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Diabetes and CKD in the United States  
Population, 2009–2014

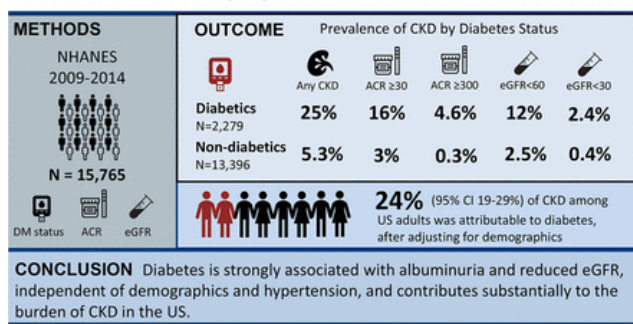
Leila R. Zelnick\*, Noel S. Weiss<sup>†</sup>, Bryan R. Kestenbaum\*,<sup>†</sup>,  
Cassianne Robinson-Cohen\*,<sup>†</sup>, Patrick J. Heagerty<sup>†</sup>,  
Katherine Tuttle\*,<sup>§,||</sup>, Yoshio N. Hall<sup>†</sup>, Irl B. Hirsch\*, Ian H. de Boer\*,<sup>†</sup>

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## Visual Overview

Diabetes and Chronic Kidney Disease in  
the US population, 2009-2014

Leila Zelnick, Noel Weiss, Bryan Kestenbaum, Cassianne Robinson-Cohen, Patrick Heagerty, Katherine Tuttle, Yoshio Hall, Irl Hirsch, and Ian de Boer. Diabetes and chronic kidney disease in the US population, 2009-2014. CJASN. doi: 10.2215/CJN.03700417.

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## Abstract

**Background and objectives** Diabetes is an important cause of CKD. However, among people with diabetes, it is unclear to what extent CKD is attributable to diabetes itself versus comorbid conditions, such as advanced age and hypertension. We examined associations of diabetes with clinical manifestations of CKD independent of age and BP and the extent to which diabetes contributes to the overall prevalence of CKD in the United States.

**Design, setting, participants, & measurements** We performed a cross-sectional study of 15,675 participants in the National Health and Nutrition Examination Surveys from 2009 to 2014. Diabetes was defined by use of glucose-lowering medications or hemoglobin A<sub>1c</sub> ≥6.5%. eGFR was calculated using the CKD Epidemiology Collaboration formula, and albumin-to-creatinine ratio was measured in single-void urine samples. We calculated the prevalence of CKD manifestations by diabetes status as well as prevalence ratios, differences in prevalence, and prevalence attributable to diabetes using binomial and linear regression, incorporating data from repeat eGFR and urine albumin-to-creatinine ratio measurements to estimate persistent disease.

**Results** For participants with diabetes ( $n=2279$ ) versus those without diabetes ( $n=13,396$ ), the estimated prevalence of any CKD (eGFR <60 ml/min per 1.73 m<sup>2</sup>; albumin-to-creatinine ratio ≥30 mg/g, or both) was 25% versus 5.3%, respectively; albumin-to-creatinine ratio ≥30 mg/g was 16% versus 3.0%, respectively; albumin-to-creatinine ratio ≥300 mg/g was 4.6% versus 0.3%, respectively; eGFR <60 ml/min per 1.73 m<sup>2</sup> was 12% versus 2.5%, respectively; and eGFR <30 ml/min per 1.73 m<sup>2</sup> was 2.4% versus 0.4%, respectively (each

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$P < 0.001$ ). Adjusting for demographics and several aspects of BP, prevalence differences were 14.6% ( $P < 0.001$ ), 10.8% ( $P < 0.001$ ), 4.5% ( $P < 0.001$ ), 6.5% ( $P < 0.001$ ), and 1.8% ( $P = 0.004$ ), respectively. Approximately 24% (95% confidence interval, 19% to 29%) of CKD among all United States adults was attributable to diabetes after adjusting for demographics.

**Conclusions** Diabetes is strongly associated with both albuminuria and reduced GFR independent of demographics and hypertension, contributing substantially to the burden of CKD in the United States.

diabetes   diabetic nephropathy   chronic kidney disease  
Epidemiology and outcomes   albuminuria   Hemoglobin A, Glycosylated  
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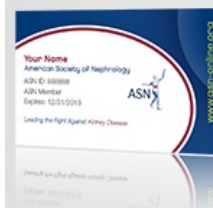
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