Distribution of Albuminuria and Low Glomerular Filtration Rate in a Rural Area, Shahreza, Iran

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Introduction. Chronic kidney disease (CKD) is becoming a major public health problem worldwide. A remarkable part of health budget is designated annually to control end-stage renal disease in most countries. The aim of this study was to screen for CKD among the general population of the rural area of Shahreza, in the central region of Iran.
Materials and Methods. In a study of rural area around Shahreza, Iran, in 2009, a total of 1400 participants aged over 30 years old were selected by systematic randomized sampling. Glomerular filtration rate (GFR) was used as an index of kidney function and albuminuria, as an index of kidney damage. The simplified Modification of Diet in Renal Disease Study equation was used for estimation of GFR.
Results. A GFR less than 60 mL/min/m^2 was found in 4.7% of the study population (1.8% in men and 6.1% in women). Microalbuminuria and macroalbuminuria were present in 16.2% of the participants (15% of men and 16.8% of women). Pyuria and hematuria rates were 12.3% and 12.6%. The prevalence of a GFR less than 60 mL/min/1.73 m^2 was significantly increasing by age groups in both genders.
Conclusions. Considering its high prevalence, CKD needs measures to identify the disease sooner and requires an active national screening program to identify patients in earlier stages. It seems reasonable to integrate such programs in the primary healthcare system.

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INTRODUCTION

Chronic kidney disease (CKD) is a growing public health problem leading to the increasing prevalence of kidney failure, high costs, and poor outcomes.[1] Chronic kidney disease is mostly characterized by a progressive decline in the glomerular filtration rate (GFR). The diagnosis is based on a reduced GFR for a minimum of 3 months and is often accompanied by albuminuria.[2] In Iran, the prevalence and incidence of end-stage renal disease (ESRD) have been increasing from 137 per million people (pmp) and 13.8 pmp in 1997 to 238 pmp and 49.9 pmp in 2000 and to 357 pmp and 63.8 pmp in 2006, respectively. The mean growth rate of patients with ESRD has been 12% in the past 10 years in Iran.[3] In a study of 17 240 individuals aged over 14 years from 30 counties of Iran, 31.7% of the participants had an estimated GFR between 60 mL/min/1.73 m^2 and 89 mL/min/1.73 m^2 and 7.8% and 0.5% had

GFRs between 30 mL/min/1.73 m^2 and 59 mL/min/1.73 m^2 and less than 30 mL/min/1.73 m^2, respectively. In all, 12.6% of the studied population had CKD.[4] Diabetes mellitus and hypertension account for 45% of the initiating factors of CKD in Iran.[5]

Screening for microalbuminuria in the general population is a matter of debate at present. Selective screening of people with hypertension, diabetes mellitus, and those over the age of 55 years old is considered the most effective strategy to detect patients with CKD.[6] Screening for albuminuria and treatment of individuals with an elevated urine albumin excretion with an angiotensin-converting enzyme inhibitor was proved cost-effective for prevention of cardiovascular events and effective in decreasing mortality.[7] The aim of this study was to investigate the prevalence of CKD among the rural population of Shahreza, a central region of Iran.

MATERIALS AND METHODS

Study Population

Shahreza CKD Study (SCKD study) was designed to determine the prevalence of CKD in Shahreza for integration of a CKD program in the public health system. This is a descriptive study in subsidiary villages of Shahreza town in Isfahan province in 2009. The study was approved by the Human Research Review Committee of the Urologic Research Center. For sampling, the list of all households under the coverage of the district's 3 rural healthcare centers was used. Then, a random sample of the nearby households, stratified according to the 3 healthcare centers was selected to achieve a distribution similar to the original population. In each household, all members above 30 years old were recruited. The inclusion criteria were Iranian nationality and an age greater than 30 years old. The exclusion criteria were pregnancy and refusing participation in the study.

A total of 1400 adults (442 men and 958 women) participated in the SCKD study. All of the participants were visited at the *healthcare homes*. Fifty-nine percent of the men and 37.0% of the women were literate. The educational levels attained by the literate participants were high school (61.2%), primary school (27.6%), and college (10.5%). 41.4% were housewives, 31.5% were employed, and 14.8% were students.

Measurements

Following informed consent, all eligible participants were evaluated by trained personnel offering primary health care in the healthcare home according to a standard protocol. Personal, demographic, and clinical data were obtained using a standardized questionnaire. Diabetes mellitus was identified as a history of diabetes mellitus (self-reported) or elevated blood glucose (fasting, ≥ 126 mg/dL; nonfasting, ≥ 200 mg/dL). Blood pressure was measured twice after the participant was seated for 15 minutes, using a standard mercury sphygmomanometer calibrated by the Iranian Institute of Health System. There was at least a 10-minute interval between these two separate measurements and the mean of two measurements was taken as the blood pressure. Hypertension was identified as a history of hypertension (self-reported) or elevated blood pressure measured during the study (systolic, ≥ 140 mm Hg or diastolic, ≥ 90 mm Hg).

Laboratory studies including serum creatinine level, urine microalbumin and creatinine levels, and urinalysis were done. Body mass index, GFR, and urine albumin-creatinine ratio (ACR) were calculated. Kidney function (GFR), kidney damage (microalbuminuria), and stages of CKD were estimated using calibrated serum creatinine levels, spot urine ACR, age, gender, and race. The simplified Modification of Diet in Renal Disease (MDRD) Study equation was used to estimate GFR. A low GFR was defined as an estimated GFR less than 60 mL/min/1.73m^2. Stages of CKD were defined as follows: stage 1, GFR ≥ 90 mL/min/1.73 m^2 and ACR ≥ 30 mg/g; stage 2, GFR between 60 mL/min/1.73 m^2 and 89 mL/min/1.73 m^2 and ACR ≥ 30 mg/g; stage 3, GFR between 30 mL/min/1.73 m^2 and 59 mL/min/1.73 m^2; stage 4, GFR between 15 mL/min/1.73 m^2 and 29 mL/min/1.73 m^2; and stage 5, GFR < 15 mL/min/1.73 m^2.

Blood samples were drawn between 7:00 AM and 9:00 AM into tubes from all study participants after 12 to 14 hours of overnight fasting. All blood analyses were made at Amirolmomenin Hospital laboratory on the day of blood collection using a BP2000 auto-analyzer. Urine microalbuminuria was measured with a Randox kit (Randox Laboratories, Antrim, UK). Albuminuria was categorized as follows: hyperalbuminuria, 10 mg/L to 29 mg/L;

microalbuminuria, 30 mg/L to 299 mg/dL; and macroalbuminuria, 300 mg/dL and higher. Albuminuria was defined as urine albumin of 30 mg/dL and higher.

Statistical Analyses

For the purpose of data analysis, the study population was divided into four age groups (30 to 44 years, 45 to 59 years, 60 to 74 years, and 75 years and older). The analysis was done using the SPSS software (Statistical Package for the Social Sciences, version 17.0, SPSS Inc, Chicago, Ill, USA). The data are presented as frequencies, percentages, mean ± standard deviation, and 95% confidence intervals. The age-specific distributions of the prevalence of metabolic abnormalities were calculated separately for men and women. The prevalence of different abnormalities was compared using the chi square test, and the *t* test was used to compare continuous variables between groups. A *P* value less than .05 was considered significant.

RESULTS

Based on the MDRD estimation of GFR, 4.7% of the participants (1.8% of the men and 6.1% of the women) had a GFR less than 60 mL/min/1.73 m^2. Albuminuria was present in 16.2% of the participants (15% of the men and 16.8% of the women). Of the men, 18.2% were smokers (Table 1).

Taking antihypertensive medication was reported in 7.3% and hypoglycemic agents or insulin in 3.6% of the participants. History of hypertension, heart disease, diabetes mellitus, and kidney disease were reported by 12.2%, 6.6%, 3.4%, and 4% of the participants. The prevalence of pyuria, hematuria, and proteinuria were 12.3% (7.2% and 14.6% in the men and women), 12.6% (7.2% and 14.6% in the men and women), and 4.9%, respectively.

Hypertension was present in 13.7% of the study population, and a total of 20% had either a GFR less than 60 mL/min/1.73 m^2 or microalbuminuria (16.6% of the men and 21.6% of the women). The estimated GFR significantly correlated with gender ($P = .04$), age ($P = .001$), literacy ($P < .001$), diabetes mellitus ($P = .001$), hypertension ($P < .001$), and smoking ($P = .03$; Table 2). Albuminuria was significantly associated with gender ($P = .02$), age ($P < .001$), diabetes mellitus ($P = .03$), and hypertension ($P < .001$; Table 3).

Table 1. Demographic and Clinical Characteristics of Participants*

Characteristic	Men		Women		All	
	Mean (Range)	95% CI	Mean (Range)	95% CI	Mean (Range)	95% CI
Age, y	56 ± 11 (30 to 92)	55 to 58	50 ± 13 (30 to 83)	49 to 51	52 ± 14 (30 to 92)	51 to 53
Body weight, kg	69 ± 11 (40 to 112)	67 to 70	63 ± 11 (35 to 118)	62 to 64	65 ± 12 (35 to 118)	64 to 65
Height, cm	167 ± 8 (141 to 188)	166 to 167	154 ± 7 (125 to 179)	154 to 155	158 ± 9 (125 to 188)	158 to 159
BMI, kg/m^2	25.0 ± 3.6 (14 to 37)	24.3 to 25.0	26.6 ± 4.6 (16 to 47)	26.2 to 26.8	26.0 ± 4.5 (14 to 47)	25.7 to 26.2
Waist, cm	89 ± 10 (52 to 124)	88 to 90	89 ± 12 (47 to 140)	88 to 90	89 ± 11 (47 to 140)	86 to 90
Serum creatinine, mg/dL	0.9 ± 0.2 (0.6 to 1.8)	0.86 to 0.89	0.7 ± 0.1 (0.4 to 1.9)	0.71 to 0.73	0.8 ± 0.2 (0.4 to 1.9)	0.76 to 0.78
ACR, mg/g	42 ± 179 (0 to 2433)	25 to 59	43 ± 164 (0 to 2387)	33 to 54	43 ± 169 (0 to 2433)	34 to 52
GFR, mL/min/1.73 m^2	103 ± 23 (37 to 203)	100 to 105	88 ± 20 (31 to 160)	87 to 90	93 ± 22 (31 to 204)	92 to 94

*CI indicates confidence interval; BMI, body mass index; ACR, albumin-creatinine ratio; and GFR, glomerular filtration rate.

Table 2. Indicators of Kidney Function and Kidney Injury in Men and Women*

	All		Women		Men	
Age Group	ACR	GFR	ACR	GFR	ACR	GFR
30 to 44 years	22 ± 90	101 ± 23	25 ± 98	96 ± 20	14 ± 53	119 ± 24
45 to 59 years	40 ± 192	93 ± 19	43 ± 200	88 ± 17	33 ± 175	105 ± 19
60 to 74 years	70 ± 210	84 ± 20	66 ± 169	79 ± 19	77 ± 263	92 ± 18
≥ 75 years	64 ± 168	79 ± 20	97 ± 228	65 ± 12	42 ± 110	88 ± 20

*ACR indicates albumin-creatinine ratio and GFR, glomerular filtration rate.

Table 3. Urinary Albumin Excretion Levels*

Urine Albumin Level	All	Men	Women	Diabetics	Hypertensives	Elderly
Normal	817 (60.8)	274 (63.9)	543 (59.3)	22 (39.3)	57 (31.5)	179 (43.1)
High normal	308 (22.9)	90 (21.0)	218 (23.8)	19 (33.9)	54 (29.8)	117 (28.2)
Microalbuminuria	176 (13.1)	52 (12.1)	124 (13.6)	14 (25.0)	59 (32.6)	95 (22.9)
Macroalbuminuria	43 (3.2)	13 (3.0)	30 (3.3)	1 (1.8)	11 (6.1)	24 (5.8)

*Values in parentheses are percents.

DISCUSSION

The present study showed that 4.7% of a sample of 1400 individuals aged 30 years and older in Shahreza rural area had a GFR less than 60 mL/min/1.73 m^2, which means of the total population of 13660, about 2800 individuals are estimated to have some degrees of kidney dysfunction. The number of dialysis patients of the area is 45, and in 2008, the number of new cases of ESRD was 19. Unfortunately, we could not repeat measurement of the abnormal results 3 months later and we analyzed only a single measurement. In epidemiologic studies such as the PREVEND study, data were based on a one-time screening for urine albumin concentration.[7]

The prevalence of a low GFR in the present study was similar to that reported from Golestan Province, Iran,[8] but less than those of 2 other studies from Iran (Table 4).[4,9-13] Distribution of albuminuria in diabetic patients was 16.2% in one study in Iran.[14] In Safarinejad's study, albuminuria was defined more than 300 mg/g, but in this study, values more than 30 mg/g were considered, and therefore, there is a significant different in results.

There were meaningful relations between CKD and age, history of hypertension, and diabetes mellitus. Twenty-eight percent of our participants with CKD stage 3 had albuminuria; this rate was reported to be 32% in the NAHNES III,[15] in which an ACR higher than 17 in men and higher than 25 in women were the cutoffs. These data show that proteinuria in patients with diabetes mellitus and hypertension is high. Screening for diabetes mellitus and hypertension had begun 10 years before the SCKD study in Shahreza. For this reason, recognition of hypertension and diabetes mellitus was 78% and 80%, respectively. Whereas recognition of CKD was 3%, which conforms to the 3rd National Health and Nutrition Examination Survey study. This shows that there is a need to intervention for improving knowledge of population and physicians about CKD.

Table 4. Prevalence of Chronic Kidney Disease in Different Studies

Study	Population	Country	Sample	Proteinuria/Albuminuria, % (Cutoff)	Kidney Dysfunction, %*
Mathew et al[9]	High risk	Australia	402	23.6 (> 30 mg/g)	8
Keep mexico[10]	High risk	Mexico	1519	19 (> 30 mg/g)	7
Takahashi et al[11]	High risk	Japan	1065	23.6 (> 30 mg/g)	6
Safarinejad[4]	General population	Iran	17 240	4.3 (> 300 mg/g)	8.3
Najafi et al[8]	General population	Iran	3700	4.4 (1+)	4.7
Mahdavi-Mazdeh et al[12]	Taxi drivers	Iran	31 999	0.6 in men, 1.8 in women (1+)	6.5
Ghafari et al[3]	High risk	Iran	905	…	37.9 (high creatinine)
Present study	General population	Iran	1400	16.2 (> 30 mg/g)	4.7

*Glomerular filtration rate < 60 mL/min/1.73 m^2

Because creatinine measurement is not sensitive for GFR determination, its measurement for screening will be troublesome for diagnosis particularly in the elderly population. The Cockroft-Gault formula overestimates and the MDRD formula underestimates GFR. It is recommended that when we use the Cockroft-Gault formula for calculation of GFR, if the result is less than 60 mL/min/1.73 m^2, we should use the MDRD formula too, and this number should be used as scale for drug adjustment.[15] For on-time identification of CKD, it is recommended that physicians consider the memory of GFR and complete simultaneous reporting of GFR to the laboratory. Estimation equations may be less accurate in populations of different ethnics and from outside of the United States, and a standard equation could be determined for the Iranian population.

Investigation of possible tools on integration of CKD, such as what is established for hypertension and diabetes mellitus, is recommended in the form of coordinated facilities in the first level of primary healthcare under direct supervision of government (which reduces the costs). Also, in the second, third, and fourth levels of primary healthcare it can be formed under supervision of the private sector. The government should have a regulatory role with respect to its population in these levels. Increasing information of care units staffs is of utmost importance. Retraining programs for physicians for CKD knowledge is necessary. Continuing training program with preventing and early diagnostic approach should be proposed.

CONCLUSIONS

Controlling ESRD needs screening for risk factors of CKD and intervention for improving them. Considering the prevalence of CKD, we need to screen and identify the disease early and integrate into a CKD care in health care system.

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CONFLICT OF INTEREST

None declared.

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