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Epidemiology of chronic kidney disease: Results from a population of older adults in Germany

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ABSTRACT

Objective. To determine prevalences and stages of chronic kidney disease (CKD), and evaluate association of CKD with related covariables in a large population of older adults.

Methods. This cross-sectional analysis included 9806 participants of a general health check-up aged 50–74 years in Germany. We performed multivariate analysis to identify association of CKD with related covariables. Partial spearman correlations of eGFR with related biomarkers were calculated.

Results. Overall, 17.4% of subjects had CKD. Prevalences of stages 1, 2, 3, 4/5 CKD were 4.6%, 4.7%, 17.0% and 0.4%, respectively. Prevalence of CKD increased with age and peaked in age 70–74 years with 23.9%. In multivariable analysis of older age, female, self-reported history of cardiovascular diseases, diabetes and statin usage were independently associated with increased risk for CKD. Significant correlations were found between eGFR and serum cystatin C (−0.28), C-reactive protein (−0.04), fasting glucose (0.12), HbA_{1c} (−0.06), total cholesterol (−0.32), and triglycerides (−0.07) after adjustment for covariates.

Conclusions. This study shows a high prevalence of CKD among older adults. It highlights the association of eGFR with history of cardiovascular diseases, glycemic markers, and cardiovascular risk factors and may point to further possible targets in early prevention of CKD.

Introduction

Chronic kidney disease (CKD) emerges as a worldwide public health problem. CKD has complicated interrelationship with diabetes and hypertension and other associated diseases, and it is an independent risk factor for cardiovascular diseases (CVD) and all cause mortality (Snively and Gutierrez, 2004; Weiner et al., 2004). Outcomes of CKD include not only progression to end-stage renal disease (ESRD) but also complications of reduced kidney function, such as hypertension, malnutrition, anemia, bone disease and a decreased quality of life. The enormous costs of treatment of the associated morbidity including ESRD lead to a large burden for the health care system worldwide (Collins et al., 2003). However, early detection and treatment of CKD can prevent or delay the progression of CKD to ESRD and the severe complications (Locatelli et al., 2002).

After the Kidney Disease Outcome Quality Initiation (K/DOQI) clinical practice guideline for definition and classification of CKD have been published (Levey et al., 2003, 2005), more epidemiologic data about prevalence of CKD in the general population are available. However, few studies focused on risk factors for early stages of CKD among older adults.

The objective of this study was to determine the prevalences and stages of CKD in a large sample of older adults aged from 50 to 74 years and to evaluate the association of CKD with related covariables.

Methods

Study design

The study included participants of a statewide, older adult cohort study (ESTHER Study-**E**pidemiologische **S**tudie zu Chancen der Verhuetung, Frueherkennung und optimierten **Th**erapie chronischer **Er**krankungen in der aelteren Bevoelkerung) conducted in the federal state of Saarland located in Southwest Germany. The inclusion criteria for the study were: age between 50 and 74 years, inhabitant of Saarland and sufficient knowledge of the German language.

Setting and participants

From July 2000 to December 2002, 9953 inhabitants in Saarland were recruited by their general practitioner during a general health examination offered biennially to older adults in Germany. The

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Table 1
Basic characteristics of the study population (July 2000–December 2002, Saarland, Southwest Germany)

	Females (n=5394)	Males (n=4412)	Total (n=9806)
	n (%) or mean±SD		
Age (years)	62.1±6.69	62.2±6.54	62.1±6.62
Nationality (German)	5296 (98.2%)	4262 (96.6%)	9558 (98.2%)
School education (>9 years)	1149 (21.3%)	1256 (28.5%)	2405 (25.2%)
Smoking status			
Never smokers	3472 (64.4%)	1386 (21.4%)	4858 (50.8%)
Former smokers	934 (17.3%)	2151 (48.7%)	3085 (32.3%)
Current smokers	809 (15.0%)	809 (18.3%)	1618 (16.9%)
Alcohol consumption (g week^{-1})			
Never	1691 (31.4%)	852 (19.5%)	2550 (30.0%)
<60	1595 (29.6%)	974 (22.1%)	2569 (30.2%)
60–140	857 (15.9%)	1336 (30.3%)	2193 (25.8%)
>140	220 (4.1%)	980 (22.2%)	1200 (14.1%)
Body mass index (kg m^{-2})			
<25	1664 (30.9%)	965 (21.9%)	2629 (26.8%)
25–30	2238 (41.5%)	2297 (52.1%)	4535 (46.3%)
≥30	1492 (27.7%)	1150 (26.1%)	2642 (26.9%)
Self-reported disease history[a] of			
Cardiovascular disease	1572 (29.1%)	1530 (34.7%)	3102 (31.6%)
Hypertension	2243 (41.5%)	1891 (42.9%)	4134 (44.2%)
Hyperlipidemia	2153 (39.1%)	1824 (41.3%)	3977 (44.8%)
Diabetes	503 (9.3%)	565 (12.8%)	1068 (11.6%)
Drug usage			
ACE inhibitors	819 (15.2%)	844 (19.1%)	1633 (17.0%)
Angiotensin II receptor blockers	294 (5.5%)	230 (5.2%)	524 (5.3%)
Statins	397 (7.4%)	451 (10.2%)	848 (8.7%)

[a] Self-reported history of physician diagnosed disease.

distribution of the study population is representative with respect to age and gender as well as major risk factors and diseases for the general German population in this age segment (Löw et al., 2004). All participants and their physicians were asked to complete a standardized questionnaire including information on sociodemographics, lifestyle factors and medical history. Serum and urine samples of all participants were drawn during the initial visit by their physician in practice and frozen at −80°C until laboratory measurements were done. The study was approved by local and regional ethic committees and written informed consent was obtained from each participant. Details of the study design and the data collection have been published elsewhere (Rothenbacher et al., 2005). Our study subjects were limited to participants with available serum creatinine measurement.

Definition and stages of CKD

CKD was defined as estimated glomerular filtration rate (eGFR) of <60 mL min^{-1} 1.73 m^{-2}. eGFR was estimated using simplified Modification of Diet in Renal Disease (MDRD) equation as follows (Levey et al., 1999, 2000): eGFR = 186.3 * (serum creatinine)$^{-1.154}$ * age$^{-0.203}$ * (0.742 for females) * (1.210 if African American), where eGFR was expressed in mL min^{-1} 1.73 m^{-2}, serum creatinine in mg dL^{-1}, age in years.

Stages of CKD followed the classification of the K/DOQI guidelines: stage 1 was kidney damage with eGFR ≥ 90 mL min^{-1} 1.73 m^{-2}; stage 2 was kidney damage with mildly decreased eGFR 60–89 mL min^{-1} 1.73 m^{-2}; stage 3 was moderately decreased eGFR 30–59 mL min^{-1} 1.73 m^{-2}; stage 4 and 5 (4/5) was eGFR ≤ 29 mL min^{-1} 1.73 m^{-2}. Considering the few cases of severe stages of kidney disease (eGFR < 15 mL min^{-1} 1.73 m^{-2}) in the present study, we combined stages 4 and 5 together. Kidney damage was indicated by albuminuria (urinary albumin ≥ 20 mg L^{-1}) in spot urine sample.

Laboratory measurements

Serum creatinine measurements were performed by kinetic Jaffe method (interassay CV 6%). Serum cystatin C concentrations were measured by immunonephelometry on a Behring Nephelometer II (Dade-Behring Diagnostic, Marburg, Germany; interassay CV 3.8%). Urinary albumin concentration was measured by immunonephelometry assay (interassay CV 5.2%) in spot urine sample. HbA_{1c} was measured by high performance liquid chromatography. C-reactive protein (CRP), total cholesterol and triglyceride levels were measured by routine methods. All measurements were performed in a double-blinded fashion.

Statistical analysis

We calculated prevalences of CKD (overall and by stage) across different variables and stages of CKD indicated by the combination of eGFR level and urinary albumin concentration. In addition, multivariable logistic regression analysis was conducted to assess association of CKD with related covariables. First, adjusted odds rations (OR) by age and gender were presented and then a variables selection strategy was conducted. The covariates specified in the initial model were age (50–54, 55–59, 60–64, 65–69, 70–74 years), gender (female, male), BMI (<25, 25–<30, ≥30 kg m^{-2}), nationality (others, German), school education (≤9, >9 years), smoking status (never, former, current), alcohol consumption (never, 0–60, 60–140, >140 g week^{-1}), self-reported history of cardiovascular disease (yes, no), history of hypertension (yes, no), history of hyperlipidemia (yes, no), history of diabetes (yes, no), ACE inhibitors use (yes, no), angiotensin II receptor blockers use (yes, no), statin use (yes, no). Covariates were included in the model because they were associated significantly with CKD in unadjusted analysis in the present study or were known determinants of CKD in the literature (Mann et al., 2001; Sarnak et al., 2003; Snively and Gutierrez, 2004; Weiner et al., 2004). A backward selection strategy was used to identify the association of CKD with related covariables (p<0.05 for inclusion). Odds ratios (OR) and 95%

Table 2
Laboratory measurement in the study population (July 2000–December 2002, Saarland, Southwest Germany)

	Female (n=5394)	Male (n=4412)	Total (9806)
	n (%) or median (Q1, Q3)		
C-reactive protein (mg L^{-1})	2.31 (1.05, 4.84)	1.85 (0.93, 4.08)	2.09 (1.00, 4.53)
Total cholesterol (mg dL^{-1})	227.60 (194.9, 257.8)	212.70 (179.5, 243.9)	220.70 (187.4, 252.1)
Triglyceride (mg dL^{-1})	108.10 (77.0, 154.7)	126.30 (86.4, 191.0)	115.60 (79.9, 169.5)
Glucose (mg dL^{-1})	91.00 (82.0, 103.0)	95.00 (85.0, 109.0)	93.00 (83.0, 106.0)
HbA_{1c} (%)	5.60 (5.30, 5.90)	5.60 (5.30, 6.00)	5.60 (5.30, 6.00)
Cystatin C (mg L^{-1})	0.90 (0.81, 1.01)	0.93 (0.84, 1.04)	0.91 (0.82, 1.02)
Creatinine (mg dL^{-1})	0.78 (0.66, 0.94)	0.95 (0.81, 1.13)	0.86 (0.71, 1.04)
eGFR (mL min^{-1} 1.73 m^{-2})	80.20 (64.4, 97.4)	85.00 (70.0, 102.4)	82.40 (66.7, 100.0)
Urinary albumin (mg L^{-1})			
<20	4863 (90.2%)	3739 (84.7%)	8602 (87.7%)
20–200	421 (7.8%)	476 (10.8%)	897 (9.2%)
≥200	88 (1.6%)	179 (4.1%)	267 (2.7%)

Abbreviation: eGFR, estimated glomerular filtration rate; Q1, first quartile; Q3, third quartile.