0.034) | 70.28 (0.037) | 63.33 (0.044) | 56.44 (0.048) | -13.62 | 2013 | 2.3 (-1.9, 6.7) | -3.8 (-6.1, -1.3) | -1.3 (-3.2, 0.65) |
| 45 to 64 | 81.92 (0.014) | 80.50 (0.014) | 80.35 (0.016) | 82.38 (0.016) | 83.61 (0.015) | 75.36 (0.018) | 71.10 (0.024) | -13.20 | 2015 | 0.54 (-0.77, 1.9) | -2.9 (-5.0, -0.74) | -0.90 (-1.9, 0.11) |
| 65 to 74 | 86.67 (0.019) | 89.09 (0.017) | 87.24 (0.017) | 90.06 (0.018) | 93.02 (0.014) | 84.67 (0.015) | 83.11 (0.020) | -4.112 |  | -0.19 (-0.74, 0.36) |  | -0.19 (-0.74, 0.36) |
| 75+ | 86.06 (0.024) | 88.85 (0.019) | 88.23 (0.023) | 92.84 (0.015) | 91.51 (0.018) | 81.86 (0.023) | 79.54 (0.029) | -7.575 | 2015 | 0.87 (-0.27, 2.0) | -3.1 (-4.9, -1.2) | -0.79 (-1.7, 0.086) |
| Highest degree earned |
| Greater than high school | 85.35 (0.060) | 81.57 (0.051) | 83.75 (0.091) | 80.02 (0.049) | 80.70 (0.054) | 80.94 (0.049) | 75.45 (0.043) | -11.60 |  | -0.82 (-1.5, -0.14) |  | -0.82 (-1.5, -0.14) |
| High school | 72.94 (0.038) | 76.23 (0.041) | 79.33 (0.063) | 78.55 (0.043) | 80.90 (0.041) | 69.16 (0.037) | 65.29 (0.033) | -10.49 |  | -1.1 (-2.2, -0.062) |  | -1.1 (-2.2, -0.062) |
| Less than high school | 62.29 (0.055) | 62.15 (0.053) | 73.30 (0.081) | 69.94 (0.060) | 68.69 (0.055) | 57.38 (0.046) | 42.93 (0.040) | -31.09 | 2015 | 2.0 (-1.2, 5.2) | -8.6 (-13., -3.7) | -2.6 (-4.9, -0.22) |
| Race/Ethnicity |
| Asian/Not Hispanic | 84.76 (0.17) | 72.73 (0.13) | 86.93 (0.15) | 77.08 (0.11) | 72.39 (0.16) | 77.41 (0.12) | 58.36 (0.079) | -31.15 |  | -1.4 (-3.3, 0.49) |  | -1.4 (-3.3, 0.49) |
| Black/Not Hispanic | 67.65 (0.059) | 72.40 (0.062) | 69.21 (0.064) | 83.15 (0.068) | 77.19 (0.067) | 64.50 (0.057) | 67.15 (0.069) | -0.7494 |  | -1.0 (-2.5, 0.41) |  | -1.0 (-2.5, 0.41) |
| Hispanic | 68.14 (0.35) | 49.28 (0.27) | 71.03 (0.057) | 76.40 (0.065) | 75.31 (0.061) | 64.40 (0.052) | 52.53 (0.042) | -22.92 | 2015 | -0.56 (-4.4, 3.4) |  | -0.56 (-4.4, 3.4) |
| White/Not Hispanic | 75.33 (0.033) | 75.48 (0.033) | 82.33 (0.045) | 73.95 (0.039) | 80.01 (0.039) | 74.93 (0.040) | 69.42 (0.034) | -7.840 | 2012 | 2.7 (-1.5, 7.1) | -1.8 (-3.2, -0.38) | -0.34 (-1.8, 1.1) |
| Sex |
| Female | 77.41 (0.040) | 77.24 (0.039) | 78.78 (0.043) | 76.08 (0.038) | 77.61 (0.038) | 71.90 (0.035) | 65.78 (0.031) | -15.03 |  | -1.2 (-1.9, -0.45) |  | -1.2 (-1.9, -0.45) |
| Male | 69.77 (0.039) | 71.80 (0.038) | 74.69 (0.041) | 78.29 (0.043) | 78.74 (0.043) | 68.55 (0.036) | 64.20 (0.033) | -7.981 | 2015 | 1.7 (-0.21, 3.7) | -4.7 (-7.7, -1.6) | -1.0 (-2.5, 0.46) |
| Insurance coverage |
| Any private | 80.09 (0.037) | 82.30 (0.039) | 83.01 (0.041) | 79.26 (0.037) | 83.87 (0.040) | 75.70 (0.035) | 70.52 (0.031) | -11.96 |  | -1.1 (-1.9, -0.35) |  | -1.1 (-1.9, -0.35) |
| Public only | 70.70 (0.064) | 70.11 (0.052) | 77.08 (0.057) | 77.06 (0.052) | 72.25 (0.048) | 68.48 (0.043) | 59.69 (0.037) | -15.57 | 2014 | 1.9 (-1.2, 5.1) | -4.6 (-7.5, -1.6) | -1.4 (-3.2, 0.46) |
| Uninsured | 48.80 (0.15) | 57.45 (0.12) | 45.20 (0.079) | 61.11 (0.11) | 63.73 (0.11) | 28.92 (0.056) | 33.36 (0.064) | -31.63 |  | -3.5 (-7.0, 0.098) |  | -3.5 (-7.0, 0.098) |
| Poverty income ratio |
| > 400% | 78.25 (0.053) | 89.77 (0.065) | 85.49 (0.066) | 87.76 (0.064) | 86.51 (0.056) | 83.91 (0.066) | 79.29 (0.046) | 1.322 | 2010 | 7.3 (0.38, 15.) | -0.85 (-1.4, -0.33) | 0.47 (-0.55, 1.5) |
| 200% - 399% | 76.85 (0.052) | 68.68 (0.044) | 77.63 (0.054) | 75.42 (0.054) | 67.77 (0.049) | 72.57 (0.043) | 61.68 (0.039) | -19.73 |  | -1.3 (-2.3, -0.22) |  | -1.3 (-2.3, -0.22) |
| 100% - 199% | 74.46 (0.062) | 76.53 (0.061) | 72.17 (0.059) | 67.75 (0.050) | 78.81 (0.059) | 59.91 (0.043) | 48.93 (0.044) | -34.29 |  | -2.9 (-4.6, -1.2) |  | -2.9 (-4.6, -1.2) |
| < 100% | 58.86 (0.057) | 62.30 (0.056) | 68.17 (0.061) | 76.62 (0.062) | 76.28 (0.064) | 62.42 (0.059) | 59.66 (0.051) | 1.373 |  | -0.36 (-2.1, 1.4) |  | -0.36 (-2.1, 1.4) |

# Figures

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| 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. |

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| 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. |

## Alternative figure options





