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Prevalence of chronic kidney disease among individuals with diabetes in the SUPREME-DM Project, 2005–2011

Emily B. Schroeder [a,b,*], J. David Powers [a], Patrick J. O'Connor [c], Gregory A. Nichols [d], Stanley Xu [a], Jay R. Desai [c], Andrew J. Karter [e], Leo S. Morales [f,1], Katherine M. Newton [f], Ram D. Pathak [g], Gabriela Vazquez-Benitez [c], Marsha A. Raebel [a,h], Melissa G. Butler [i,2], Jennifer Elston Lafata [j,k], Kristi Reynolds [l], Abraham Thomas [k,3], Beth E. Waitzfelder [m], John F. Steiner [a,b], On behalf of the SUPREME-DM Study Group

[a] Institute for Health Research, Kaiser Permanente Colorado, Denver, Colorado
[b] University of Colorado School of Medicine, Aurora, Colorado
[c] HealthPartners Institute for Education and Research, Minneapolis, Minnesota
[d] Kaiser Permanente Center for Health Research, Portland, Oregon
[e] Division of Research, Kaiser Permanente Northern California, Oakland, California
[f] Group Health Research Institute, Seattle, Washington
[g] Marshfield Clinic, Marshfield, Wisconsin
[h] University of Colorado Skaggs School of Pharmacy and Pharmaceutical Sciences, Aurora, Colorado
[i] Center for Clinical and Outcomes Research, Kaiser Permanente Georgia, Atlanta, Georgia
[j] Department of Social and Behavioral Health, Virginia Commonwealth University, Richmond, Virginia
[k] Henry Ford Health System, Detroit, Michigan
[l] Department of Research & Evaluation, Kaiser Permanente Southern California, Pasadena, California
[m] Kaiser Permanente Center for Health Research, Honolulu, Hawaii

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ABSTRACT

Aims: Diabetes is a leading cause of chronic kidney disease (CKD). Different methods of CKD ascertainment may impact prevalence estimates. We used data from 11 integrated health systems in the United States to estimate CKD prevalence in adults with diabetes (2005–2011), and compare the effect of different ascertainment methods on prevalence estimates.

Methods: We used the SUPREME-DM DataLink (n = 879,312) to estimate annual CKD prevalence. Methods of CKD ascertainment included: diagnosis codes alone, impaired estimated glomerular filtration rate (eGFR) alone (eGFR < 60 mL/min/1.73 m^2), albuminuria alone (spot urine albumin creatinine ratio > 30 mg/g or equivalent), and combinations of these approaches.

Results: CKD prevalence was 20.0% using diagnosis codes, 17.7% using impaired eGFR, 11.9% using albuminuria, and 32.7% when one or more method suggested CKD. The criteria had poor concordance. After age- and sex-standardization to the 2010 U.S. Census population, prevalence using diagnosis codes increased from 10.7% in 2005 to 14.3% in 2011 ($P < 0.001$). The prevalence using eGFR decreased from 9.7% in 2005 to 8.6% in 2011 ($P < 0.001$).

Conclusions: Our data indicate that CKD prevalence and prevalence trends differ according to the CKD ascertainment method, highlighting the necessity for multiple sources of data to accurately estimate and track CKD prevalence.

1. Introduction

Diabetes is a leading cause of chronic kidney disease (CKD) (de Boer et al., 2011; US Renal Data System, 2013). CKD occurs in 20–40% of individuals with diabetes (American Diabetes Association, 2014; de Boer et al., 2011; Garg, Kiberd, Clark, Haynes, & Clase, 2002; Nathan et al., 2009; National Kidney Foundation, 2007), and even small degrees of renal impairment are associated with increased cardiovascular disease risk, cardiovascular mortality, and health care costs

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* Corresponding author at: Institute for Health Research, Kaiser Permanente Colorado, 10065 E. Harvard Ave., Suite 300, Denver, CO 80231. Tel.: +1 303 614 1396; fax: +1 303 614 1305.
E-mail address: Emily.X.Schroeder@kp.org (E.B. Schroeder).
[1] Present addresses: Department of Medicine, University of Washington, Seattle, Washington.
[2] Present addresses: The Argus Group, Hamilton, Bermuda.
[3] Present addresses: Department of Medicine, Lutheran Medical Center, Brooklyn, New York.

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(de Boer et al., 2009, 2011; Ninomiya et al., 2009; Tuttle et al., 2014; US Renal Data System, 2013). The U.S. Renal Data System (USRDS) annually compiles information about CKD prevalence in the U.S., including CKD prevalence among individuals with diabetes. Its data primarily come from four sources: 1) Medicare claims, 2) laboratory test results and self-reported health information from NHANES, 3) claims from the Truven Health Marketscan Database, and 4) claims and laboratory test results from the Clinformatics DataMart (US Renal Data System, 2013). Methods of estimating CKD prevalence have differed depending on the data source used. Studies using Medicare and Marketscan databases have relied entirely on claims data (diagnosis and procedure codes), since these databases do not include laboratory test results. Studies using NHANES are based on cross-sectional laboratory test results and self-reported health information, but do not capture claims data. Only the Clinformatics DataMart database contains both claims and laboratory data on the non-end-stage renal disease population, and to date the USRDS use of these laboratory data has been limited (US Renal Data System, 2013). Previous publications have found poor concordance between CKD ascertainment methods based on diagnosis codes and those based on laboratory test results (Ferris et al., 2009; Grams et al., 2011; Kern et al., 2006; Stevens et al., 2005; Winkelmayer et al., 2005). However, the implications of this lack of concordance for estimation of CKD prevalence among individuals with diabetes have not been explored.

The electronic health records of large health care delivery systems offer a complementary source of data for estimation of trends in disease prevalence as well as comparative effectiveness research to prevent or delay the development of CKD or end-stage renal disease. We used data from the SUrveillance, PREvention, and ManagEment of Diabetes Mellitus (SUPREME-DM) DataLink, a database that includes over one million individuals with diabetes from 11 U.S. healthcare delivery systems, to examine CKD prevalence and trends among individuals with diabetes from 2005 to 2011, describe the agreement among different CKD ascertainment methods, and compare CKD prevalence and trends among pre-specified clinical and demographic subgroups (age, gender, hypertension, and cardiovascular disease).

2. Material and methods

2.1. Setting and data sources

SUPREME-DM is a consortium of 11 member organizations of the HMO Research Network. Collectively, SUPREME-DM includes data from approximately 16 million adults in 10 states from 2005 to 2011. Health systems in SUPREME-DM include Geisinger Health System (Pennsylvania), Group Health (Washington), HealthPartners (Minnesota), Henry Ford Health System (Michigan), Kaiser Permanente regions in Colorado, Northern California, Southern California, Hawaii, Georgia, Northwest (Oregon and Washington), and Marshfield Clinic (Wisconsin). Research institutions embedded in these health systems have developed a distributed virtual data warehouse that contains information on demographics, outpatient pharmacy dispensing, laboratory tests and laboratory results, and diagnosis and procedure codes from outpatient and inpatient health care encounters from their electronic health record and administrative data systems (Hornbrook et al., 2005). The dataset developed within SUPREME-DM, the DataLink, is the largest and clinically detailed privately-insured diabetes patient cohort ever assembled in the U.S (Nichols et al., 2012, 2015). This study was approved by the Kaiser Permanente Colorado Institutional Review Board (IRB), and each participating site either ceded oversight to the Kaiser Permanente Colorado IRB or received approval from their local IRB.

2.2. Study participants

We used inpatient and outpatient diagnosis codes, laboratory, and pharmacy data elements included in the DataLink to identify adults with diabetes. Specifically, we considered diabetes identification in the DataLink as the earlier of one inpatient diagnosis (ICD-9-CM 250.x, 357.2, 366.41, 362.01–362.07, either primary or secondary) or any combination of two of the following events, using the date of the first event in the pair as the identification date: 1) HbA1c > 6.5%; 2) fasting plasma glucose > 126 mg/dl; 3) random plasma glucose > 200 mg/dl; 4) outpatient diagnosis code (same codes as for inpatient); 5) any anti-hyperglycemic medication dispensing. When the two events were from the same source (e.g. two outpatient diagnoses or two elevated laboratory values), we required them to occur on separate days no more than two years apart. Two dispensings of metformin or thiazolidinediones with no other indication of diabetes were not included because these agents could be used for diabetes prevention or to treat polycystic ovarian syndrome. Criteria ascertained during periods of pregnancy were excluded. Information on diabetes status was available from 2005 through 2011, and from as early as 2000 at some sites. Once an individual was identified as having diabetes, they remained in the diabetes cohort until the date of censoring (the earliest of disenrollment from a participating health plan for greater than 90 days, death, or December 31, 2011).

For this study, the eligible source population for each calendar year consisted of individuals enrolled in a participating health plan from January 1 through December 31 of that year, without any enrollment gaps greater than 90 days. The index date was defined as the latest of the diabetes diagnosis date (if diagnosed after January 1, 2005) or January 1st of the first full year of enrollment in 2005–2011 when an individual was 20 years or older, the age that is traditionally used by the Centers for Disease Control and Prevention to differentiate adults and youth with diabetes (Centers of Disease Control and Prevention, 2014).

Individuals with diabetes were included in these analyses if they: 1) were at least 20 years old by January 1st, 2011, 2) were enrolled at the diabetes diagnosis date and had at least one day of enrollment after the index date, 3) had at least one full calendar year of enrollment, and 4) had at least two laboratory measurements of hemoglobin A1c, fasting glucose, or random glucose or two blood pressures recorded within 365 days before or after the index date. This last criterion was designed to exclude people receiving care at locations where their data were not being captured in the participating plans' electronic health records.

2.3. Study variables

We calculated CKD prevalence separately for each calendar year. Following the USRDS methodology, we did not carry CKD definitions forward into future years. We examined the following distinct methods of CKD ascertainment, separately and in combination.

1) Diagnosis codes. Following USRDS claims data methodology, we required at least one inpatient ICD-9 diagnosis code or two outpatient ICD-9 diagnosis codes that indicate kidney disease. We used the USRDS eligibility codes: 016.0, 095.4, 189.0, 189.9, 223.0, 236.91, 250.4, 271.4, 274.1, 283.11, 403.x1, 403.x0, 404.x2, 404.x3, 404.x0, 404.x1, 440.1, 442.1, 447.3, 572.4, 580–588, 591, 642.1, 646.2, 753.12–753.17, 753.19, 753.2, and 794.4 (US Renal Data System, 2013).
2) Impaired estimated glomerular filtration rate (eGFR). Using all available ambulatory serum creatinine results, we estimated GFR using the CKD-EPI equation (Levey et al., 2009). To meet the definition for impaired eGFR, we required at least two eGFR < 60 mL/min/1.73 m^2 separated by 91–365 days without any intervening values > 60 mL/min/1.73 m^2. At least one of the eGFR's < 60 mL/min/1.73 m^2 was required to be in the given calendar year; the other could be in the same year or the preceding year.