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Research Article

Screening for Occult Renal Disease (SCORED) is A Useful Tool to Identify Individuals at High-Risk for Chronic Kidney Disease

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Abstract

Background and Objective: The health burden of renal disease is high for patients and health services worldwide, and screening for chronic kidney disease (CKD) has been advocated with increasing frequency. Population-based studies relating to the prevalence of CKD in the community are limited. We prospectively studied whether stratification by SCORED values could be useful in identifying subjects who are at high-risk for CKD in a general population-based sample.

Design, Participants & Methods: The frequency of individuals at high-risk for CKD was determined using a cross-sectional study of 873 adult households in Palmas, Brazil, that were randomly selected using a stratified, cluster method. The age, gender, and race of the study sample were similar to the urban population of Palmas.

Results: An estimated GFR <60 ml/min/1.73 m2 was present in 46 (5.3%) of the participants studied, and the risk of CKD was greater in women than in men, and increased with age from 2.7% in the 18-44 age group to 19.0% in those 65 years of age and older. The frequencies of CKD Stage 3, 4 and 5 were 4.8%, 0.5%, and 0%, respectively. The SCORED values included 224 (25.7%) patients with high SCORED values (≥4), and 649 (74.3%) subjects with low SCORED values. The subjects with higher SCORED values were at a significantly higher risk for CKD compared with those who had lower SCORED values (12.9% vs. 2.6%, $\chi 2 = 35.58$; $p < 0.001$). The sensivity specificity and negative predictive value for predicting CKD by the SCORED model was 63%, 76%, and 76%, respectively.

Conclusion: High SCORED values were associated with a higher risk for CKD in a general population-based sampling. This simple screening tool was useful in identifying individuals at high-risk for CKD

Keywords: *chronic kidney disease; screening; predictive model;*

Introduction

Chronic kidney disease (CKD) is increasingly recognized as a public health problem [1]. Several studies have indicated that the prevalence of CKD is high throughout the world [2-5], and the incidence of end-stage renal disease (ESRD) has increased dramatically, imposing a heavy burden on healthy economies [6,7]. Furthermore, CKD is associated with increased cardiovascular morbidity and even death [8,9].

The general public lacks sufficient awareness that chronic kidney disease (CKD) is a serious and progressive medical condition. In the early stages, CKD is often asymptomatic, and often remains under-diagnosed and undertreated. However, if CKD is detected and treated early, its widespread consequences may be prevented or delayed.

Hence, screening for CKD has been increasingly advocated over the last few years [1,8,10].

Screening for Occult Renal Disease (SCORED) is a simple screening questionnaire able to identify patients at risk for CKD, and it demonstrates greater accuracy and predictive power in identifying individuals at high-risk for CKD than current clinical practice guidelines [11,12]. The aim of this prospective study was to examine whether stratification by SCORED values could be useful in identifying subjects who are at high-risk for CKD in a general population-based sample.

Material and Methods Study

Population

This was a population-based survey of adult households in Palmas, Brazil, which is the Tocantins State capital. The resident population was 184,010 in 2008. The sample size was calculated considering the urban area population, which included individuals over the age of 18 (117,733 inhabitants), and using the national census information available at the National Census and Statistics Bureau of Brazil [13].

The calculated sample size included 873 households in 32 blocks, which corresponded to one individual per household, and was based on a significance level (α error) of 0.05, a β error of 0.1, and a power (1- β) of 0.9. The subjects were visited at their homes for recruitment and data collection. In each household, one eligible subject above the age of 18 was randomly selected. The subjects were ineligible if they were mentally unable to answer the questionnaire, were not a resident of Palmas, or directly declined to participate. Substitution of refusal by another participant was not allowed in the same household. A user-friendly questionnaire was administered to collect participant data, and the trial was conducted from August to December 2008. The Institutional Ethics Committee approved this research protocol, and all participants gave their informed consent to participate in the study.

During on-site domiciliary interviews, data were collected by previously trained personnel (*medical student from Federal University of Tocantins*) to ascertain medical and health information from

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participants via direct interview, examination, and blood sample (actual capillary glycemia, Accu-Chek Active® Roche). Body weight was measured to the nearest 0.1 kg with a digital scale, and height was measured to the nearest centimeter with a wall stadiometer. Self-reported diabetes mellitus and hypertension were validated with the recommended definitions of the Expert Committee on the Diagnosis and Classification of Diabetes Mellitus [14] and the Third Joint National Committee on the Detection, Evaluation, and Treatment of High Blood Pressure [15]. For our analysis, the mean follow-up blood pressure was defined as the average of 3 blood pressure measurements obtained during the interview and ambulatory controls. Following the domically interview, the subject was referred to the University Hospital for blood tests (fasting blood glucose and creatinine) and urine analysis. Serum creatinine concentration was determined by the modified kinetic Jaffe method, and all samples were analyzed in the same laboratory using the same equipment.

The glomerular filtration rate (GFR) was estimated by using the abbreviated Modification of Diet in Renal Disease (MDRD) equation [16]:

GFR (ml/min/1.73 m^2) = 186 x Serum Creatinine (mg/dl)$^{-1.154}$ x Age (years)$^{-0.203}$x1.212(if Black) x(0.742(if Female).

All individuals with GFRs less than 60 ml/min/1.73 m^2 at the time of first interview were recruited 3 months later for a second plasma creatinine analysis. CKD was defined as kidney damage and/or a GFR less than 60 ml/min/1.73 m^2 for more than 3 months, with no identified reversible cause [8,17]. This range corresponds to Stage 3 or higher CKD [8,17], and helps identify individuals with clinically significant CKD [8,18].

The SCORED value was calculated for each subject as previously described [11,12,19]. The SCORED model is a validated multivariable mathematical function that gives an estimated probability of CKD, using the following variables: age>50 years (ages 50–59 years, 2 points; ages 60–69 years, 3 points; aged ≥70 years, 4 points), gender (woman, 1 point), anemia (presence, 1 point), proteinuria (presence, 1 point), cardiovascular disease (presence, 1 point), congestive heart failure (presence, 1 point), diabetes mellitus (presence, 1 point), and peripheral vascular disease (presence, 1 point) [11,12]. The SCORED values were stratified into low (<4) or high (≥4) categories. In the National Health and Nutrition Examination Surveys (NHANES) study, patients with SCORED values ≥4 had a 20% risk of CKD, whereas those with SCORED values <4 had a very low risk of CKD [11]. The SCORED value was applied to each individual case to assess the model for calculating sensitivity (S), specificity (E), positive predictive value (PPV) and negative predictive value (NPV) to identify patients with CKD, according to the MDRD estimated GFR.

Statistical Analysis

The categorical variables were presented as percentages and the numerical variables by mean, median, and standard deviation. Categorical variables were tested using Pearson's chi-squared test, and continuous variables were tested using Student's t-test. Variables associated with significant risk (p<0.20) in the univariate analysis were included in a multivariate Cox regression model. We used the SPSS 17.0 software to analyze the data.

Values of P<0.05 and β ≤0.20 were considered statistically significant.

Results

Baseline Characteristics

The baseline characteristics of the entire studied population are presented in Table 1. Our cohort consisted of 873 households, with a mean age of 40.3±15.7 years (range: 18 to 87 y), and included 50.7% females, 71.8% nonwhite and 28.2% whites participants. The age, gender, and race distributions were similar to those of the entire urban population of Palmas: 38.7±14.6 yr, 49.1% female, 78.8% non-white and 24.2% white [13].

Table 1: Basic characteristics of the studied population.

Characteristics	n = 873
Age (yr)	40.3±15.7
Female (%)	50.7
Non-white (%)	71.8
Height (cm)	162±10
BMI (kg/m^2)	25.0±4.7
Serum creatinine (mg/dl)	0.8±0.3
DM (%)	3.6
HTN (%)	32.2
CKD (%)	5.3
eGFR (ml/min/1.73 m^2)	113.2±41.9

[a] Data are means±SD. BMI, body mass index; DM, diabetes mellitus; HTN, Hypertension; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

Prevalence of Diabetes and Hypertension

The study population had a 3.6% prevalence of diabetes mellitus. The frequency of diabetes mellitus was greater in women than in men (2.6% vs 7.9%, χ^2 = 12,42; p<0.0001), and increased with age from 2.1% in the <38 age group to 11.9% in the >68 of age group (χ^2 = 16.63; p<0,001 for trend across age groups). Hypertension was detected in 281 (32.2%) of the studied subjects, was more frequent in men than women (58.7% vs 41.3%; χ^2 = 14.29; p<0,001), and increased with age from 20.3% in the <38 age group to 59.7% in the >68 age group (χ^2 = 72.33; p<0,001).

Prevalence of Renal Impairment

An estimated GFR <60 ml/min/1.73 m^2 was present in 46 (5.3%) of the participants studied. The frequencies of CKD Stage 3, 4 and 5 were 4.8%, 0.5% and 0%, respectively. The risk for CKD was greater in women than in men (7.9% vs 2.6%, χ^2 = 12.48; p<0.0001, with odds ratio 3.27, CI95% = 1.64 - 6.52), and it increased with age from 2.7% in the 18-44 age group to 19.0% in those >65 (p <0.001 for the trend across age groups). The patients with CKD were older than the subjects with GFR >60 ml/min/ 1.73 m^2 (54,0±16,8 vs 39,5±15,3 years, p<0.0001). The prevalence of estimated GFR <60 ml/min/ 1.73 m^2 was similar in white and non-white subjects (p=0.380), and greater in lower as compared to higher socioeconomic classes (χ^2 =23.32, p<0001).

SCORED model

SCORED values were calculated for all individuals, and included 224 (25.7%) patients with high SCORED values (≥4), and 649 (74.3%) subjects with low SCORED values. The subjects with higher SCORED values were at a significantly higher risk of CKD compared to those who had lower SCORED values (12.9% vs 2.6%, χ^2 = 35.58; p<0.0001 – odds ratio = 5.523 and CI95% 2.98 – 10.28) – Table 2. The sensitivity for predicting CKD by the SCORED model was 63%, and the specificity was 76%; the positive predictive value was 13%, whereas the negative predictive value was 76%.

Discussion

In the general population, the SCORED model was designed and validated to identify individuals with undiagnosed CKD who could be referred for further laboratory evaluation and follow-up testing [11,20]. Using a cutoff score of 4 or higher, we showed a sensitivity, specificity, and negative predictive value of 63%, 76%, and 76%, respectively, and the study population had a 5.3% prevalence of CKD. An extensive analysis of the cost effectiveness of screening for proteinuria in adult showed that maximization of the sensitivity and negative predictive value was more important than that of specificity to detect this abnormality [21].

To our knowledge, this paper is the first prevalence study in the world that was designed to screen for CKD using the SCORED

Table 2: Distribution of SCORED values in the studied population.

Variable		Chronic Kidney Disease		OR (95% CI)		$\chi 2$	*P*	
		Negative	%	Positive	%			
Scored Value	Low, <4	632	97.4	17	2.6	5.523 (2.9828)0.	35.58	<0.001
	High, ≥4	195	87.1	29	12.9			

OR: odds ratio

model in a population-based survey of adult households. It is also the first randomized study to investigate the prevalence of CKD in a community, taking into account the new definitions for kidney disease.

The demographic characteristics of the study participants were similar to those of the urban population of Palmas, and the subjects studied here could be considered a representative sample of this population. The prevalence of diabetes mellitus was lower than that reported by previous international and Brazilian studies [22,23]; however, a survey by the Brazilian Ministry of Health, found that the prevalence of a previous medical diagnosis of diabetes mellitus (telephone interview) was 2.4% in the population of Palmas in 2008 [23]. This finding could be explained by the relatively younger Palmas´ adult population. The prevalence of hypertension among studied households (32.2%) was similar to that previously reported for the population of Palmas and the general Brazilian population [23-25].

Analyzed for the NHANES dataset, the sensivity and the negative predictive value of SCORED were estimated to be 95% and 99%, respectively [11,12]. The SCORED model was evaluated in the ARIC (Atherosclerosis Risk in Communities) dataset, which enrolled more than 15,000 participants, aged 45 to 64 years. In this community study, the sensitivity and negative predictive value were estimated to be 88% and 98%, respectively [12]. In the same paper, using the Cardiovascular Heart Study (ARIC/CHS), a community study enrolled 5,201 subjects 65 years and older, and reported the sensitivity and negative predictive value to be estimated at 90% and 98%, respectively [12].

Recently, the higher risk of CKD in patients with specific diseases and high SCORED values was demonstrated. For heart attack and stroke patients, respectively, the SCORED guideline yielded sensitivities of 94% and 97%, and negative predictive value of 93% and 89% [20]. A study investigated whether the SCORED model could identify patients with renal masses who were at risk for having or developing CKD, after partial or radical unilateral nephrectomy, and a high SCORED value was associated with a higher risk for having or developing CKD [19].

Currently, CKD can be considered a public health issue [11,12,26], and CKD fulfills the following criteria for a disease suitable for screening: the disease has serious clinical and economic consequences, treatment is more effective at earlier stages, and has a long preclinical phase [12]. Based on the evidence, only a few studies are available to choose an ideal method of screening for CKD, but the greater specificity of the SCORED model compared to other screening models, may reduce over diagnosis and enhance the use of public resources to detect CKD [12].

Our study has several limitations that must be further explored. In this study, the measured serum creatinine levels were not calibrated to the methods used by the MDRD research laboratory. They were based on the clinical assay, which may differ from the assay used to update the MDRD formula [27]. The diagnosis of CKD was based on only two determinations of serum creatinine and eGFR, as suggested by new definitions for CKD [8,17], and more measurements over time are recommended for the accurate clinical diagnosis of CKD [8,16-18]. However, the high sensitivity and negative predictive value of the SCORED questionnaire and the implications of these data for the adult population of Palmas, and Brazil in general, are significant.

In summary, the results of the SCORED questionnaire showed a strong relationship with CKD and its risk factors, and it was useful in tracking the disease in the general population. Because of its easy and inexpensive application, the SCORED questionnaire should be implemented in health policy, and primary care physicians should be encouraged to use this tool as an initial screening for CKD.

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Disclosures None.

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