

Prevalence of Chronic Kidney Disease Associated With Type 1 Diabetes in the US

Peter Rossing,¹ Per-Henrik Groop,^{2,3} Rakesh Singh,⁴ Robert Lawatscheck,⁵ Katherine Tuttle⁶

¹Steno Diabetes Center Copenhagen, Herlev, Denmark; ²University of Helsinki and Helsinki University Central Hospital, Helsinki, Finland; ³Folkhälsan Research Center, Helsinki, Finland; ⁴Bayer Healthcare, Whippany, NJ, USA; ⁵Clinical Research Cardiorenal, Bayer AG, Berlin, Germany; ⁶Providence Inland Northwest Health, University of Washington, Spokane, WA, USA

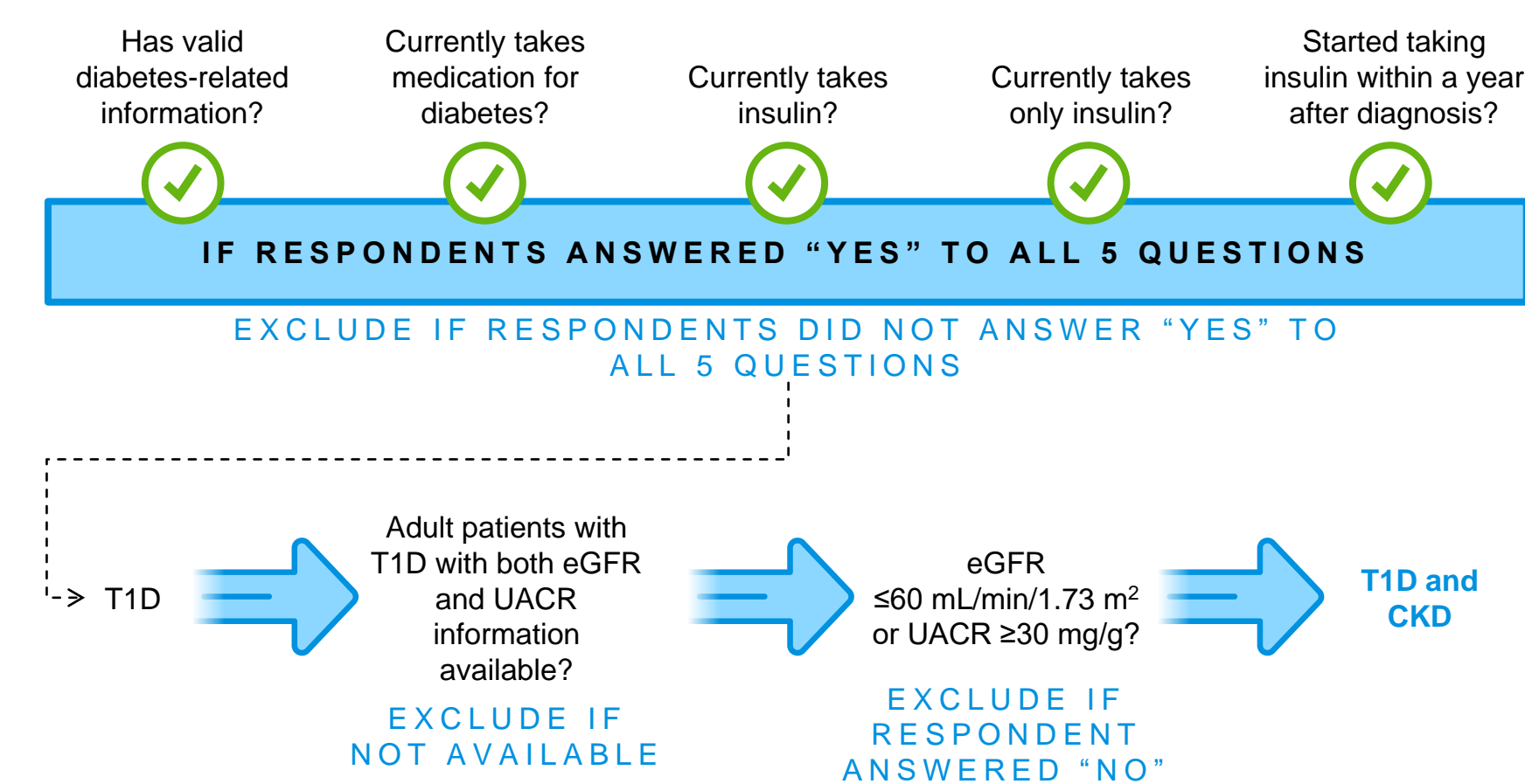
Background

- Chronic kidney disease (CKD) is proposed to affect up to 40% of people with type 1 diabetes (T1D) and is associated with an increased risk of kidney failure, cardiovascular events, and mortality¹⁻³
 - However, direct estimates for prevalence of CKD in T1D are not available
- The National Health and Nutrition Examination Survey (NHANES) is a program of studies, which combine interviews and physical examinations to assess the health and nutritional status of people in the US⁴
- The aim of this study was to directly estimate the prevalence of CKD in people with T1D in the US from 2015 to 2018 using NHANES data

Methods

- As NHANES does not collect data on the specific subtypes of diabetes, adults with T1D and CKD were identified using a modified version of a published algorithm⁵ (Figure 1)
- T1D was defined as:
 - Beginning insulin treatment within the first year after diagnosis of diabetes and
 - Insulin being the only anti-hyperglycemic drug used
- There was no age limit for the onset of diabetes
- CKD was identified in respondents with T1D by single measurements of:
 - Estimated glomerular filtration rate (eGFR) ≤ 60 mL/min/1.73 m² or
 - Urinary albumin-to-creatinine ratio (UACR) ≥ 30 mg/g

Figure 1. Algorithm used to identify adult respondents^a with T1D and CKD in NHANES⁵



^aAs part of the inclusion criteria all respondents had to be ≥ 18 years old at the time of the interview. CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; NHANES, National Health and Nutrition Examination Survey; T1D, type 1 diabetes; UACR, urinary albumin-to-creatinine ratio.

- The NHANES data were used to create corresponding weighted variables to represent the US population
- Demographic characteristics of the unweighted and weighted populations are presented using descriptive statistics

Results

- During 2015–2018, 1,647 of 19,225 adults surveyed in NHANES had diabetes. According to the algorithm, 54 of these respondents were identified as having T1D (Table 1)
- The weighted overall number of adults with T1D in the US was estimated at 1,202,739 (95% CI: 681,820–1,723,657)
- CKD was identified in 20 out of 47 people with T1D with evaluable eGFR and UACR (Table 1), corresponding to an unweighted estimate of 43%
- The weighted overall number of adults with T1D and CKD with evaluable eGFR and UACR was 258,196 (95% CI: 71,189–445,203)
- CKD status was uncertain in 7 respondents with T1D as their eGFR and/or UACR measurements were not available (Table 1)
- In the CKD and T1D population, 59% were male (Table 2)
- Non-Hispanic White (60%) accounted for the highest proportion of patients with CKD and T1D followed by non-Hispanic Black (18%)
 - Ethnicity was self-identified by respondents
- The median age of respondents at interview was 65 years
 - As part of the inclusion criteria all respondents had to be ≥ 18 years old at the time of the interview
- Mean eGFR (standard deviation) was 57 (4) mL/min/1.73 m² and median UACR (interquartile range) was 89 (8–875) mg/g (weighted characteristics; Table 2)

Table 1. Identification of respondents with CKD and T1D

	Excluded, n	Unweighted respondents, n	Weighted respondents, n (95% CI)
Total NHANES population (2015–2018)	–	19,225	–
Total respondents aged ≥ 18 years at interview	7,957	11,268	243,784,023 (228,265,774–259,302,272)
T1D identification			
Adults with diagnosed diabetes	9,621	1,647	–
Has valid diabetes-related information ^a	47	1,600	–
Currently takes medication for diabetes	278	1,369	–
Currently takes insulin	1,173	474	–
Currently takes only insulin	1,451	196	–
Started taking insulin within a year after diagnosis	1,560	87	–
Adult respondents with T1D	1,593	54	1,281,913 (758,202–1,805,624)
CKD identification among adult respondents with T1D			
Adult patients with T1D with both eGFR and UACR information available	7	47	1,202,739 (681,820–1,723,657)
Adult patients with T1D and CKD ^b	34	20	258,196 (71,189–445,203)

^aDiabetes-related information was determined using NHANES questions (Q10 – Other than during pregnancy, have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes? Q40 – How old were you when a doctor or other health professional first told you that you had diabetes or sugar diabetes? Q50 – Are you now taking insulin? Q60 – For how long have you been taking insulin? Q70 – Are you now taking diabetic pills to lower your blood sugar? These are sometimes called oral agents or oral hypoglycemic agents?).

^bIncludes patients with laboratory data for eGFR and UACR. Patients were required to meet the CKD definition based on the eGFR definition (eGFR ≤ 60 mL/min/1.73 m²) or UACR definition (UACR ≥ 30 mg/g). CI, confidence interval; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; NHANES, National Health and Nutrition Examination Survey; Q, question; T1D, type 1 diabetes; UACR, urinary albumin-to-creatinine ratio.

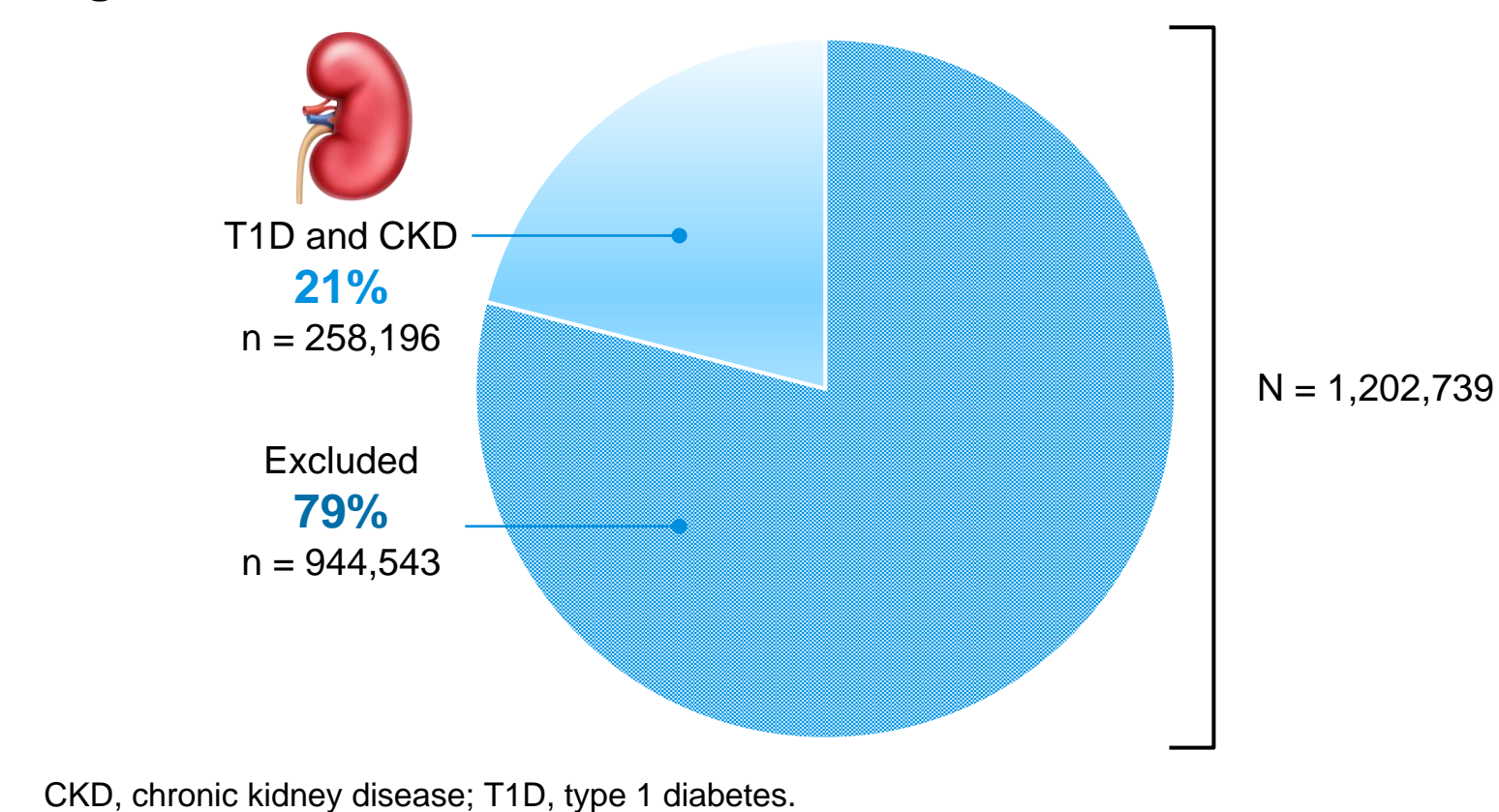
Table 2. Weighted baseline variables of respondents with CKD and T1D

Variable	N = 258,196
Age at interview, ^a median (IQR), years	65 (63–76)
Male, n (%)	152,061 (59)
Ethnicity, ^{b,c} n (%)	
Non-Hispanic White	155,929 (60)
Non-Hispanic Black	47,303 (18)
Mexican American	4,380 (2)
Other Hispanic	18,277 (7)
Other ethnicity	32,306 (13)
eGFR, ^d mean (SD), mL/min/1.73 m ²	57 (4)
UACR, median (IQR), mg/g	89 (8–875)

^aAs part of the inclusion criteria all respondents had to be ≥ 18 years old at the time of the interview. ^bEthnicity was self-identified. ^cNon-Hispanic Black was oversampled. However, applying weights adjusted the distribution to reflect that of the US population. ^dFor age, eGFR, and UACR, the weighted sample assumes the same value as the unweighted sample. CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; IQR, interquartile range; SD, standard deviation; T1D, type 1 diabetes; UACR, urine albumin-to-creatinine ratio.

- Since the weighted overall number of adults with T1D in the US was estimated at 1,202,739, the corresponding number with T1D and CKD with evaluable eGFR and UACR was 258,196, corresponding to a weighted estimate of 21% (Figure 2)

Figure 2. Prevalence of T1D and CKD in the US



Conclusions

- CKD was common in people with T1D and evaluable eGFR and UACR based on recent US data
- There was a high proportion of non-Hispanic Black participants with CKD and T1D
 - These results are consistent with observations that African Caribbean ethnicity was associated with higher risk of kidney function loss in people with T1D⁶
- This analysis excluded patients < 18 years
 - Resultantly, the incidence of CKD in T1D is underestimated in this analysis
- CKD status could not be determined in 7 out of 54 participants with T1D in the unweighted dataset, due to missing eGFR and/or UACR values
- Therefore, these prevalence estimates should be interpreted cautiously and validated in other dedicated cohort studies

Acknowledgments

We thank Ryan Fiano and Augustina Ogbonnaya from AmerisourceBergen for the statistical analysis of the data; this assistance was funded by Bayer AG. Medical writing support was provided by Charlotte Simpson, PhD, and editorial support was provided by Melissa Ward, BA, both of Scion, London, UK, supported by Bayer AG according to Good Publication Practice guidelines (Link).

Funding

This work was supported by Bayer AG.

Disclosures

PR has received institutional grants from Bayer, Novo Nordisk, and AstraZeneca; and has acted as consultant for Novo Nordisk, Bayer, Astellas, Boehringer Ingelheim, AstraZeneca, Gilead, Merck, Mundipharma, and Sanofi (honoraria to institution). PHG has received lecture honoraria from Astellas, AstraZeneca, Bayer, Boehringer Ingelheim, Eli Lilly, Elo Water, Genzyme, Medscape, MSD, Mundipharma, Novartis, Novo Nordisk, PeerVoice, Sanofi, and Sciaric; and is an advisory board member for AbbVie, Astellas, AstraZeneca, Bayer, Boehringer Ingelheim, Eli Lilly, Medscape, MSD, Mundipharma, Novartis, Novo Nordisk, and Sanofi. RL is an employee of Bayer AG. KT has received fees from Eli Lilly, Boehringer Ingelheim, Gilead, AstraZeneca, Goldfinch Bio, Novo Nordisk, Bayer, and Travers for research and other support regarding diabetes and CKD.

References

- Mora-Fernández C, et al. *J Physiol*. 2014;592:3997–4012.
- Bakris GL, Molitch M. *Diabetes Care*. 2018;41:389–390.
- Cressman M, et al. *Diabetes*. 2018;67(Suppl_1):544-P.
- Centers for Disease Control and Prevention. About the National Health and Nutrition Examination Survey. Available from https://www.cdc.gov/nchs/nhanes/about_nhanes.htm. Accessed March 20, 2023.
- Mosslimi M, et al. *Cardiovasc Endocrinol Metab*. 2020;9:9–16.
- Mangelis A, et al. *Diabetes Care*. 2022;45:2095–2102.