KI REPORTS
KIReports.org
CLINICAL RESEARCH

Geographic Variation and US County Characteristics Associated With Rapid Kidney Function Decline

Benjamin Bowe[1], Yan Xie[1], Hong Xian[1,2], Min Lian[3] and Ziyad Al-Aly[1,3,4]

[1]Clinical Epidemiology Center, Research and Education Service, VA Saint Louis Health Care System, Saint Louis, Missouri, USA; [2]Department of Biostatistics, College for Public Health and Social Justice, Saint Louis University, Saint Louis, Missouri, USA; [3]Department of Medicine, Washington University School of Medicine, Saint Louis, Missouri, USA; and [4]Department of Medicine, Division of Nephrology, VA Saint Louis Health Care System, Saint Louis, Missouri, USA

Introduction: Geographic variation in the prevalence of chronic kidney disease and incidence of end-stage renal disease has been previously reported. However, the geographic epidemiology of rapid estimated glomerular filtration rate (eGFR) decline has not been examined.

Methods: We built a longitudinal cohort of 2,107,570 US veterans to characterize the spatial epidemiology of and examine the associations between US county characteristics and rapid eGFR decline.

Results: There were 169,029 (8.02%) with rapid eGFR decline (defined as eGFR slope < -5 ml/min per 1.73 m^2/year). The prevalence of rapid eGFR decline adjusted for age, race, gender, diabetes, and hypertension varied by county from 4.10%–6.72% in the lowest prevalence quintile to 8.41%–22.04% in the highest prevalence quintile (P for heterogeneity < 0.001). Examination of adjusted prevalence showed substantial geographic variation in those with and without diabetes and those with and without hypertension (P for heterogeneity < 0.001). Cohort participants had higher odds of rapid eGFR decline when living in counties with unfavorable characteristics in domains including health outcomes (odds ratio [OR] = 1.15; confidence interval [CI] = 1.09–1.22), health behaviors (OR = 1.08; CI = 1.03–1.13), clinical care (OR = 1.11; CI = 1.06–1.16), socioeconomic conditions (OR = 1.15; CI = 1.09–1.22), and physical environment (OR = 1.15; CI = 1.01–1.20); living in counties with high percentage of minorities and immigrants was associated with rapid eGFR decline (OR = 1.25; CI = 1.20–1.31). Spatial analyses suggest the presence of cluster of counties with high prevalence of rapid eGFR decline.

Discussion: Our findings show substantial geographic variation in rapid eGFR decline among US veterans; the variation persists in analyses stratified by diabetes and hypertension status; results show associations between US county characteristics in domains capturing health, socioeconomic, environmental, and diversity conditions, and rapid eGFR decline.

Kidney Int Rep (2017) **2,** 5–17; http://dx.doi.org/10.1016/j.ekir.2016.08.016
KEYWORDS: disparity in kidney disease; eGFR decline; geographic information systems; geographic variation; kidney function; spatial epidemiology

Geographic information systems provide an important platform to advance our understanding of the relationship between geography and human health and disease.[1–3] Tanner *et al.*[4] examined the geographic epidemiology of chronic kidney disease (CKD) and end-stage renal disease (ESRD) in the United States and reported substantial geographic variations in the prevalence of CKD and incidence of ESRD, and that CKD prevalence only modestly correlated with ESRD incidence suggesting that the burden of CKD does not explain geographic variation in ESRD incidence. Mills *et al.*[5] showed that the global burden of CKD is high, and that significant variation exists in the prevalence of CKD between high-income countries and low- and middle-income countries. Brück *et al.*[6] examined the geographic variation in CKD prevalence in the European continent and identified substantial variation that followed the same pattern in analyses stratified by status of diabetes mellitus and hypertension—chronic diseases generally considered major drivers of CKD prevalence—suggesting that variation in CKD prevalence is likely to be due to factors other than those traditional drivers. The development of CKD and ESRD

Correspondence: Ziyad Al-Aly, Clinical Epidemiology Center, Research and Education Service, VA Saint Louis Health Care System, 915 North Grand Boulevard, 151-JC Saint Louis, Missouri 63106, USA. E-mail: zalaly@gmail.com

Received 2 July 2016; revised 20 August 2016; accepted 22 August 2016; published online 30 August 2016

is inherently dependent on the decline in estimated glomerular filtration rate (eGFR), where faster (or more rapid) rate of eGFR decline not only leads to earlier manifestation of kidney disease (whether development of CKD or ESRD), but is also associated with a significant increase in risk of all-cause mortality, cardiovascular mortality, hospitalizations, and readmissions.[7–13]

The rate of eGFR decline varies at the individual patient level, and much is known about individual risk factors associated with rapid kidney function decline.[14,15] The prevalence of rapid eGFR decline might also vary by geography; however, the spatial epidemiology of longitudinal changes in kidney function including rate of eGFR decline and of particular interest rapid eGFR decline has not been characterized. Furthermore, although geographic attributes of pre-ESRD nephrology care have been described, data on the relationship between geographic attributes, social, economic, physical and environmental conditions of communities, and rate of kidney function decline are lacking.[16–19]

The Department of Veterans Affairs operates a national integrated network of health care systems guided by centrally developed policies where eligible veterans have access to the same health care resources nationwide—a factor that may reduce heterogeneity of care practices. We aimed to characterize the spatial epidemiology of rapid eGFR decline among US veterans, identify US county characteristics associated with rapid eGFR decline, and to undertake spatial cluster analyses to identify areas with high prevalence (and low prevalence) of rapid eGFR decline.

MATERIALS AND METHODS

Patients

Using administrative data from the US Department of Veterans Affairs (VA), we identified users of the VA Health Care System who had an outpatient serum creatinine between 1 October 2002 and 30 September 2003 with no prior history of ESRD, dialysis, or kidney transplant, and designated the date of last eGFR measurement in this time frame as time zero (T_0) (n = 2,462,191). Patients were further selected on having at least one other eGFR ≥90 days after T_0 (n = 2,287,495), and followed until 30 September 2013. Participants were then limited to those in the continental United States and Hawaii (n = 2,250,428) who had data on all covariates, yielding an analytic cohort of 2,107,570 (Figure 1). The study was approved by the Institutional Review Board of the VA Saint Louis Health Care System, Saint Louis, MO.

Data Sources

We used Department of Veterans Affairs databases including inpatient and outpatient medical Statistical Analysis System (SAS) datasets (that include utilization data related to all inpatient and outpatient encounters within the VA system) to ascertain detailed patient demographic characteristics, location based on Federal Information Processing Standard county codes, and comorbidity information based on Current Procedural Terminology codes, and International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) diagnostic and procedure codes associated with inpatient and outpatient encounters.[20–23] The VA Decision Support System Laboratory Results file (a comprehensive database that includes VA-wide results for selected laboratory tests obtained in the clinical setting) provided information on outpatient and inpatient serum creatinine measurements.[20,21,24] The VA Vital Status and Beneficiary Identification Records Locator Subsystem files provided demographic characteristics and death follow-up through 30 September 2013.[20,21] United States Renal Data System (USRDS) data from the VA Centers for Medicare and Medicaid Services were used in assessing ESRD status.[25] The

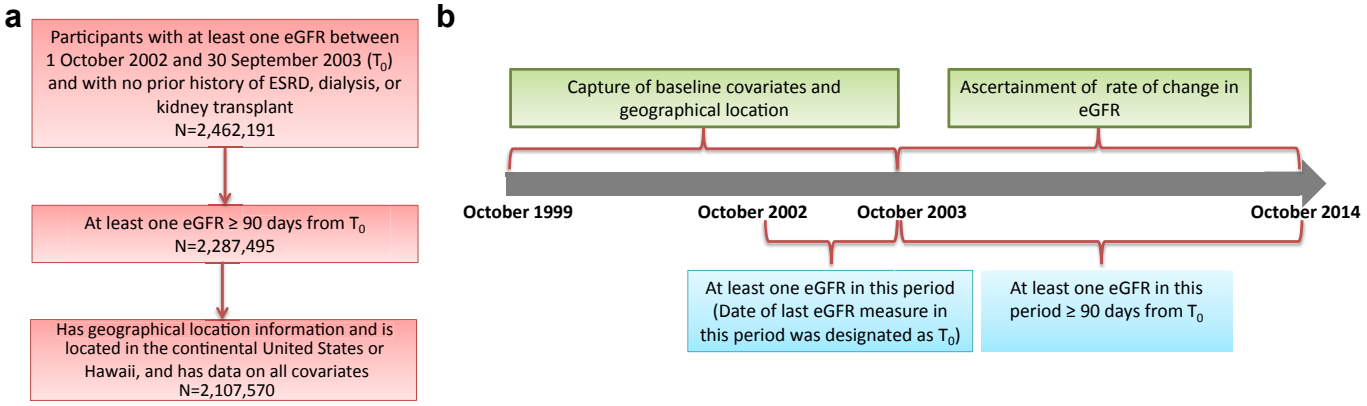

Figure 1. Cohort construction. (a) Flow diagram of cohort assembly. (b) Timeline of cohort selection. eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease.