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Identifying High-Risk Individuals for Chronic Kidney Disease: Results of the CHERISH Community Demonstration Project

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Abstract

Background—Most people with chronic kidney disease (CKD) are not aware of their condition.

Objectives—To assess screening criteria in identifying a population with or at high risk for CKD and to determine their level of control of CKD risk factors.

Method—CKD Health Evaluation Risk Information Sharing (CHERISH), a demonstration project of the Centers for Disease Control and Prevention, hosted screenings at 2 community locations in each of 4 states. People with diabetes, hypertension, or aged ≥50 years were eligible to participate. In addition to CKD, screening included testing and measures of hemoglobin A1C, blood pressure, and lipids.

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Authors Contribution

N.R.B. and J.A.V. contributed to the conceptualization and design of the study, interpretation of data, and drafting and revision of content. S.H.S. did the drafting and revision of content. M.G., S.P., and R.S. were responsible for data collection. S.L. and S.C.C. provided support in data analysis, interpretation of data, and revision of content. A.J.C. and D.E.W. contributed to the conceptualization and design of the study and revision of content.

At the time of the study, R.S. and M.G. were with the NKF, New York, NY, USA, and S.C.C., S.P., and A.J.C. were with the Chronic Disease Research Group, Minneapolis Medical Research Foundation, Minneapolis, MN, USA.

Disclosure Statement

N.R.B., J.A.V., S.H.S., R.S., M.G., S.L., and D.E.W. have no conflicts of interest to declare.

Ethics Statement

All participants provided informed consent before data collection. The Institutional Review Board at the Minneapolis Medical Research Foundation approved the CHERISH program, including the research protocol, the informed consent process, and data management procedures.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

Results—In this targeted population, among 894 people screened, CKD prevalence was 34%. Of participants with diabetes, 61% had A1C < 7%; of those with hypertension, 23% had blood pressure < 130/80 mm Hg; and of those with high cholesterol, 22% had low-density lipoprotein < 100 mg/dL.

Conclusions—Using targeted selection criteria and simple clinical measures, CHERISH successfully identified a population with a high CKD prevalence and with poor control of CKD risk factors. CHERISH may prove helpful to state and local programs in implementing CKD detection programs in their communities.

Keywords

Diabetes; Hypertension; Older adults; Detection; Albuminuria; Chronic kidney disease

Introduction

Chronic kidney disease (CKD) has emerged as one of the major public health problems facing the US population, with a high burden of disability, disproportionate distribution, poor outcomes, and high costs [1]. CKD collectively represents chronic kidney damage or loss of kidney function from early stages, characterized by elevated albumin excretion in the urine, to kidney failure requiring dialysis or kidney transplantation for survival. More than 1 in 7 adults in the United States are estimated to have CKD [2, 3]. Yet awareness of kidney disease among adults with CKD remains low; less than 10% of adults with CKD report having CKD [4, 5]. Increased awareness and early detection of CKD and appropriate treatment and management may slow the progression of loss of kidney function and reduce both morbidity and mortality [6–11].

The US Preventive Services Task Force found insufficient evidence to support CKD screening for the general population without risk conditions [12]. However, a number of clinical and public health programs indicate that adverse outcomes of CKD can be prevented or delayed [13]. The feasibility and benefits of conducting a screening program focusing on a high risk, targeted population and the longer-term effect is unknown.

In 2006, the Centers for Disease Control and Prevention (CDC) in collaboration with the National Kidney Foundation (NKF) developed the 3-year screening demonstration project, CKD Health Evaluation Risk Information Sharing (CHERISH). CHERISH aimed to (1) examine the usefulness of an algorithm based on National Health and Nutrition Examination Survey (NHANES) data in identifying the high-risk groups for CKD, and (2) examine the yield of a pilot program designed to use simple techniques for early detection of CKD in these high-risk groups.

Materials and Methods

Selecting the Target Population

The target population for screening included adults at high risk for CKD and those with undiagnosed CKD. We used previously published data from NHANES 1999–2004 (n ~15,000) to determine the inclusion criteria for screening in the CHERISH program [14]. In

the paper by Collins et al. [14], CKD was defined as an estimated glomerular filtration rate (eGFR) < 60 mL/min/1.73 m^2 or urinary albumin-to-creatinine ratio (ACR) ≥30 mg/g. The prevalence of CKD in people aged ≥60 years was 39.2% compared to 9.3% for the population aged 20–59 years. Among individuals aged 20–59 years, demographics, comorbidities, and CKD risk conditions were assessed using weighted logistic regression overall and a decision tree or branching diagram to evaluate CKD distribution (Fig. 1) [14]. CKD prevalence was greater for participants with diabetes (33.8%) than for those without diabetes (8.2%). Using hypertension in the decision tree, participants with both diabetes and hypertension had a higher CKD prevalence (43.0%) than participants with diabetes but without hypertension (25.5%). On the other hand, CKD prevalence among participants with hypertension but without diabetes was 15.2% compared with 6.8% for those without these 2 conditions. The prevalence of self-reported cardiovascular disease (CVD) in adults aged 20–59 years without diabetes or hypertension (7.9%) was too low to qualify as an additional primary risk factor [14]. Furthermore, using ACR to screen people aged ≥50 years with diabetes or hypertension has been shown to be cost effective [15]. Thus, we used diabetes, hypertension, or age ≥50 years as criteria for inclusion in the target population for screening. Because diabetes and hypertension are more common with older age, the risk of developing CKD increases with increasing age [3]. Participants were excluded from screening if they did not meet these selection criteria, were < 18 years old, currently undergoing dialysis treatment or had ever had a kidney transplant, hemophiliac, or received chemotherapy within the last 4 weeks. Additional exclusion was the presence of the following on both arms: rashes, gauze dressings, casts, edema, paralysis, tubes, open sores or wounds, withered arms or limbs missing, damaged or sclerosed or occluded veins, allergies to cleansing reagents, burned or scarred tissue, shunt or intravenous infusion.

Selecting the Screening Sites

To narrow down the selection of screening sites, we began with the top 25 metropolitan statistical areas (MSAs) in the Medicare 5% sample with a minimum of 7,500 CKD patients. Criteria for selecting screening sites included the following: (1) risk of CKD in these populations based on the MSA data, (2) diverse study population to reflect the racial and ethnic distribution of the US population, (3) previous local work experience with the NKF, (4) US geographic distribution, (5) other factors such as logistics and availability of personnel to conduct screenings. Using these criteria, from the initial 25 MSAs, we selected 4 states and 2 cities within each state: California (Los Angeles, San Bernardino), Florida (Miami, Orlando), New York (Bronx, Syracuse), and Minnesota (Minneapolis, Prior Lake). With the exception of Minneapolis/Prior Lake, the age-adjusted prevalence of diabetes and hypertension in these cities was equal to or greater than the overall age-adjusted prevalence in the United States (≥9% for diabetes and ≥29% for hypertension) [16]. Minneapolis and Prior Lake were selected to increase study enrollment of the vulnerable Native American population that is known to have higher rates of type 2 diabetes and kidney failure than whites [1, 17], and to increase study feasibility and efficiency based on previous local work experience with the NKF.

Recruitment Methods

Power calculations were used to determine a minimum sample size for recruitment based on the objective of testing differences from the initial to the follow-up screening and the assumption that 50% of those screened will return for a follow-up screening. To recruit a minimum of 100 participants for screening at each site, a community outreach program was implemented, using CKD lectures, educational meetings, printed materials, word of mouth, and media. The outreach was designed to educate the public about CKD and CKD risk conditions, as well as to provide phone numbers to allow eligible and interested individuals to make an appointment for the designated local detection program. Presentations were given in churches, senior centers, and local community centers, prior to CHERISH detection programs in the Bronx, Syracuse, Minneapolis, San Bernardino, Miami, and Orlando. Educational sessions preceded all events as short, informal discussions of CKD given by knowledgeable volunteers to inform others about CKD risk factors and encourage participation in events. Printed materials (posters and flyers) were mailed to community partners for display in public places preceding each event. Word of mouth recruitment was encouraged wherein a potential participant was informed by a friend or family member. CHERISH was promoted through local radio and television public service announcements and interviews. In addition, articles about the CHERISH program appeared in Renal Business Today (July 2008), e-Kidney (the NKF's electronic newsletter, circulation 120,000), and the New York Times ("Overshadowed, Kidney Disease Takes a Growing Toll," by David Tuller, November 18, 2008) [18]. The initial screening was conducted between September 25, 2008 and August 29, 2009, and the follow-up screening between September 24, 2009 and April 28, 2010.

Screening Methods

All participants provided informed consent before data collection. The Institutional Review Board at the Minneapolis Medical Research Foundation approved the CHERISH program, including the research protocol, the informed consent process, and data management procedures. A screening questionnaire was used to collect data on demographic characteristics, family and medical history, smoking habits, education level, access to physicians, and health insurance status. Detailed information on medication use was obtained only for angiotensin-converting enzyme (ACE) inhibitors, angiotensin receptor blockers (ARBs), and diuretics. The diagnostic panel included blood pressure, height and weight to calculate body mass index, and blood and urine collection.

Hypertension was defined as systolic blood pressure ≥130 mm Hg, diastolic blood pressure ≥80 mm Hg, self-reported history of hypertension, or use of blood pressure lowering medication [19, 20]. Diabetes was defined as fasting blood glucose level ≥126 mg/dL, non-fasting blood glucose level ≥200 mg/dL, a self-reported history of diabetes (including eye or nerve damage from diabetes), or use of glucose lowering medications [20]. Only those with blood glucose levels diagnostic of diabetes or with self-reported diabetes received a hemoglobin A1C test. Good diabetes control was defined as an A1C < 7%. High cholesterol was defined as self-reported, currently taking medication for high cholesterol, or direct low density lipoprotein cholesterol ≥100 mg/dL [21]. Albuminuria was defined as ACR level ≥30 mg/g [8]. CVD was defined by a self-reported history of heart angina, heart attack, heart

bypass surgery, heart angioplasty, stroke, heart failure, abnormal heart rhythm, or coronary artery disease. Participants were asked the question “Have you ever been told by a doctor or health care professional you have weak or failing kidneys (do not include kidney stones, bladder infections, or incontinence)?” and those who answered “yes” were considered being aware of having CKD.

We determined CKD status and staging of disease using measures of eGFR and albuminuria [8]. Participants with eGFR < 60 mL/min/1.73 m^2 or with ACR ≥30 mg/g were considered to have CKD. The CKD Epidemiology Collaboration (CKD-EPI) equation and the isotope dilution mass spectrometry-traceable serum creatinine were used to calculate eGFR [22]. Clinitek Microalbumin 2 reagent strips and Clinitek status analyzers were used to assess ACR on site. Blood glucose, A1C, and low density lipoprotein levels were assessed using the Architect c8000 analyzer. A1C was measured in accordance with the National Glycohemoglobin Standardization Program [23]. The central laboratory for the off-site testing was Consolidated Laboratory Services, Van Nuys, CA, USA.

CHERISH participants were invited to a follow-up screening 1 year after the initial screening. The protocol for this follow-up screening was the same as that of the initial screening.

Statistical Analysis

All analyses were descriptive. For characteristics of participants, we reported percentages and CIs. For comparing differences in prevalence of risk factors between participants at the initial screening and those who returned for the follow-up screening, we used chi-square tests. For comparing changes in prevalence and treatment of CKD, diabetes, and hypertension, and changes in CKD awareness from the initial to the follow-up screening among participants who completed both screenings, we calculated the standardized difference for each variable. The difference was considered significant if the absolute value of the standardized difference was > 10 [24].

Results

CKD lectures and educational series were reported by participants as the most important recruitment method (43%), followed by posters, flyers, mailing and other outreach (20%), word of mouth (19%), and newspapers and other media (18%).

Table 1 presents the characteristics of participants at the initial screening and of those who returned for the follow-up screening. A total of 894 participants were screened initially with an average of 112 (range 100–140) participants per site. The study was successful in recruiting the target population at risk for CKD, with an overall CKD prevalence of 34.1% in the screened population.

In the initial screening, the mean age was 62.6 years, 87.1% of participants were aged ≥50 years, and 61.4% were aged ≥60 years. Of participants, 64.1% were women, 40.4% white, 22.0% African American, and 37.6% other race; 39.4% were of Hispanic ethnicity. Most participants were high school graduates (69.6%), and most had health insurance (79.4%).

Regarding comorbid conditions, 42.9% of participants had diabetes, 84.6% had hypertension, 32.1% had self-reported CVD, 59.5% had self-reported high cholesterol, and 50.4% were measured as having obesity with body mass index at least 30 kg/m^2.

Of the initially screened participants, 482 (53.9%) returned for a follow-up screening. Their prevalence of CKD was similar (34.5%) to those initially screened. Based on the characteristics at the initial screening, the participants who returned for the follow-up screening were similar in age, sex, and comorbidities to those who did not return (Table 1).

Table 2 presents CKD risk factors of participants at the initial screening and of those who returned for the follow-up screening. Overall, 43.0% of participants had diabetes, of which 68.8% reported being treated (i.e., taking pills or insulin) and 60.9% had good diabetes control (i.e., A1C < 7%). Of the participants screened initially, 84.9% had hypertension and 60.1% reported being treated. However, blood pressure control was poor with only 22.6% of the screened participants having systolic pressure < 130 mm Hg and diastolic pressure < 80 mm Hg. Among the screened participants, high cholesterol was also very common with 87.1% having high cholesterol. Among the participants who attended both the initial and follow-up screenings and those who attended the initial screening only, the diabetes and cholesterol measures were similar (Table 2). On the other hand, the percentage of participants with hypertension was lower among those who completed both initial and follow-up screenings compared to those who completed the initial screening only (82.7% vs. 87.3%, $p = 0.048$).

Table 3 presents changes in the prevalence and treatment of CKD, diabetes, and hypertension, and changes in CKD awareness from the initial to the follow-up screening among participants who completed both screenings. Standardized differences between initial and follow-up screenings were significant in the percentage of participants with CKD reporting being aware of having CKD, in the percentage of participants with diabetes reporting diabetes treatment, in the percentage of participants with hypertension reporting hypertension treatment, and in the percentage of participants with diabetes (including those with diabetes and CKD) reporting ACE/ARB use. However, between initial and follow-up screenings, the difference in the percentage of participants with hypertension reporting ACE/ARB use was not significant.

Discussion

CHERISH was a demonstration project designed to assess screening criteria to help identify a population with or at high risk for CKD. Based on the selection criteria of having diabetes, hypertension, or age ≥50 years, the CHERISH screening program identified a population with a CKD prevalence of over 30%, twice the prevalence observed in the general adult population of 15% [2, 3], and similar to the prevalence in people with diabetes [25]. Furthermore, in this high-risk population, control of risk factors for CKD or CKD complications was poor. About 2 of 5 participants with self-reported diabetes and about 4 of 5 participants with self-reported hypertension or high cholesterol were not in control and there was little improvement in the population that returned for the follow-up screening.

An important benefit of screening is that diagnosing CKD at an earlier disease stage may lead to slower disease progression and a reduction of morbidity and mortality over time [4, 26]. Management of CKD to reduce or slow the progression of disease can reduce the incidence of kidney failure [27]. Compared to adults without diabetes or hypertension, individuals with these risk factors progress more quickly through the stages of CKD to kidney failure [26, 28]. In addition to control of diabetes and hypertension, interventions to slow CKD progression include the use of ACE/ARBs, which besides lowering blood pressure have been shown to reduce albuminuria (a sign of kidney damage) [2]. However, in this screened population, even when the use of ACE/ARBs is clearly indicated (e.g., among those with diabetes and advanced CKD) [8, 20], 1 in 3 did not report taking ACE/ARBs. For screening to realize its potential, it would have to be linked to appropriate intervention.

The major limitation of this study was that the screened population was relatively small, thus limiting the information on the scalability of the population reached. Furthermore, the small sample size might have restricted the ability to detect differences between groups. Second, the participants were not representative of the general population, as they were volunteers who had heard about the program and were likely to be more motivated to participate. How this would translate into a population-based program is unknown. Determining the full impact of the screening would entail additional follow-up with data merges to the US Renal Data System, the National Death Index, and Medicare. Third, one of the definitions for self-reported diabetes was taking glucose lowering medications, which is a potential limitation as metformin is also used to treat prediabetes. However, data from NHANES 2005–2012 showed the age-adjusted prevalence of metformin use in the prediabetes population was 0.7%, suggesting the impact of this limitation was minimal [29]. Finally, these data were collected about 10 years ago; however, the selection criteria for screening – diabetes, hypertension, and older age – continue to be the major risk factors for CKD and relevant in identifying the population with CKD [1].

A comprehensive public health plan to reduce CKD in the community may include surveillance, screening, and increasing awareness of the disease [30]. While evidence to support CKD screening among the general population may be lacking [12], screening among a high risk population can lead to improvements in treatment and awareness of CKD and prevention or delay of adverse outcomes. Screening a high-risk older population with diabetes or hypertension has also been shown to be cost effective [15]. The CHERISH demonstration project used simple screening criteria and easy-to-implement tests to successfully reach in all screening sites a target population at risk for CKD. More than 1 in 3 people screened were found to have CKD. CHERISH encouraged participants to see and inform healthcare practitioners of their CKD or CKD risk status to facilitate early intervention and improve patient management. The screening process described in this report may prove helpful to state and local programs in implementing CKD detection programs in their communities and in channeling patients to appropriate care.

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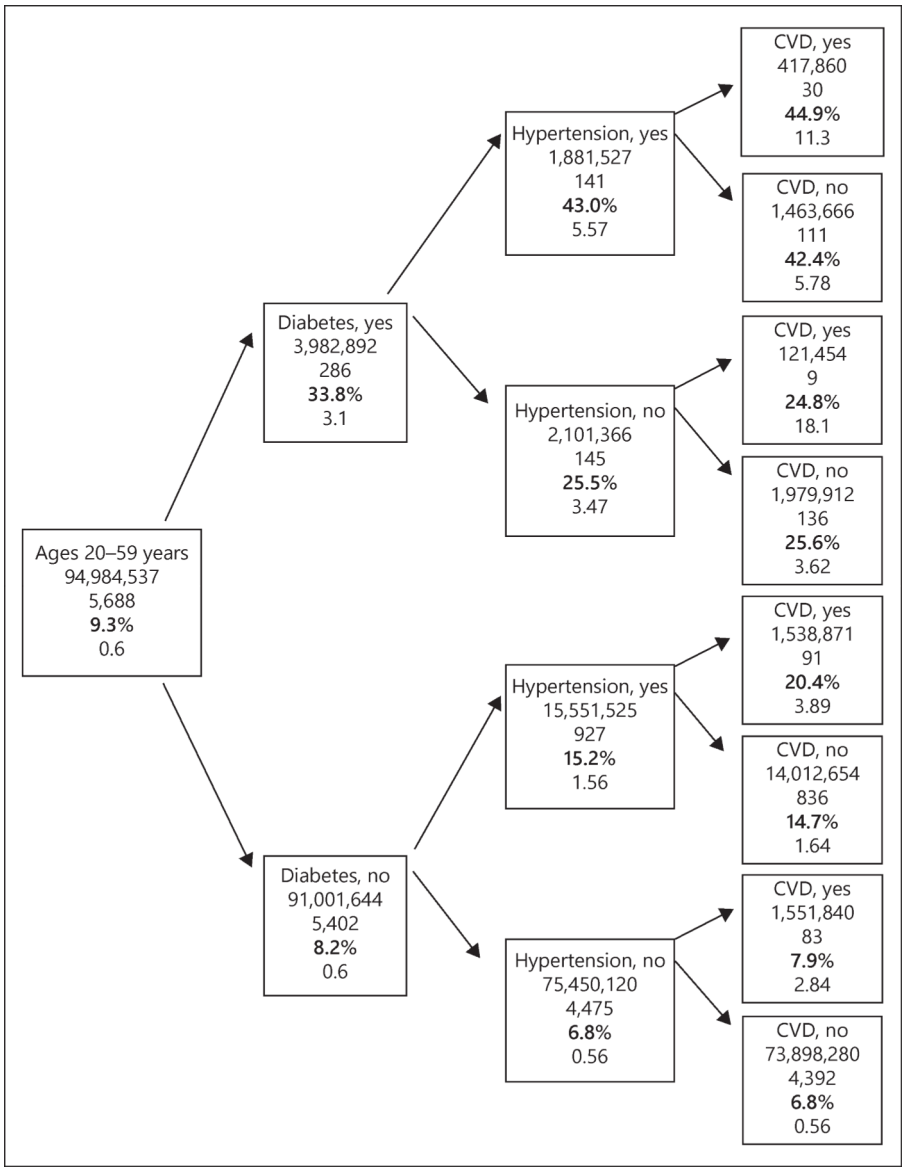

Fig. 1.

Chronic kidney disease (CKD) decision tree analysis* showing the distribution of CKD among persons aged 20–59 years by diabetes, hypertension, and cardiovascular disease status, National Health and Nutrition Examination Survey (NHANES), 1999–2004. * Reprinted from Collins et al. [14].

Table 1.

Characteristics of participants at the initial screening, and by whether or not they returned for the follow-up screening, CHERISH study

	Percentage (95% CI)		
	participants screened (*n* = 894)	**completed initial and follow-up screenings (*n* = 482)**	**completed initial screening only (*n* = 412)**
Having CKD[a]	34.1 (30.9–37.3)	34.5 (30.2–38.8)	33.7 (29.0–38.4)
Age, years			
18–49	12.9 (10.6–15.2)	11.0 (8.1–13.9)	15.0 (11.4–18.6)
50–59	25.7 (22.8–28.6)	26.5 (22.5–30.5)	24.8 (20.5–29.1)
60–69	30.6 (27.5–33.7)	30.3 (26.1–34.5)	31.1 (26.5–35.7)
≥70	30.8 (27.7–33.9)	32.2 (27.9–36.5)	29.1 (24.6–33.6)
Gender			
Male	35.9 (32.7–39.1)	35.5 (31.1–39.9)	36.4 (31.6–41.2)
Female Race[b]	64.1 (60.9–67.3)	64.5 (60.1–68.9)	63.6 (58.8–68.4)
Race[b]			
White	40.4 (37.1–43.7)	40.0 (35.3–44.5)	40.8 (35.9–45.7)
African American	22.0 (19.2–24.8)	25.1 (21.1–29.1)	18.5 (14.6–22.4)
Other	37.6 (34.4–40.8)	34.9 (30.5–39.3)	40.8 (35.9–45.7)
Ethnicity[b]			
Non-Hispanic	60.6 (57.3–63.9)	62.4 (58.0–66.8)	58.5 (53.6–63.4)
Hispanic	39.4 (36.1–42.7)	37.6 (33.2–42.0)	41.5 (36.6–46.4)
High school graduate or higher			
No	30.4 (27.3–33.5)	27.3 (23.2–31.4)	33.9 (29.2–38.6)
Yes	69.6 (66.5–72.7)	72.7 (68.6–76.8)	66.1 (61.4–70.8)
Health insurance			
No	20.6 (17.9–23.3)	21.9 (18.1–25.7)	19.2 (15.3–23.1)
Yes	79.4 (76.7–82.1)	78.1 (74.3–81.9)	80.8 (76.9–84.7)
Seen doctor within last year			
No	11.1 (9.0–13.2)	10.4 (7.6–13.2)	11.9 (8.7–15.1)
Yes	88.9 (86.8–91.0)	89.6 (86.8–92.4)	88.1 (84.9–91.3)
Diabetes[c]			

	Percentage (95% CI)		
	participants screened (*n* = 894)	**completed initial and follow-up screenings (*n* = 482)**	**completed initial screening only (*n* = 412)**
No	57.1 (53.8–60.4)	59.5 (55.0–64.0)	54.1 (49.2–59.0)
Yes	42.9 (39.6–46.2)	40.5 (36.0–45.0)	45.9 (41.0–50.8)
Hypertension[d]			
No	15.3 (12.9–17.7)	17.4 (13.9–20.9)	12.9 (9.5–16.3)
Yes	84.6 (82.2–87.0)	82.6 (79.1–86.1)	87.1 (83.7–90.5)
Self-reported CVD[e]			
No	67.9 (64.8–71.0)	69.6 (65.4–73.8)	65.8 (61.1–70.5)
Yes	32.1 (29.0–35.2)	30.4 (26.2–34.6)	34.2 (29.5–38.9)
Self-reported high cholesterol			
No	40.5 (37.2–43.8)	39.0 (34.5–43.5)	42.2 (37.3–47.1)
Yes	59.5 (56.2–62.8)	61.0 (56.5–65.5)	57.8 (52.9–62.7)
BMI ≥30			
No	49.6 (46.3–52.9)	51.5 (46.9–56.1)	47.5 (42.6–52.4)
Yes	50.4 (47.1–53.7)	48.5 (43.9–53.1)	52.5 (47.6–57.4)
Current smoker			
No	87.5 (85.3–89.7)	89.3 (86.4–92.2)	85.3 (81.8–88.8)
Yes	12.5 (10.3–14.7)	10.7 (7.8–13.6)	14.7 (11.2–18.2)

[a] CKD based on eGFR <60 mL/min/1.73 m^2 (CKD-EPI equation) or albumin-to-creatinine ratio ≥30 mg/g.

[b] Race categories include people of Hispanic origin; Hispanics may be of any race.

[c] Self-reported diabetes (including neuropathy or retinopathy), fasting blood glucose ≥126 mg/dL, non-fasting blood glucose ≥200 mg/dL, or use of glucose-lowering medication.

[d] Self-reported hypertension, systolic blood pressure ≥130 mm Hg, diastolic blood pressure ≥80 mm Hg, or use of blood pressure lowering medication.

[e] Self reported history of heart angina, heart attack, heart bypass surgery, heart angioplasty, stroke, heart failure, abnormal heart rhythm, or coronary artery disease.

CKD, chronic kidney disease; CVD, cardiovascular disease; BMI, body mass index (kg/m^2); eGFR, estimated glomerular filtration rate.

Table 2.

Prevalence and control of diabetes, hypertension, and high cholesterol among participants at the initial screening, and by whether or not they returned for the follow-up screening, CHERISH Study

	Percentage[a]			
	total (*n* = 892)[b]	completed initial and follow-up screenings (*n* = 481)	completed initial screening only (*n* = 411)	*p* value
Diabetes[c]	43.0	40.5	46.0	0.10
Diabetes treatment among those with diabetes (*n* = 384)	68.8	68.7	68.8	0.99
A1C <7% among those with diabetes (*n* = 384)	60.9	63.1	58.7	0.13
A1C <7% among those with diabetes taking medication (*n* = 264)	51.9	53.7	50.0	0.47
A1C <7% among those with diabetes not taking medication (*n* = 120)	80.0	82.0	78.0	0.58
Hypertension[d]	84.9	82.7	87.3	0.048
Hypertension treatment among those with hypertension (*n* = 757)	60.1	60.1	60.2	0.97
Blood pressure control (<130/80 mm Hg) among those with hypertension (*n* = 757)	22.6	22.6	22.6	0.99
Blood pressure control (<130/80 mm Hg) among those with hypertension taking medication (*n* = 455)	28.4	27.2	29.6	0.57
Blood pressure control (<130/80 mm Hg) among those with hypertension not taking medication (*n* = 302)	13.9	15.7	11.9	0.34
Systolic blood pressure, mean (median), mm Hg		130.6 (130.0)	132.8 (130.0)	0.0505
Diastolic blood pressure, mean (median), mm Hg		76.0 (76.0)	76.9 (78.0)	0.23
Taking ACE/ARB	33.2	33.9	32.4	0.63
Taking ACE/ARB among those with diabetes (*n* = 384)	42.7	44.6	40.7	0.44
Taking ACE/ARB among those with diabetes and ACR ≥30 mg/g (*n* = 134)	46.3	47.2	45.7	0.87
Taking ACE/ARB among those with diabetes and ACR ≥30 mg/g and eGFR <60 mL/min/1.73 m^2 (*n* = 39)	64.1	61.5	65.4	0.81
Taking ACE/ARB among those with hypertension (*n* = 757)	37.4	38.4	36.2	0.53
High cholesterol[b, e]	87.1	87.3	86.8	0.84
High cholesterol treatment among those with high cholesterol (*n* = 775)	38.2	39.6	36.5	0.38
LDL < 100 mg/dL among those with high cholesterol (*n* = 775)	21.9	23.6	19.9	0.22
LDL <100 mg/dL among those with high cholesterol taking medication (*n* = 296)	45.6	47.6	43.1	0.44
LDL <100 mg/dL among those with high cholesterol not taking medication (*n* = 479)	7.3	7.9	6.6	0.59
LDL cholesterol, mean (median) mg/dL		119.1 (115.5)	120.0 (117.0)	0.74

[a]Percentages unless otherwise indicated.

[b] Excluding 2 participants with missing blood glucose values. For high cholesterol estimates, excluding an additional 2 participants with missing blood cholesterol values.

[c] Self-reported diabetes (including neuropathy or retinopathy), fasting blood glucose ≥126 mg/dL, non-fasting blood glucose ≥200 mg/dL, or use of glucose lowering medication.

[d] Self-reported hypertension, systolic blood pressure ≥130 mm Hg, diastolic blood pressure ≥80 mm Hg, or use of blood pressure lowering medication.

[e] Self-reported high cholesterol, direct LDL cholesterol ≥100 mg/dL, or currently taking medication for high cholesterol.

A1C, hemoglobin A1C; ACE/ARB, angiotensin-converting enzyme/angiotensin receptor blocker; ACR, albumin-to-creatinine ratio; eGFR, estimated glomerular filtration rate; LDL, low density lipoprotein.

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Table 3.

Changes in prevalence and treatment of CKD, diabetes, and hypertension, and changes in CKD awareness from initial to follow-up screening among participants who completed both screenings, CHERISH study

	Percentage (95% CI)		Standardized difference[a]
	initial screening (n = 482)	follow-up screening (n = 481)[b]	initial and follow-up screenings
CKD[c]	34.9 (30.5–39.3)	34.5 (30.1–38.9)	−0.84
ACR ≥30 mg/g	24.2 (20.3–28.1)	24.2 (20.3–28.1)	0.00
ACR ≥30 mg/g and eGFR ≥90 mL/min/1.73 m^2	7.9 (5.4–10.4)	8.3 (5.7–10.9)	1.47
ACR ≥30 mg/g and eGFR 60–89 mL/min/1.73 m^2	11.0 (8.1–13.9)	10.8 (7.9–13.7)	−0.64
eGFR <60 mL/min/1.73 m^2	16.0 (12.6–19.4)	15.4 (12.1–18.7)	−1.65
Awareness of CKD among those with CKD[c]	19.6 (13.3–25.6)	24.7 (17.8–31.6)	12.30
Diabetes[d]	40.5 (36.0–45.0)	37.7 (33.3–42.1)	−5.74
Diabetes treatment among those with diabetes	68.7 (61.9–75.5)	75.1 (68.7–81.5)	14.27
Hypertension[e]	82.6 (79.1–86.1)	82.3 (78.8–85.8)	−0.79
Hypertension treatment among those with hypertension	60.1 (55.2–65.0)	65.9 (61.1–70.7)	12.03
Taking ACE/ARB	33.9 (29.6–38.2)	37.1 (32.7–41.5)	6.69
Taking ACE/ARB among those with diabetes	44.6 (37.4–51.8)	54.7 (47.3–62.1)	20.30
Taking ACE/ARB among those with diabetes and ACR ≥30 mg/g	47.2 (32.8–61.6)	60.7 (47.0–74.4)	27.34
Taking ACE/ARB among those with diabetes and ACR ≥30 mg/g and eGFR <60 mL/min/1.73 m^2	61.5 (31.2–91.8)	66.7 (46.7–86.7)	10.86
Taking ACE/ARB among those with hypertension	38.4 (33.5–43.3)	43.2 (38.2–48.2)	9.78

[a] Absolute value of the standardized difference >10 indicates a significant difference between the 2 groups.

[b] Excluding 1 participant with missing blood glucose values.

[c] CKD based on eGFR <60 mL/min/1.73 m^2 (CKD-EPI equation) or albumin-to-creatinine ratio ≥30 mg/g.

[d] Self-reported diabetes (including neuropathy or retinopathy), fasting blood glucose ≥126 mg/dL, non-fasting blood glucose ≥200 mg/dL, or use of glucose lowering medication.

[e] Self-reported hypertension, systolic blood pressure ≥130 mm Hg, diastolic blood pressure ≥80 mm Hg, or use of blood pressure lowering medication.

ACE/ARB, angiotensin-converting enzyme/angiotensin receptor blocker; ACR, albumin-to-creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.