



Trends in Diagnosed and Undiagnosed Diabetes Among Adults in the U.S., 2005–2016

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Diabetes Care 2021;44:e175–e177 | <https://doi.org/10.2337/dc21-1156>

Accurate surveillance of diabetes is crucial for establishing relevant policies of diabetes prevention and control. Previous studies estimated the trends in diabetes among adults in the U.S.; however, many did not consider results of the oral glucose tolerance test (OGTT) (1), and those studies that included the OGTT results reported a higher prevalence of undiagnosed diabetes (2). Capitalizing on the OGTT data since 2005–2006 in the National Health and Nutrition Examination Survey (NHANES), we assessed the trends in diagnosed and undiagnosed diabetes among adults in the U.S. from 2005 to 2016.

NHANES is a cross-sectional survey with a stratified, multistage probability design to assess the health status of the noninstitutionalized civilian population in the U.S. (3). A household interview was conducted to collect health-related information including demographic characteristics and medical history. A subset of participants was randomly selected to provide a fasting blood sample and take an OGTT at the mobile examination center. Sample weights were constructed to account for nonresponse and oversampling. The survey was approved by the research ethics review board of the National Center for Health Statistics. Written informed consent was obtained from each participant.

This investigation included nonpregnant participants aged 20 years or older, recruited from 2005–2006 to 2015–2016 cycles, who had information on self-reported diagnosed diabetes or laboratory results of fasting plasma glucose (FPG), hemoglobin A_{1c} (HbA_{1c}), and 2-h plasma glucose (2-h PG). We calibrated plasma glucose measurements to early survey cycles by using the recommended backward equations (3).

Diagnosed diabetes was established by self-report. Undiagnosed diabetes was defined as an FPG of ≥ 126 mg/dL, an HbA_{1c} of $\geq 6.5\%$, or a 2-h PG of ≥ 200 mg/dL among participants without diagnosed diabetes (4). Total diabetes was defined as having either diagnosed or undiagnosed diabetes.

To estimate nationally representative prevalence, we used interview weight for patients with diagnosed diabetes and OGTT subsample weight for participants without diagnosed diabetes (2). Age-standardized prevalence was calculated with use of the data from the 2000 census for the standard population. All CIs were estimated with Taylor series linearization to account for the complex sample design. Analyses were performed with SAS, version 9.4 (SAS Institute).

The age-standardized prevalence of total diabetes was 13.0% (95% CI

11.4–14.7) in 2005–2006 and 14.7% (12.7–16.7) in 2015–2016 ($P = 0.47$ for trend) (Fig. 1A). The prevalence of diagnosed diabetes increased from 7.6% (6.8–8.5) in 2005–2006 to 8.1% (7.1–9.0) in 2009–2010 and to 10.1% (8.7–11.5) in 2015–2016 ($P = 0.002$ for trend). The prevalence of undiagnosed diabetes showed a decreasing trend ($P = 0.055$), from 5.4% (4.0–6.7) in 2005–2006 to 5.8% (4.5–7.1) in 2009–2010 and to 4.6% (3.3–5.8) in 2015–2016.

No significant trend was noted when FPG or HbA_{1c} or both were used as the criteria for defining undiagnosed diabetes (Fig. 1B and C). A significant decreasing trend was observed for undiagnosed diabetes defined only by 2-h PG ($P = 0.049$), from 4.8% (95% CI 3.6–6.1) in 2005–2006 to 2.9% (2.2–3.6) in 2013–2014 and to 3.8% (2.5–5.1) in 2015–2016. The prevalence of undiagnosed diabetes was underestimated without 2-h PG in the definition; e.g., the prevalence was 5.4% (4.0–6.7) and 2.9% (1.7–4.1) with and without 2-h PG in the definition in 2005–2006, and the corresponding values were 4.6% (3.3–5.8) and 2.7% (1.9–3.4) in 2015–2016.

The trends in diagnosed diabetes were generally consistent with previous findings (1). The increasing trend in diagnosed diabetes and decreasing trend in undiagnosed diabetes, particularly since the 2011–2012 survey cycle,

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Received 1 June 2021 and accepted 22 June 2021

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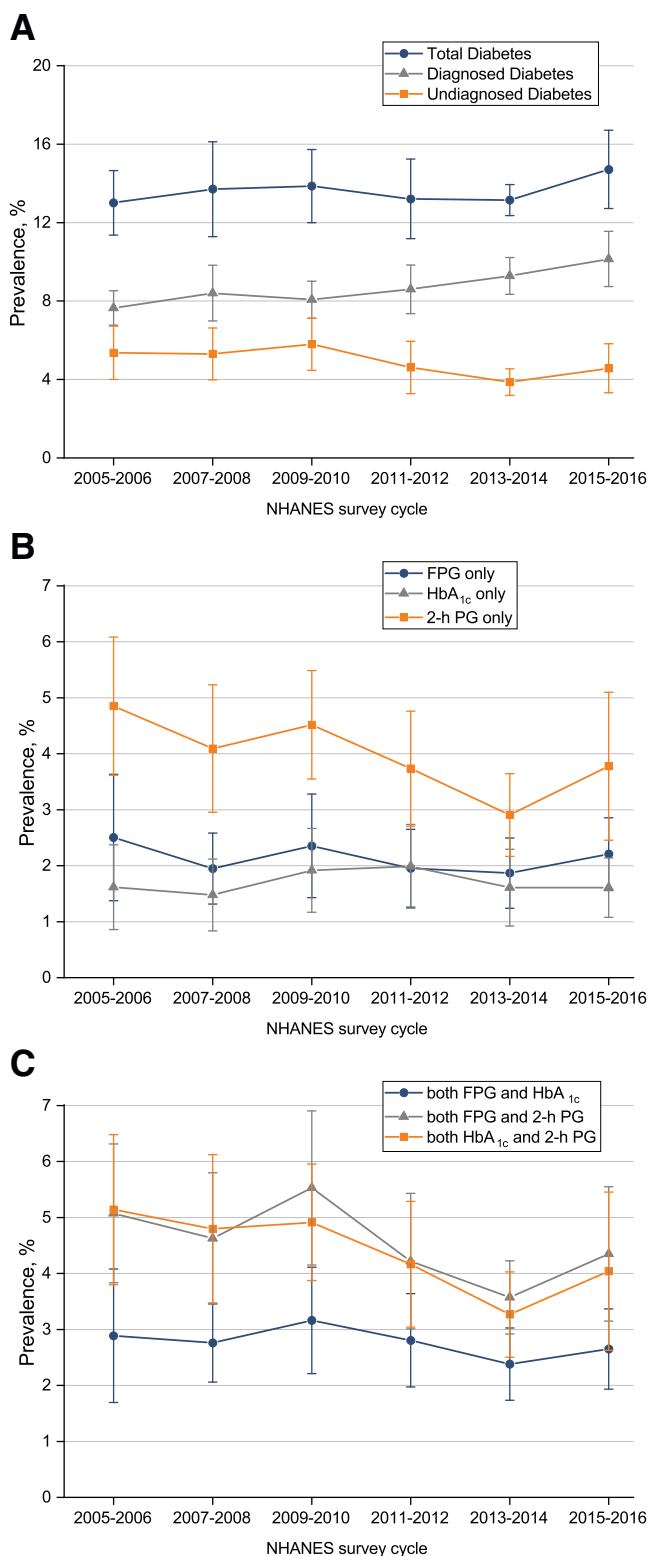


Figure 1—Trends in diagnosed and undiagnosed diabetes among adults aged 20 years or older in the U.S., 2005–2006 to 2015–2016. Data are from NHANES. The error bars indicate 95% CIs. The prevalence estimates were weighted and age standardized with age-groups of 20–39 years, 40–59 years, and 60 years or older. **A:** The trend was not statistically significant in prevalence of total diabetes ($P = 0.47$), while a significant increasing trend was found for diagnosed diabetes ($P = 0.002$) and a decreasing trend in undiagnosed diabetes was marginally significant ($P = 0.055$). **B:** The trend was significantly decreasing in undiagnosed diabetes defined by 2-h PG only ($P = 0.049$), while no significant changing trend was found in undiagnosed diabetes defined by FPG only ($P = 0.51$) or HbA_{1c} only ($P = 0.99$). **C:** The trend was significantly decreasing in undiagnosed diabetes defined by both HbA_{1c} and 2-h PG ($P = 0.04$), while no significant changing trend was found in undiagnosed diabetes defined by both FPG and HbA_{1c} ($P = 0.41$) or both FPG and 2-h PG ($P = 0.08$).

may be due to the changes in diagnostic criteria in 2010 when HbA_{1c} was adopted for the diagnosis of diabetes (4), which increased detection of undiagnosed diabetes.

The increase in prevalence by adding 2-h PG emphasizes the important role of an OGTT in comprehensive surveillance of diabetes. Although the administration of an OGTT is time-consuming and burdensome, 2-h PG value not only is a relatively more efficient plasma glucose criterion for diagnosis of diabetes but also has important prognostic value. The 2-h PG has been reported to predict risks of cardiovascular disease and mortality, independent of FPG and/or HbA_{1c} (5).

This study has several limitations. First, diagnosed diabetes was based on self-reported data but not medical records, and measurement error was possible. Second, a single measurement of glucose level might lead to potential overestimate of undiagnosed diabetes.

The prevalence of self-reported diabetes increased significantly while the prevalence of undiagnosed diabetes detected by all three glycemic parameters (FPG, HbA_{1c}, and 2-h PG) decreased from 2005 to 2016 among adults in the U.S. Overall, total diabetes prevalence remained stable from 2005 to 2016.

Funding. A.P. was supported by the National Nature Science Foundation of China (81930124 and 82021005), the Fundamental Research Funds for the Central Universities (2021GCRC075), and the Shanghai Municipal Science and Technology Major Project (2017SHZDZX01).

The funding agencies played no role in the design or conduct of the study; collection, management, analysis, or interpretation of the data; preparation, review, or approval of the manuscript; or decision to submit the manuscript for publication.

Duality of Interest. No potential conflicts of interest relevant to this article were reported.

Author Contributions. P.-F.X. contributed to the study concept and design, statistical analysis, interpretation of data, drafting of the manuscript, and study supervision. Y.L. and Z.-Z.T. contributed to the statistical analysis. A.P. contributed to the study concept and design, drafting of the manuscript, funding, and study supervision. All authors were involved in the critical revision of the manuscript and approved the final version of this article. A.P. attested that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. P.-F.X. 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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