# Burden of Complications in U.S. Adults With Young-Onset Type 2 or Type 1 Diabetes

*Michael Fang,*[1]
*Justin B. Echouffo-Tcheugui,*[2]
*and Elizabeth Selvin*[1]

*Diabetes Care 2020;43:e47–e49 | https://doi.org/10.2337/dc19-2394*

Young-onset type 2 diabetes has a more aggressive clinical course than type 2 diabetes that occurs at an older age (1). Accruing evidence suggests that young adults with type 2 diabetes have complication rates exceeding those of individuals of similar age with type 1 diabetes (1–3). However, prior studies have focused on select populations and the generalizability of their findings is not clear. To address this gap in the literature, we analyzed recent national data to characterize the prevalence of complications among U.S. adults with young-onset type 1 and type 2 diabetes.

We pooled data from the 2016 and 2017 National Health Interview Survey (NHIS). The NHIS is the only representative U.S. study that collects self-reported information on types of diabetes. Participants reported whether they had ever been diagnosed with diabetes other than during pregnancy. Those with diagnosed diabetes reported the type of diabetes (type 1, type 2, other), age of diagnosis, and use of antidiabetes medication.

Following past research, we defined young-onset type 2 diabetes as being diagnosed before age 40 (1). We defined young-onset type 1 diabetes using this same cut point for comparability. We classified participants as having young-onset type 1 diabetes if they reported having type 1 diabetes diagnosed before age 40 and were currently using insulin ($n = 232$). We classified all remaining participants with diabetes diagnosed by age 40, except those with "other" types of diabetes, as having young-onset type 2 diabetes ($n = 1{,}207$) (4).

Participants reported history of cardiovascular events (coronary heart disease, angina, heart attack, other heart condition, stroke). We defined cardiovascular disease (CVD) as having at least one of these conditions. We also examined each cardiovascular condition separately. Participants reported whether they had ever been diagnosed with diabetic retinopathy and whether they had been diagnosed with "weak or failing kidneys" during the past year.

We conducted analyses using recommended sample weights to generate estimates representative of the U.S. civilian noninstitutionalized population. We examined participant characteristics and the prevalence of complications according to diabetes type and used $\chi^2$ tests to assess group differences.

U.S. adults with young-onset type 1 diabetes were younger (42.6 vs. 50.5 years of age, $P < 0.001$) and diagnosed at an earlier age than those with young-onset type 2 diabetes (19.0 vs. 27.2 years of age, $P < 0.001$), but disease duration between the two groups was similar (23.6 vs. 23.3 years, $P = 0.84$) (Table 1). Adults with type 1 diabetes generally had fewer clinical and lifestyle risk factors than those with young-onset type 2 diabetes.

The prevalence of any CVD was high but did not differ between those with young-onset type 1 versus young-onset type 2 diabetes (23.1% vs. 28.3%, $P = 0.18$) (Table 1). Results were similar when considering each CVD outcome separately. One exception was the prevalence of angina; however, the estimate for adults with type 1 diabetes was imprecise and should be interpreted with caution. The prevalence of recently diagnosed kidney disease ("weak or failing kidneys") did not differ significantly between the two groups (10.4% vs. 8.5%, $P = 0.49$). The prevalence of diabetic retinopathy was higher among those with young-onset type 1 diabetes versus young-onset type 2 diabetes (24.7% vs. 11.4%, $P < 0.001$). Results were similar after adjustment for sociodemographic characteristics (results not shown).

Our findings differ from previous research. Prior studies have reported a higher prevalence of CVD, kidney disease, and, to a lesser extent, retinopathy among those with young-onset type 2 diabetes compared with similarly aged adults with type 1 diabetes (1–3). We suspect these differences may be due to differences in data collection and study

[1]*Department of Epidemiology and the Welch Center for Prevention, Epidemiology, and Clinical Research, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD*
[2]*Division of Endocrinology, Diabetes, and Metabolism, Department of Medicine, Johns Hopkins School of Medicine, Baltimore, MD*
*Corresponding author: Elizabeth Selvin, eselvin@jhu.edu*

*Received 27 November 2019 and accepted 16 January 2020*

**Table 1—Characteristics and prevalence of complications among U.S. adults with young-onset type 2 and type 1 diabetes, NHIS, 2016–2017**

| | Type 1 diabetes† ($n$ = 232) | Type 2 diabetes ($n$ = 1,207) | $P$ value# |
|---|---|---|---|
| Sociodemographic characteristics | | | |
| Age, mean, years | 42.6 (40.0–45.2) | 50.5 (49.4–51.7) | <0.001 |
| Age of diagnosis, mean, years | 19.0 (17.3–20.7) | 27.2 (26.5–27.9) | <0.001 |
| Duration of diabetes, mean, years | 23.6 (21.3–25.9) | 23.3 (21.9–24.7) | 0.84 |
| Sex, % | | | |
| Female | 47.9 (39.6–56.3) | 53.4 (49.6–57.3) | 0.24 |
| Male | 52.1 (43.7–60.4) | 46.6 (42.7–50.4) | |
| Race/ethnicity, % | | | |
| Non-Hispanic white | 79.1 (71.5–85.1) | 48.0 (43.8–52.3) | <0.001 |
| Non-Hispanic black | 7.4 (4.3–12.7) | 19.5 (16.8–22.6) | |
| Hispanic | 10.6 (6.0–17.8) | 23.3 (19.4–27.6) | |
| Other | 2.9 (1.3–6.5) | 9.2 (7.0–12.0) | |
| Family income level, % | | | |
| Income-poverty ratio <200% | 29.3 (23.1–36.3) | 49.9 (46.0–53.9) | <0.001 |
| Income-poverty ratio ≥200% | 70.7 (63.7–76.9) | 50.1 (46.1–54.0) | |
| Education, % | | | |
| <High school | 28.9 (22.3–36.6) | 51.6 (47.5–55.7) | <0.001 |
| ≥High school | 71.1 (63.4–77.7) | 48.4 (44.3–52.5) | |
| Health insurance status, % | | | |
| Insured | 94.7 (90.7–97.0) | 89.7 (87.1–91.9) | 0.03 |
| Uninsured | 5.3 (3.0–9.3) | 10.3 (8.1–12.9) | |
| Health status characteristics | | | |
| Ever diagnosed with hypertension, % | 36.4 (29.1–44.4) | 62.4 (58.5–66.1) | <0.001 |
| Ever diagnosed with high cholesterol, % | 46.6 (38.3–55.0) | 55.3 (51.5–59.0) | 0.07 |
| Family history of diabetes, % | 51.2 (43.2–59.1) | 79.7 (76.6–82.4) | <0.001 |
| BMI, mean, kg/m$^2$ | 29.3 (25.7–31.1) | 34.5 (33.7–35.4) | <0.001 |
| Obese‡, % | 26.2 (20.0–33.5) | 60.8 (56.9–64.5) | <0.001 |
| Current smoking, % | 15.7 (11.0–21.7) | 18.8 (16.2–21.7) | 0.33 |
| Physically inactive§, % | 35.3 (28.4–42.9) | 45.2 (41.6–48.9) | 0.02 |
| Current treatment, % | | | |
| Oral antidiabetes drugs only | 0.0 | 50.1 (46.5–53.6) | <0.001 |
| Insulin only | 89.7 (84.0–93.4) | 10.2 (8.3–12.5) | |
| Both insulin and oral antidiabetes drugs | 10.3 (6.6–16.0) | 21.0 (18.1–24.2) | |
| Neither insulin nor oral antidiabetes drugs | 0.0 | 18.8 (16.0–22.0) | |
| Complications | | | |
| Any CVD, %‖ | 23.1 (16.5–29.7) | 28.3 (25.1–31.5) | 0.18 |
| Coronary heart disease | 10.7 (5.3–16.1) | 11.2 (8.8–13.5) | 0.87 |
| Angina | 2.2¶ (0.6–3.7) | 5.7 (4.0–7.5) | 0.01 |
| Heart attack | 8.8 (3.7–13.8) | 7.8 (5.9–9.7) | 0.71 |
| Other heart condition | 15.7 (9.5–21.9) | 13.8 (11.2–16.3) | 0.56 |
| Stroke | 6.0 (2.8–9.2) | 8.7 (6.6–10.7) | 0.21 |
| Kidney disease, % | 10.4 (5.1–15.6) | 8.5 (6.6–10.4) | 0.49 |
| Retinopathy, % | 24.7 (17.1–32.2) | 11.4 (8.9–13.9) | <0.001 |

Data are presented as mean or percentage with 95% CI in parentheses. Estimates were weighted and based on pooled data from the 2016 and 2017 waves of the NHIS. Young-onset diabetes was defined as a self-reported diagnosis of diabetes by a health care provider before the age of 40 years. †Type 1 diabetes was defined as self-report of type 1 diabetes and current insulin use. ‡Respondents with a reported BMI ≥30 were classified as obese. §Respondents who reported performing no physical activity during their leisure time were classified as physically inactive. ‖Respondents who reported ever being diagnosed with coronary heart disease, angina, myocardial infarction, any other heart conditions, or stroke were classified as having CVD. ¶Estimate may be unreliable because of large relative SE (>30%) and should be interpreted with caution. #$P$ values are from $\chi^2$ (for categorical measures) and $t$ tests (for continuous measures) assessing differences across diabetes subtype.

populations. The NHIS sampled from the general U.S. adult population, and all information was self-reported. Past research generally recruited clinical populations, often outside of the U.S., but has involved more objective measures of complications.

Limitations included possible misclassification, especially for type 1 diabetes. We attempted to minimize this by using self-reported diabetes subtype and insulin usage for classification. Additionally, because young-onset diabetes was rare, we may have lacked power to detect moderate differences in complications. Survival bias is also a potential concern given the cross-sectional nature of these data. Differential survival from complications may have affected our comparison across diabetes subtypes.

In conclusion, we found a high burden of complications among U.S. adults with young-onset diabetes. Rates of CVD and kidney disease were similar across type 1 and type 2 diabetes, while rates of diabetic retinopathy were notably higher among those with young-onset type 1 diabetes.

Given the rising incidence of young-onset diabetes in the U.S. (5), our results highlight the need for early and aggressive monitoring and management of diabetes and cardiovascular risk factors.

**Funding.** M.F. was supported by National Heart, Lung, and Blood Insitute grant T32 HL007024. E.S. was supported by National Institute of Diabetes and Digestive and Kidney Diseases grant K24 DK106414.

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

**Author Contributions.** M.F., J.E.-T., and E.S. designed the study. M.F. conducted the statistical analysis and drafted the manuscript. J.E.-T. and E.S. guided the statistical analysis and provided critical revisions to the manuscript. All authors approved the final manuscript. M.F. 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.

## References

1. Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. Lancet Diabetes Endocrinol 2018;6:69–80

2. Dabelea D, Stafford JM, Mayer-Davis EJ, et al.; SEARCH for Diabetes in Youth Research Group. Association of type 1 diabetes vs type 2 diabetes diagnosed during childhood and adolescence with complications during teenage years and young adulthood. JAMA 2017;317:825–835

3. Wong J, Constantino M, Yue DK. Morbidity and mortality in young-onset type 2 diabetes in comparison to type 1 diabetes: where are we now? Curr Diab Rep 2015;15:566–577

4. Bullard KM, Cowie CC, Lessem SE, et al. Prevalence of diagnosed diabetes in adults by diabetes type—United States, 2016. MMWR Morb Mortal Wkly Rep 2018;67:359–361

5. Mayer-Davis EJ, Lawrence JM, Dabelea D, et al.; SEARCH for Diabetes in Youth Study. Incidence trends of type 1 and type 2 diabetes among youths, 2002–2012. N Engl J Med 2017;376:1419–1429