# Clinical and Public Health Implications of 2019 Endocrine Society Guidelines for Diagnosis of Diabetes in Older Adults

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EPIDEMIOLOGY/HEALTH SERVICES RESEARCH

## OBJECTIVE

**Screening for diabetes is typically done using hemoglobin $A_{1c}$ ($HbA_{1c}$) or fasting plasma glucose (FPG). The 2019 Endocrine Society guidelines recommend further testing using an oral glucose tolerance test (OGTT) in older adults with prediabetic $HbA_{1c}$ or FPG. We evaluated the impact of this recommendation on diabetes prevalence, eligibility for glucose-lowering treatment, and estimated cost of implementation in a nationally representative sample.**

## RESEARCH DESIGN AND METHODS

**We included 2,236 adults aged ≥65 years without known diabetes from the 2005–2016 National Health and Nutrition Examination Survey. Diabetes was defined using: *1*) the Endocrine Society approach ($HbA_{1c}$ ≥6.5%, FPG ≥126 mg/dL, or 2-h plasma glucose ≥200 mg/dL among those with $HbA_{1c}$ 5.7–6.4% or FPG 100–125 mg/dL); and *2*) a standard approach ($HbA_{1c}$ ≥6.5% or FPG ≥126 mg/dL). Treatment eligibility was defined using $HbA_{1c}$ cut points (≥7% to ≥9%). OGTT screening costs were estimated using Medicare fee schedules.**

## RESULTS

**Diabetes prevalence was 15.7% (∼5.0 million) using the Endocrine Society's approach and 7.3% (∼2.3 million) using the standard approach. Treatment eligibility ranged from 5.4% to 0.06% and 11.8% to 1.3% for diabetes cases identified through the Endocrine Society or standard approach, respectively. By definition, diabetes identified exclusively through the Endocrine Society approach had $HbA1_{1c}$ <6.5% and would not be recommended for glucose-lowering treatment. Screening all older adults with prediabetic $HbA_{1c}$/FPG (∼18.3 million) with OGTT could cost between $737 million and $1.7 billion.**

## CONCLUSIONS

**Adopting the 2019 Endocrine Society guidelines would substantially increase the number of older adults classified as having diabetes, require significant financial resources, but likely offer limited benefits.**

Age is one of the most important risk factors for type 2 diabetes. The prevalence of type 2 diabetes and prediabetes is highest in older age and the aging of the U.S. population suggests that diabetes will continue to be a major public health challenge in the coming years (1–3). There is growing attention to the unique clinical issues related to screening, diagnosing, and managing diabetes in the older adult population (4).

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**See accompanying article, p. 1373.**

In clinical practice, the usual approach to screening and diagnosis of diabetes in older adults is based on hemoglobin $A_{1c}$ ($HbA_{1c}$) and/or fasting plasma glucose (FPG) testing ("standard diagnostic approach"). In clinical guidelines published in 2019 (5), the Endocrine Society endorsed the standard approach but also recommended administering a 2-h oral glucose tolerance test (OGTT) to adults aged ≥65 years with an $HbA_{1c}$ and/or an FPG in the prediabetes range ("Endocrine Society diagnostic approach"). According to the Endocrine Society, this additional screening using the OGTT is important to avoid underdiagnosis, as "...many [older adults] affected with diabetes...are not diagnosed unless an oral glucose tolerance test is performed" (5).

The population-level impact of the Endocrine Society's approach to diabetes diagnosis is unclear. To this end, we used nationally representative data to compare the percentage of older adults who would be classified as having diabetes based on the Endocrine Society's approach versus the standard diagnostic approach. We also examined the percentage of older adults who would be eligible for glucose-lowering medication based on different recommended $HbA_{1c}$ targets. Finally, we assessed the potential financial cost of administering an OGTT to all eligible older adults in the population per the Endocrine Society's new recommendation.

## RESEARCH DESIGN AND METHODS

### Study Population

The National Health and Nutrition Examination Survey (NHANES) is an ongoing, nationally representative, cross-sectional study designed to assess population health in the U.S. During each survey cycle, a sample of individuals are selected from the U.S. noninstitutionalized, civilian population using a complex, stratified, multistage probability cluster sampling design. Data are collected from participants through in-home interviews and visits to a mobile examination center. More details about the NHANES are available elsewhere (6). Study protocols were approved by the National Center for Health Statistics institutional review board and participants provided written informed consent.

In this study, we pooled data from all NHANES survey cycles for which OGTTs were administered to study participants (2005–2016). We included participants in our analysis if they were aged 65 years or older, had no history of diagnosed diabetes, attended the fasting morning examination, and had data for all three measures of glycemia ($HbA_{1c}$, FPG, and 2-h plasma glucose [2-h PG]) available. These criteria yielded a final analytic sample of 2,236 participants.

### Measurement of Glycemia

$HbA_{1c}$ was measured using high-performance liquid chromatography methods (7). Plasma glucose was measured using the hexokinase method in fasting and 2-h post–75-g glucose load blood samples. To account for changes in laboratory methods over time, we calibrated plasma glucose using regression equations recommended in the National Center for Health Statistics analytic guidelines (8) and calibrated $HbA_{1c}$ using an equipercentile equating approach (9).

### Approaches to Diabetes Diagnosis

We compared two approaches to identifying cases of diabetes in older adults (Fig. 1). The first was a standard approach, which defined diabetes as a single elevated $HbA_{1c}$ (≥6.5% [48 mmol/mol]) or single elevated FPG (≥126 mg/dL). The second was the Endocrine Society's diagnostic approach, which defined diabetes as an $HbA_{1c}$ ≥6.5% (48 mmol/mol), FPG ≥126 mg/dL, or an elevated 2-h PG (≥200 mg/dL) among individuals who had prediabetic $HbA_{1c}$ (5.7–6.4% [39–46 mmol/mol]) or FPG (100–125 mg/dL).

### Sociodemographic and Risk Factor Measures

Computer-assisted interviews were conducted to collect information on participants' age, sex, race/ethnicity, education, household income, family history of diabetes, history of prediabetes, smoking status, and history of cardiovascular disease. Health information was also collected during physical examinations. Obesity was defined as BMI ≥30 kg/m$^2$ (10), abdominal obesity was defined as waist circumference ≥88 cm for women and ≥102 cm for men (11), hypertension was defined as mean blood pressure ≥140/90 mmHg or current use of blood pressure–lowering medication (12), high cholesterol was defined as total cholesterol ≥240 mg/dL or use of cholesterol-lowering medication (13), and microalbuminuria was defined as albumin/creatinine ratio ≥30 mg/g (14).

### Statistical Analyses

We estimated the percentage of older adults in the U.S. that would be classified

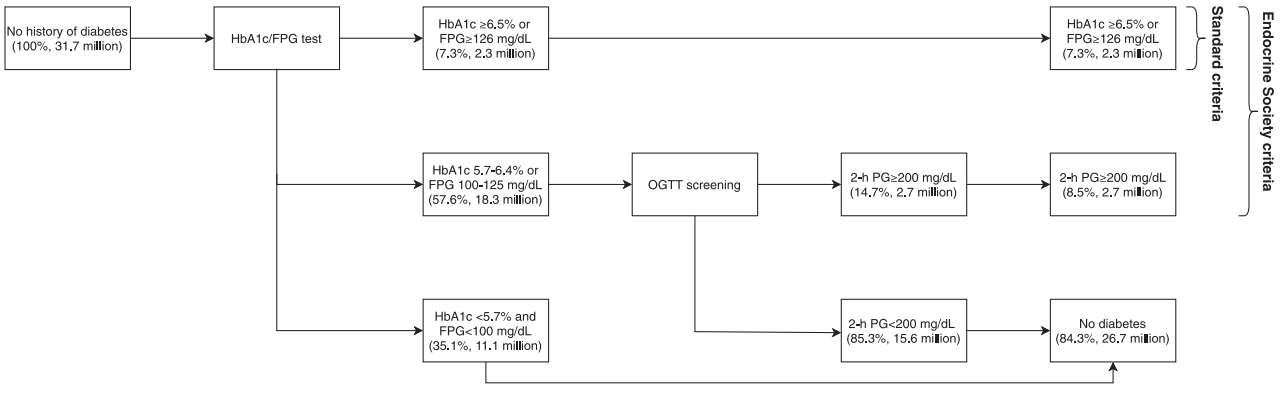


**Figure 1**—Flow chart of diabetes status classification among U.S. adults aged 65 years and older with no prior diagnosis by different diagnostic approaches, NHANES 2005–2016. Participants meeting diabetes by the Endocrine Society criteria had $HbA_{1c}$ ≥6.5% (48 mmol/mol), FPG ≥126 mg/dL, or 2-h PG ≥200 with prediabetic $HbA_{1c}$ or FPG. Participants meeting diabetes by the standard criteria had $HbA_{1c}$ ≥6.5% (48 mmol/mol) or FPG ≥126 mg/dL.

**Table 1—Percentage of U.S. adults aged 65 years and older (95% CI) with no prior diagnosis who would be classified as having diabetes by different diagnostic approaches, NHANES 2005–2016**

| | Endocrine Society approach* | | | Standard approach† | | | Endocrine Society but not standard approach‡ | | |
|---|---|---|---|---|---|---|---|---|---|
| | Percentage | 95% CI | *P* value§ | Percentage | 95% CI | *P* value§ | Percentage | 95% CI | *P* value§ |
| Overall | 15.7 | 13.9–17.7 | | 7.3 | 6.0–8.7 | | 8.5 | 7.1–10.0 | |
| Age (years) | | | | | | | | | |
| 65–74 | 12.8 | 10.8–15.1 | 0.00 | 6.8 | 5.3–8.6 | 0.27 | 6.0 | 4.6–7.8 | 0.00 |
| ≥75 | 20.2 | 17.3–23.5 | | 8.0 | 6.4–10.0 | | 12.2 | 9.9–15.0 | |
| Sex | | | | | | | | | |
| Male | 16.3 | 13.6–19.4 | 0.62 | 8.5 | 6.8–10.5 | 0.12 | 7.8 | 5.8–10.3 | 0.38 |
| Female | 15.3 | 13.0–18.0 | | 6.3 | 4.7–8.5 | | 9.0 | 7.4–10.8 | |
| Race/ethnicity | | | | | | | | | |
| Non-Hispanic white | 15.6 | 13.4–18.0 | 0.21 | 7.1 | 5.7–8.8 | 0.34 | 8.5 | 6.8–10.5 | 0.38 |
| Mexican-American | 21.8 | 16.0–28.8 | | 9.5 | 5.5–15.8 | | 12.3 | 8.3–17.9 | |
| Non-Hispanic black | 16.8 | 12.6–22.0 | | 9.0 | 6.1–13.2 | | 7.7 | 4.7–12.5 | |
| Educational level | | | | | | | | | |
| Beyond high school | 12.5 | 10.2–15.2 | 0.00 | 6.0 | 4.4–8.1 | 0.04 | 6.5 | 5.0–8.3 | 0.01 |
| High school or lower | 19.5 | 16.6–22.7 | | 8.8 | 7.0–10.9 | | 10.7 | 8.4–13.5 | |
| Poverty/income ratio <130% | | | | | | | | | |
| No | 14.5 | 12.3–16.9 | 0.00 | 6.7 | 5.2–8.5 | 0.04 | 7.8 | 6.2–9.7 | 0.01 |
| Yes | 23.5 | 19.0–28.5 | | 10.5 | 7.5–14.4 | | 13.0 | 9.3–17.9 | |
| Family history of diabetes | | | | | | | | | |
| No | 15.0 | 12.9–17.4 | 0.01 | 6.5 | 5.0–8.4 | 0.04 | 8.5 | 6.9–10.3 | 0.36 |
| Yes | 19.9 | 16.4–23.9 | | 9.9 | 7.2–13.6 | | 9.9 | 7.3–13.5 | |
| Prior history of prediabetes | | | | | | | | | |
| No | 12.8 | 11.0–14.8 | 0.00 | 5.3 | 4.2–6.6 | 0.00 | 7.5 | 6.1–9.2 | 0.05 |
| Yes | 31.2 | 23.4–40.2 | | 18.8 | 12.7–26.9 | | 12.4 | 7.7–19.3 | |
| Smoking | | | | | | | | | |
| Never smoker | 15.0 | 12.7–17.7 | 0.57 | 6.7 | 5.0–8.8 | 0.61 | 8.3 | 6.5–10.6 | 0.77 |
| Former smoker | 16.0 | 13.1–19.5 | | 7.8 | 6.0–10.1 | | 8.3 | 6.2–10.9 | |
| Current smoker | 18.2 | 13.4–24.3 | | 8.2 | 5.0–12.9 | | 10.0 | 6.3–15.6 | |
| Obese | | | | | | | | | |
| No | 12.3 | 10.3–14.6 | 0.00 | 4.5 | 3.6–5.6 | 0.00 | 7.8 | 6.2–9.9 | 0.22 |
| Yes | 23.3 | 19.4–27.8 | | 13.4 | 10.3–17.2 | | 10.0 | 7.5–13.1 | |
| Abdominal obesity | | | | | | | | | |
| No | 9.6 | 7.6–12.2 | 0.00 | 3.7 | 2.7–5.2 | 0.00 | 5.9 | 4.3–8.1 | 0.00 |
| Yes | 18.5 | 16.1–21.1 | | 8.5 | 6.8–10.7 | | 9.9 | 8.1–12.0 | |
| Hypertension | | | | | | | | | |
| No | 9.2 | 7.1–11.9 | 0.00 | 4.5 | 3.0–6.6 | 0.00 | 4.7 | 3.3–6.8 | 0.00 |
| Yes | 19.2 | 16.9–21.7 | | 8.5 | 7.1–10.3 | | 10.7 | 8.9–12.7 | |
| High cholesterol | | | | | | | | | |
| No | 14.5 | 12.0–17.3 | 0.13 | 7.5 | 5.9–9.5 | 0.64 | 6.9 | 5.4–8.9 | 0.02 |
| Yes | 17.1 | 14.8–19.6 | | 7.0 | 5.5–8.9 | | 10.1 | 8.0–12.5 | |
| History of CVD | | | | | | | | | |
| No | 14.7 | 12.7–16.8 | 0.03 | 6.8 | 5.5–8.3 | 0.17 | 7.9 | 6.5–9.6 | 0.11 |
| Yes | 19.1 | 15.5–23.3 | | 8.8 | 6.3–12.3 | | 10.2 | 7.7–13.5 | |
| Microalbuminuria | | | | | | | | | |
| No | 14.0 | 11.9–16.3 | 0.00 | 6.6 | 5.2–8.3 | 0.05 | 7.4 | 5.9–9.2 | 0.00 |
| Yes | 24.1 | 19.7–29.0 | | 10.3 | 7.4–14.1 | | 13.8 | 10.5–17.9 | |

CVD, cardiovascular disease. *Participants meeting diabetes by the Endocrine Society approach had $HbA_{1c}$ ≥6.5% (48 mmol/mol), FPG ≥126 mg/dL, or 2-h PG ≥200 mg/dL with prediabetic $HbA_{1c}$ or FPG. †Participants meeting diabetes by the standard approach had $HbA_{1c}$ ≥6.5% (48 mmol/mol) or FPG ≥126 mg/dL. ‡Participants meeting diabetes by only the Endocrine Society approach had 2-h PG ≥200 mg/dL with prediabetic $HbA_{1c}$ or FPG. §*P* values are from $\chi^2$ tests.

as having diabetes according to the standard approach and the Endocrine Society's diagnostic approach. We also estimated the percentage of the population that would be defined as "new" cases of diabetes identified exclusively through the additional OGTT screening recommended in the Endocrine Society guidelines. We computed these percentages in the overall population and across categories of participant characteristics. We used $\chi^2$ tests to assess differences in prevalence across participant characteristics for each definition of diabetes.

Among adults classified as having diabetes, we determined the percentage that would be eligible for glucose-lowering medication based on their $HbA_{1c}$. Major guidelines recommend different $HbA_{1c}$ treatment targets in specific subpopulations (15,16), including older adults for

**Table 2—Percentage of the population (95% CI) eligible for glucose-lowering medication treatment according to different $HbA_{1c}$ thresholds among persons meeting the 2019 Endocrine Society definition of diabetes for older adults and standard diagnostic criteria for diabetes, U.S. adults aged 65 years and older with no prior diagnosis of diabetes, NHANES 2005–2016**

| | Diabetes by Endocrine Society criteria ($n$ = 398)* | | Diabetes by standard criteria ($n$ = 188)† | |
|---|---|---|---|---|
| Treatment threshold | Percentage | 95% CI | Percentage | 95% CI |
| $HbA_{1c}$ ≥7.0% | 5.4 | 2.5–8.4 | 11.8 | 5.5–18.0 |
| $HbA_{1c}$ ≥7.5% | 3.3 | 0.9–5.7 | 7.1 | 2.0–12.3 |
| $HbA_{1c}$ ≥8.0% | 2.0 | 0.0–4.0 | 4.4 | −0.0 to 8.8 |
| $HbA_{1c}$ ≥8.5% | 1.6 | −0.3 to 3.5 | 3.4 | −0.7 to 7.6 |
| $HbA_{1c}$ ≥9.0% | 0.6 | −0.0 to 1.3 | 1.3 | −0.1 to 2.8 |

*Participants meeting diabetes by the Endocrine Society criteria had $HbA_{1c}$ ≥6.5% (48 mmol/mol), FPG ≥126 mg/dL, or 2-h PG ≥200 mg/dL with prediabetic $HbA_{1c}$ or FPG. †Participants meeting diabetes by the standard criteria had $HbA_{1c}$ ≥6.5% (48 mmol/mol) or FPG ≥126 mg/dL.

whom the targets range from <7.0 to <9.0% (53–75 mmol/mol). For instance, the Endocrine Society suggests a glycemic target between 7.5% and 8.5%, depending on patients' health status (5). Given this variability, we examined five different $HbA_{1c}$ thresholds: ≥7.0%, ≥7.5%, ≥8.0%, ≥8.5%, and ≥9.0% (≥53, ≥58, ≥64, ≥69, and ≥75 mmol/mol, respectively).

We estimated the potential additional financial cost associated with using OGTT to screen for undiagnosed diabetes among older adults with prediabetic levels of $HbA_{1c}$ or FPG. Adopting a health system perspective, we only considered the direct medical cost of an OGTT. We evaluated expenses for physician visits and laboratory tests, as these two make up the bulk of medical costs for OGTT screenings. We determined costs using Medicare fee schedules (17,18). We assumed that OGTT screenings would be performed as part of a general office visit for established patients and used the corresponding reimbursement rate for this service. However, because similar visits can be billed in different ways (19–21), we evaluated scenarios using a low, medium, and high office visit billing code (Current Procedural Terminology codes 99212, 99213, and 99214, respectively). All costs were expressed in 2019 U.S. dollars.

Analyses were conducted using Stata 15.0 (StataCorp) and used the OGTT sample weights, making the results in this study representative of the civilian, noninstitutionalized U.S. population aged 65 years or older. A two-sided $P$ value <0.05 was considered statistically significant.

## RESULTS

Among older adults in the U.S. with no prior diagnosis of diabetes, 15.7% (~5.0 million) would be classified as having diabetes based on the Endocrine Society's diagnostic approach, compared with 7.3% (~2.3 million) based on the standard approach (Table 1 and Fig. 1). The Endocrine Society recommendation to use OGTT screening in older adults with prediabetes thus resulted in an additional 8.5% (~2.7 million) of individuals being classified as having diabetes; these new cases were more common among those who were aged 75 and older, less educated, and lower income.

Among older adults who met criteria for diabetes based on the Endocrine Society's approach, between 0.06% (~0.03 million) and 5.4% (~0.27 million) could be considered for glucose-lowering treatment, depending on the $HbA_{1c}$ threshold used to define eligibility (Table 2). In contrast, between 1.3% (~0.03 million) and 11.8% (~0.27 million) of those who met the standard criteria for diabetes would be eligible for glucose-lowering medication treatment based on differing levels of $HbA_{1c}$. By definition, older adults who met the Endocrine Society criteria but not the standard definition of diabetes had prediabetic levels of $HbA_{1c}$ (5.7–6.4% [39–46 mmol/mol]), making them ineligible for glucose-lowering treatment at all thresholds, as pharmacologic treatment for diabetes is not recommended in older adults with $HbA_{1c}$ <7% (<53 mmol/mol).

An estimated 57.6% (~18.3 million) of older adults in the U.S. had prediabetic $HbA_{1c}$ or FPG and would be recommended for OGTT screening under the Endocrine Society's guidelines (Table 3 and Fig. 1). Testing all these individuals was estimated to cost between $737 million and $1.73 billion in 2019 U.S. dollars.

## CONCLUSIONS

Recent guidelines issued by the Endocrine Society recommend administering an OGTT in all older adults with prediabetic $HbA_{1c}$ or FPG to identify additional cases of diabetes (2-h PG ≥200 mg/dL). Our analysis of data from NHANES showed that adopting this practice would more than double the number of older adults classified as having diabetes, from ~2.3 to ~5.0 million. However, these new cases would be ineligible for glucose-lowering medication under current guidelines. Indeed, the lowest agreed-upon $HbA_{1c}$ treatment target for older adults in current diabetes guidelines is 7.0% (53 mmol/mol)

**Table 3—Projected medical cost of recommended OGTT screenings in U.S. adults aged 65 years and older with no prior diagnosis of diabetes, 2019 dollars**

| Type of billing code used for visit | Cost of office visit | Cost of laboratory test | Total cost per OGTT | Total number eligible | Projected medical cost |
|---|---|---|---|---|---|
| Low | $25.95 | $14.30 | $40.25 | ~18.3 million | ~$737 million |
| Medium | $51.90 | $14.30 | $66.29 | ~18.3 million | ~$1.21 billion |
| High | $80.01 | $14.30 | $94.31 | ~18.3 million | ~$1.73 billion |

Projections assume that 2019 Endocrine Society guidelines recommendations are fully implemented (i.e., all older adults with prediabetic $HbA_{1c}$ or FPG are screened with an OGTT). The costs of low-, medium-, and high-cost visits are based on Current Procedural Terminology codes 99212, 99213, and 99214, respectively, and come from the 2019 Medicare physician fee schedule. Costs for an OGTT come from the 2019 Medicare clinical laboratory fee schedule.

(15). The individuals recommended for OGTT screening in the Endocrine Society guidelines would already be eligible for evidence-based lifestyle modification (22) on the basis of their prediabetic $HbA_{1c}$ and/or FPG (i.e., regardless of their 2-h PG value) (5,23). Our results suggest that the recommendation to screen prediabetic older adults with an OGTT may offer little, if any, direct benefit.

On the other hand, there are plausible ways in which the OGTT recommendation may unintentionally harm older adults. First, it risks subjecting the 18.3 million older adults in the U.S. with prediabetic $HbA_{1c}$ or FPG to the burdensome process of fasting and receiving a 2-h glucose challenge test. OGTT testing may be especially onerous in older adults, given the high burden of comorbidities and frailty in this population (24,25). Second, our analysis found that screening eligible older adults with an OGTT could cost between $737 million and $1.73 billion. These estimates assume 100% screening implementation but nonetheless suggest that this approach (even if not fully adopted) would divert health care and financial resources away from strategies that may more effectively identify and treat high-risk patients. Third, expanding the definition of diabetes to individuals who are not eligible for pharmacological treatment may unnecessarily expose older adults to psychological and social distress that can accompany a diagnosis of diabetes (26). This is a particular concern for vulnerable populations such as those from low socioeconomic backgrounds (26), who were disproportionately identified has having diabetes through OGTT testing in this study.

There is little evidence directly supporting the proposed OGTT screening strategy. The individuals identified by the application of OGTT as recommended by the Endocrine Society will have diabetes identified by 2-h PG criteria only. The prognosis associated with diabetes defined solely by 2-h PG is poorly characterized among older adults and has not been assessed in the context of using $HbA_{1c}$ as a diagnostic test for diabetes (27–33). Moreover, the clinical value of treating older adults with an isolated elevation in 2-h PG is unclear, as clinical trials of diabetes treatment have not specifically included older individuals based on OGTT criteria. The cost effectiveness of early detection and treatment of diabetes using OGTT among older adults is also uncertain. For example, the simulation study cited by the Endocrine Society guidelines to support aggressive diabetes detection among older individuals included only middle-aged adults (34). The paucity of evidence raises further questions around whether a broad OGTT screening strategy is warranted for older adults.

The findings from this study must be considered in light of several limitations. First, our definitions of diabetes were based on single elevated test results of $HbA_{1c}$, FPG, or 2-h PG. In practice, diagnosis of diabetes would be confirmed with a second test (35,36). Moreover, while older adults with known diabetes were excluded, this information was self-reported. Second, our cost analysis involved several simplifying assumptions, including only focusing on two types of medical costs. However, the goal in this study was not to determine precisely the exact cost of OGTT screenings, but rather to provide a general idea of potential financial implications. Third, prevalence estimates for certain subgroups with limited sample size were imprecise and should be interpreted with caution.

Our study had several strengths. The NHANES is the only nationally representative sample of older adults in the U.S. with measures of $HbA_{1c}$, FPG, and 2-h PG. All measurements in this study were obtained in a rigorous and standardized fashion by trained personnel.

In conclusion, implementing additional OGTT screenings in older adults with prediabetes as recommended by the Endocrine Society's guidelines would substantially increase the number of older adults in the U.S. classified as having diabetes. At the same time, the 2-h glucose test would offer limited information related to medication eligibility, as newly identified cases would, by definition, have $HbA_{1c}$ levels below targets for pharmacotherapy. Moreover, administering the OGTT on a broad scale would be expensive and burdensome, particularly for older adults. Based on these findings, we caution that OGTT may not be a useful screening test in the general population of older adults who have $HbA_{1c}$ and FPG levels below current thresholds for the diagnosis of diabetes.

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## References

1. Boyle JP, Thompson TJ, Gregg EW, Barker LE, Williamson DF. Projection of the year 2050 burden of diabetes in the US adult population: dynamic modeling of incidence, mortality, and prediabetes prevalence. Popul Health Metr 2010;8:29

2. Caspersen CJ, Thomas GD, Boseman LA, Beckles GL, Albright AL. Aging, diabetes, and the public health system in the United States. Am J Public Health 2012;102:1482–1497

3. Menke A, Casagrande S, Geiss L, Cowie CC. Prevalence of and trends in diabetes among adults in the United States, 1988-2012. JAMA 2015;314:1021–1029

4. American Diabetes Association. 12. Older adults: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S139–S147

5. LeRoith D, Biessels GJ, Braithwaite SS, et al. Treatment of diabetes in older adults: an Endocrine Society* clinical practice guideline. J Clin Endocrinol Metab 2019;104:1520–1574

6. Johnson CL, Paulose-Ram R, Ogden CL, et al. National Health and Nutrition Examination Survey: analytic guidelines, 1999-2010. Vital Health Stat 2 2013:1–24

7. Centers for Disease Control and Prevention. Laboratory Procedure Manual, Glycohemoglobin, NHANES 2015-2016 [Internet], 2016. Available from https://wwwn.cdc.gov/nchs/data/nhanes/2015-2016/labmethods/GHB_I_MET.pdf. Accessed 1 August 2019

8. Centers for Disease Control and Prevention. National Health and Nutrition Examination Survey 2015-2016, Plasma Fasting Glucose [Internet], 2016. Available from https://wwwn.cdc.gov/nchs/nhanes/2015-2016/GLU_I.htm. Accessed 1 August 2019

9. Selvin E, Parrinello CM, Sacks DB, Coresh J. Trends in prevalence and control of diabetes in the United States, 1988-1994 and 1999-2010. Ann Intern Med 2014;160:517–525

10. National Institutes of Health. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults–the evidence report [published correction appears in Obes Res 1998;6:464]. Obes Res 1998;6(Suppl. 2):51S–209S

11. Grundy SM, Cleeman JI, Daniels SR, et al.; American Heart Association; National Heart, Lung, and Blood Institute. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. Circulation 2005;112:2735–2752

12. Chobanian AV, Bakris GL, Black HR, et al.; National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection,

Evaluation, and Treatment of High Blood Pressure; National High Blood Pressure Education Program Coordinating Committee. The seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: the JNC 7 report. JAMA 2003;289:2560–2572
13. National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002;106:3143–3421
14. Levin A, Stevens PE, Bilous RW, et al.; Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. Kidney Int Suppl 2013;3:1–150
15. Pilla SJ, Schoenborn NL, Maruthur NM, Huang ES. Approaches to risk assessment among older patients with diabetes. Curr Diab Rep 2019; 19:59
16. Garber AJ, Abrahamson MJ, Barzilay JI, et al. Consensus statement by the American Association of Clinical Endocrinologists and American College of Endocrinology on the comprehensive type 2 diabetes management algorithm—2019 executive summary [published correction appears in Endocr Pract 2019;25:204]. Endocr Pract 2019;25:69–100
17. Centers for Medicare & Medicaid Services. Physician Fee Schedule, 2019 [Internet], 2019. Available from https://www.cms.gov/apps/physician-fee-schedule/search/search-results.aspx?Y=0&T=0&HT=0&CT=3&H1=99214&M=5. Accessed 1 August 2019
18. Centers for Medicare & Medicaid Services. Medicare - Clinical Labatory Fee Schedule [Internet], 2019. Available from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ClinicalLabFeeSched/Clinical-Laboratory-Fee-Schedule-Files-Items/19CLABQ4. Accessed 1 August 2019
19. King MS, Sharp L, Lipsky MS. Accuracy of CPT evaluation and management coding by family physicians. J Am Board Fam Pract 2001;14:184–192
20. King MS, Lipsky MS, Sharp L. Expert agreement in Current Procedural Terminology evaluation and management coding. Arch Intern Med 2002;162:316–320
21. Zuber TJ, Rhody CE, Muday TA, et al.; Health Care Financing Administration. Variability in code selection using the 1995 and 1998 HCFA documentation guidelines for office services. J Fam Pract 2000;49:642–645
22. Knowler WC, Barrett-Connor E, Fowler SE, et al.; Diabetes Prevention Program Research Group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403
23. American Diabetes Association. 3. Prevention or delay of type 2 diabetes: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S29–S33
24. Bandeen-Roche K, Seplaki CL, Huang J, et al. Frailty in older adults: a nationally representative profile in the United States. J Gerontol A Biol Sci Med Sci 2015;70:1427–1434
25. Salive ME. Multimorbidity in older adults. Epidemiol Rev 2013;35:75–83
26. Helgeson VS, Zajdel M. Adjusting to chronic health conditions. Annu Rev Psychol 2017;68: 545–571
27. Shaw JE, Hodge AM, de Courten M, Chitson P, Zimmet PZ. Isolated post-challenge hyperglycaemia confirmed as a risk factor for mortality. Diabetologia 1999;42:1050–1054
28. Qiao Q, Tuomilehto J, Borch-Johnsen K. Post-challenge hyperglycaemia is associated with premature death and macrovascular complications. Diabetologia 2003;46(Suppl. 1):M17–M21
29. Borch-Johnsen K, Neil A, Balkau B, et al.; DECODE Study Group, the European Diabetes Epidemiology Group. Glucose tolerance and cardiovascular mortality: comparison of fasting and 2-hour diagnostic criteria. Arch Intern Med 2001;161:397–405
30. Barrett-Connor E, Ferrara A. Isolated post-challenge hyperglycemia and the risk of fatal cardiovascular disease in older women and men. The Rancho Bernardo Study. Diabetes Care 1998; 21:1236–1239
31. Meigs JB, Nathan DM, D'Agostino RB Sr., Wilson PW; Framingham Offspring Study. Fasting and postchallenge glycemia and cardiovascular disease risk: the Framingham Offspring Study. Diabetes Care 2002;25:1845–1850
32. Smith NL, Barzilay JI, Shaffer D, et al. Fasting and 2-hour postchallenge serum glucose measures and risk of incident cardiovascular events in the elderly: the Cardiovascular Health Study. Arch Intern Med 2002;162:209–216
33. Cederberg H, Saukkonen T, Laakso M, et al. Postchallenge glucose, A1C, and fasting glucose as predictors of type 2 diabetes and cardiovascular disease: a 10-year prospective cohort study. Diabetes Care 2010;33:2077–2083
34. Herman WH, Ye W, Griffin SJ, et al. Early detection and treatment of type 2 diabetes reduce cardiovascular morbidity and mortality: a simulation of the results of the Anglo-Danish-Dutch Study of Intensive Treatment in People With Screen-Detected Diabetes in Primary Care (ADDITION-Europe). Diabetes Care 2015;38:1449–1455
35. Selvin E, Wang D, Matsushita K, Grams ME, Coresh J. Prognostic implications of single-sample confirmatory testing for undiagnosed diabetes: a prospective cohort study. Ann Intern Med 2018;169:156–164
36. American Diabetes Association. 2. Classification and diagnosis of diabetes: *Standards of Medical Care in Diabetes—2019*. Diabetes Care 2019;42(Suppl. 1):S13–S28