Prevalence of chronic kidney disease among adults in a rural community in South India: Results from the kidney disease screening (KIDS) project

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ABSTRACT

Prevalence of chronic kidney disease (CKD) appears to be increasing in India. A few studies have studied the prevalence of CKD in urban populations, but there is a paucity of such studies in the rural populations. This project was undertaken to study the prevalence of CKD among adults in a rural population near Shimoga, Karnataka and to study the risk factor profile. Door-to-door screening of 2091 people aged 18 and above was carried out. Demographic and anthropometric data were obtained, urine was analyzed for protein by dipstick and serum creatinine was measured in all participants. Glomerular filtration rate was estimated (eGFR) using the 4-variable modification of diet in renal disease (MDRD) equation and Cockcroft-Gault equation corrected to the body surface area (CG-BSA). The total number of subjects studied was 2091. Mean age was 39.88 ± 15.87 years. 45.57% were males. The prevalence of proteinuria was 2.8%. CKD was seen in 131 (6.3%) subjects when GFR was estimated by MDRD equation. The prevalence of CKD was 16.54% by the CG-BSA method. There was a statistically significant relationship of CKD with gender, advancing age, abdominal obesity, smoking, presence of diabetes and hypertension. The prevalence of CKD is higher compared to the previous studies from rural India and is comparable to that in the studies from the urban Indian populations. The wide difference between the CKD prevalence between MDRD and CG-BSA equations suggests the need for a better measure of kidney function applicable to Indian population.

Key words: Chronic kidney disease, community-based study, estimated glomerular filtration rate, India, prevalence, rural population

Introduction

Chronic kidney disease (CKD) is rapidly assuming epidemic proportions globally.[1-3] In India too, there is a significant burden of CKD although exact figures vary.[4] This has been attributed to the increasing prevalence of diabetes, hypertension and ischemic heart disease. The awareness level among the people is poor. At least 70% of the people live in rural areas with limited access to health care services with the result that CKD is often diagnosed in advanced stages. Cost of treatment of advanced CKD is substantial. Less than 10% of end stage renal disease patients have access to any kind of renal replacement therapy.[5,6] In a country with limited resources, it is only appropriate that efforts are directed toward prevention of CKD rather than the treatment. Studies on the prevalence of diseases help in focusing attention to the magnitude of the burden and planning preventive measures. High-risk characteristics that are associated with such prevalence can be modified.

This study was carried out in a rural population in the south interior part of Karnataka, India with the objective of studying the prevalence of CKD and the association with risk factors such as diabetes mellitus, hypertension and obesity, prevalence studies were hitherto not conducted in this region of South India.

Materials and Methods

This study was undertaken in the villages of Hosakoppa, Indiranagar and part of Gajanur area in Shimoga District.

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These villages are located along the state highway about 10 km from Shimoga town, with agriculture being the most important occupation. The villages do not have a primary health center and only a female health worker is designated for health education, antenatal check-up and immunization purposes.

The study was conducted from March 2011 to February 2012. The identification of the localities and households was done with the help of a field auxiliary nurse midwife. The selection of the lane and first house, within the locality was done by random selection, by employing the procedure described in the cluster sampling technique used for evaluation of universal immunization coverage.[7]

Informed consent was obtained from all the subjects 18 years and above. Demographic details and family structure and dietary pattern were determined. Pregnant women and women who had just delivered (up to 40 days after delivery) were excluded. Menstruating women were studied only after their menstrual periods ended to avoid fallacious urinary results.

The field work was carried out by the students of the nursing college attached to Nanjappa Hospital, Shimoga. They were trained in a series of sessions regarding the methodology of data collection, examination and urine analysis. They were also trained in the hospital laboratory about the method of collection of blood. All participants were administered a structured questionnaire, taking into account the educational status and employment status. All were questioned about the presence or absence of symptoms suggestive of renal disease. Past medical history of diabetes mellitus, hypertension, ischemic heart disease and stroke was elicited. Questions pertaining to smoking, alcohol or tobacco consumption was asked. They were then subjected to detailed physical examination with special importance to anthropometrics. Weight was recorded using a standard weighing scale that was kept on a firm horizontal surface. Height was recorded using a stadiometer to the nearest 1 cm. Body mass index (BMI) was calculated using the formula, weight (kg)/height (m^2). Waist circumference and hip circumference was measured according to standard protocol.[7] Waist-hip ratio was calculated as the ratio of waist circumference over hip circumference. Blood pressure measurements were taken for the entire group using standard instruments, which were calibrated daily. Two measurements were taken in the sitting position 5 min apart with the arms resting on a surface and the average was considered to be the blood pressure.

Random midstream urine samples were then taken from all individuals and assessed using 5-parameter dipstick (Agappe diagnostics) for urine protein, urine sugar and blood. The results were visually read and compared with the given standard results and recorded. To minimize inter-observer errors, two nurses were specially designated to do this test for all samples. Blood tests were done for all participants giving their informed consent for the same. Blood was drawn in the fasting state for creatinine and blood sugar. Blood samples were sent within 1 h to the laboratory in Nanjappa Hospital (12 km away) and analyzed using the fully automated biochemistry analyzer (A-25, Biosystems, Spain). Fasting blood sugar was tested by the Glucose Oxidase-Peroxidase method and creatinine was analyzed by the Jaffe's method. Glomerular filtration rate was estimated (eGFR) in all subjects using the 4-variable modification of diet in renal diseases (MDRD) formula (eGFR) and the Cockcroft-Gault (CG) equation corrected to the body surface area (BSA).

Every week on a predetermined day, the investigator (YJA) would visit the area and all the people who had some abnormality either on clinical or laboratory examination would be examined in detail and abnormalities confirmed. This would also provide some opportunity for the villagers to get medical advice about their condition and preliminary treatment. They were also advised the need for further follow-up, treatment and evaluation as the case may be.

Statistical analysis was performed using SPSS version 11 (SPSS Inc., Chicago). Non-parametric test Chi-square was used to study the association between categorical variables. $P \leq 0.05$ were considered to be statistically significant. Multiple logistic regression analysis was performed and odds ratio with 95% confidence limits were obtained to find out the significance of factors contributing to the outcome variable.

Definitions of relevant parameters which were used in the study

CKD is defined as the presence of either kidney damage or glomerular filtration rate (GFR) <60 ml/min/1.73 m^2.[8] Proteinuria was taken as the indicator of kidney damage[9] while GFRwas estimated using predictive equations. Proteinuria was defined as the presence of protein in urine as detected by 1+ (0.3 g/l) or more on dipstick.[10] Hematuria was also defined as 1+ (25 red blood cells/μl) and above. Kidney function was determined by use of both CG corrected to the BSA and the 4-variable MDRD formula.

This estimated creatinine clearance (ml/min) was further corrected to BSA to obtain creatinine clearance (ml/min/1.73 m^2).[11]

Hypertension was defined as the presence of systolic blood pressure ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg[12] on examination or self-reported history of hypertension or use of antihypertensive medications.

Diabetes mellitus was defined as fasting blood sugar value more than or equal to 126 mg/dl[13] or self-reported history of diabetes or taking insulin or other medications for the control of diabetes.

Obesity was defined using the Indian consensus definition:[14] malnutrition < 18 kg/m^2, normal BMI: 18.0-22.9 kg/m^2, overweight: 23.0-24.9 kg/m^2, obesity: >25 kg/m^2. Abdominal obesity was defined as waist circumference in men > 90 cm, women > 80 cm.[14]

Results

This study was conducted between March 2011 and February 2012 in the three villages as mentioned above. The total population of the selected area was 4191. 3683 subjects aged 3 and above were screened for kidney diseases with a detailed questionnaire, anthropometric examination, blood pressure measurement and urine dipstick tests. We selected the cohort of 2728 adults (aged 18 and above) for serum creatinine measurements for the study of prevalence of CKD, risk factors and associations. We excluded those who refused blood tests (n = 245), pregnant women (n = 24), postnatal women (n = 18), whose interview was incomplete (n = 288) and those in whom urine tests was not done (n = 62). We could complete evaluation of 2091 individuals who form the present study cohort [Figure 1].

Demographic characteristics

The total number of subjects studied was 2091. Mean age was 39.88 ± 15.87 years. The subjects were predominantly young with more than 70% aged below 40 years [Table 1]. There was a female preponderance with females constituting (54.43%) of the population studied. 36.39% did not have any education, whereas 29.17% and 23.81% had primary and higher secondary education respectively. Only 11% had received any form of college education. Majority of them (nearly 85%) were either unemployed or were working as laborers, usually agricultural laborers. Only 13.29% subjects had BMI in the range classified as obesity. Nearly 21.75% were underweight and 53.15% had BMI in the normal range. Abdominal obesity was seen in 21.32% of subjects.

Co-morbid illnesses

The prevalence of diabetes in this study was 3.82%. Of the 80 subjects found to have diabetes, only 34 (42.5%) were aware of their diabetic status. Forty-six were newly detected to have diabetes.

Hypertension was seen in 702 (33.62%) subjects of whom only 106 (15.07%) subjects gave a history of hypertension indicating that nearly 84.93%% were unaware of their hypertensive status. The prevalence of Ischemic heart disease, stroke and arthritis as reported by the population was 0.87%, 0.76% and 2.4% respectively. Nearly 0.8% gave a history of long-term exposure to painkillers.

Kidney disease indicators

Symptoms pertaining to kidney disease were present in 9.3% subjects only. Only 6 (0.3%) claimed to have some awareness

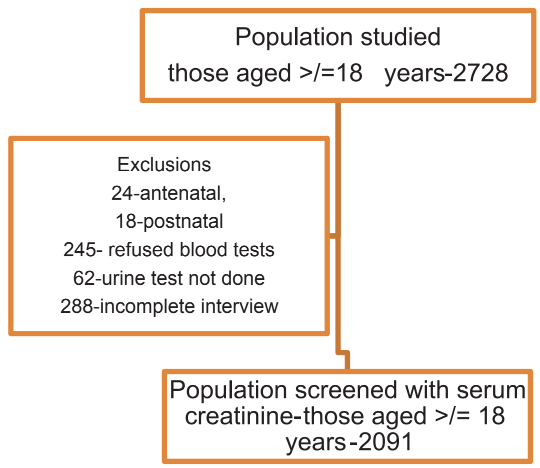

Figure 1: Schematic representation of the study design

Table 1: Demographic characteristics of the studied population (n=2091)

Characteristics	Number	Percentage
Age groups		
10-19	125	5.97
20-29	509	24.34
30-39	500	23.91
40-49	419	20.03
50-59	241	11.52
60-69	192	9.18
≥70	105	5.02
Gender		
Males	953	45.57
Females	1138	54.43
Educational status		
None	761	36.39
Primary	610	29.17
Higher secondary	498	23.81
Pre-university	133	6.30
Graduates	78	3.73
Post-graduates	11	0.52
Occupation		
None	748	35.77
Labor	990	47.34
Agriculture	229	10.95
Professional	100	4.78
Clerical	24	1.14

about kidney diseases. Proteinuria was seen in 60 (2.86%) individuals. Hematuria was seen in 25 (1.2%) subjects. Nine subjects (0.36%) had proteinuria as well as hematuria while hematuria alone was seen in 16 subjects (0.84%).

Serum creatinine was measured in all (2091) subjects (953 males and 1138 females). Mean serum creatinine was 0.93 ± 0.229 mg/dl. Lowest serum creatinine recorded was 0.50 mg/dl while the highest was 2.6 mg/dl. Serum creatinine was higher in males than in females - 1.005 ± 0.231 versus 0.875 ± 0.209 mg/dl ($P < 0.001$). eGFR by CG as well as MDRD formulae. Mean CG creatinine clearance was 73.443 ± 4.59 ml/min; when corrected to BSA, it increased to 84.77 ± 25.18 ml/min/1.73 m^2. Using MDRD formula mean eGFR was 104.44 ± 31.33 ml/min/1.73 m^2. Mean eGFR in males was 94.7 ± 26.24 ml/min/1.73 m^2 and in females was 112.59 ± 32.72 ml/min/1.73 m^2 ($P < 0.001$).

Using the MDRD formula, the prevalence of decreased GFR (<60 ml/min/m^2) was found to be 4.35% in this subgroup of the population whereas the prevalence was as high as 30.3% when the CG formula was applied. Correcting the estimated creatinine clearance to the BSA, the prevalence was found to be 15.6%. The population stratification according to the National Kidney Foundation Kidney Disease Outcomes Quality Initiative (NKF-KDOQI) criteria is tabulated in Table 2. Prevalence of CKD taking both decreased GFR and proteinuria into consideration was found to be 6.3% by MDRD criteria and 16.69% by CG-BSA method.

CKD characteristics and associations

Subgroup analysis was done in the 131 subjects with CKD (MDRD eGFR < 60 ml/min/1.73 m^2. 77 (58.7%) of these were males and 54 were females. Majority of CKD subjects were in the age group of 60-69 (32 subjects) [Table 3]. Mean age of the subjects with CKD was 52.73 ± 17.08 years. Nearly 60% were in nuclear families and only 12% had vegetarian food habits. About 40.48% were uneducated while 31.29% had primary education only. Nearly 80% were either unemployed or were laborers. More than 70% of these subjects were having normal BMI or were underweight. Only 14.5% were obese. However, nearly 30% of the subjects with CKD had abdominal obesity. Proteinuria was present in 60 (45.80%) of CKD subjects while it was absent in 71 (54.20%) of CKD subjects, which indicates that more than one-half of our CKD patients are non-proteinuric. Proteinuria alone without decreased GFR was seen in 40 (30.53%) of CKD subjects [Figure 2].

Association studies: The association of CKD with the demographic, anthropometric and examination findings were studied. The associations are as shown in the Figure 3. On univariate analysis, there was a statistically

Table 2: Stratification of the population according to the GFR (*n*=2091)

GFR categories (ml/min)	MDRD no. (%)	CG no. (%)	CG-BSA no. (%)
>90	1231 (58.87)	449 (21.47)	798 (38.16)
60-89	769 (36.77)	997 (47.68)	956 (45.71)
30-59	90 (4.30)	604 (28.88)	330 (15.78)
15-29	1 (0.05)	40 (1.91)	7 (0.33)
<15	0 (0)	1 (0.05)	0 (0)

GFR: Glomerular filtration rate, MDRD: Modification of diet in renal disease, CG: Cockcroft-Gault, BSA: Body surface area

Table 3: Characteristics of the CKD versus non-CKD group

Characteristics	CKD absent (*N*=1960) no. (%)	CKD present (*N*=131) no. (%)	*P* value	Odds ratio
Age group (years)				
<19	124 (6.3)	1 (0.9)	<0.001(S)	
20-29	497 (25.35)	12 (9.1)		
30-39	481 (24.54)	19 (14.5)		
40-49	392 (20)	27 (20.6)		
50-59	223 (11.3)	18 (13.7)		
60-69	160 (8.1)	32 (24.4)		
Greater than or equal to 70	83 (4.2)	22 (16.79)		
Sex				
Male	876 (44.6)	77 (58.7)	0.002 (S)	1.765
Female	1084 (55.3)	54 (41.2)		
Educational status				
None	708 (36.12)	53 (40.45)	0.50 (NS)	
Primary	569 (29.03)	41 (31.29)		
Higher secondary	470 (23.97)	28 (21.37)		
College	213 (10.86)	9 (6.8)		
Occupation				
None	699 (35.66)	49 (37.4)	0.28 (NS)	
Labor	935 (47.7)	55 (41.98)		
Agriculture	209 (10.66)	20 (15.26)		
Professional	93 (4.7)	7 (5.3)		
Clerical	24 (1.2)	0 (0)		
Type of family				
Joint	536 (27.34)	47 (35.88)	0.035 (S)	0.673
Nuclear	1424 (72.66)	84 (64.12)		
Food habit				
Vegetarian	124 (6.3)	12 (9.1)	0.203 (NS)	
Non-vegetarian	1836 (93.6)	119 (90.8)		
Habits				
Smoking	134 (6.83)	16 (12.2)	0.021 (S)	1.896
Alcohol	199 (10.15)	19 (14.5)	0.115 (NS)	
Tobacco	384 (19.59)	25 (19.08)	0.887 (NS)	
BMI				
<18	424 (21.63)	31 (23.6)	0.631 (NS)	
18-22.9	1054 (53.77)	65 (49.6)		
23-24.9	223 (11.37)	16 (12.21)		
>25	259 (13.21)	19 (14.5)		
Abdominal obesity				
Present	4.8 (20.8)	38 (29.0)	0.027 (S)	1.554
Hypertension				
Present	624 (31.83)	78 (59.54)	<0.001 (S)	3.151
Diabetes				
Present	67 (3.41)	13 (9.92)	<0.001 (S)	3.113

CKD: Chronic kidney disease, BMI: Body mass index significant relationship of CKD with gender, advancing age and abdominal obesity, presence of diabetes, hypertension and smoking. There was however no statistically significant relationship with nutritional status as measured by BMI, educational status, occupation, alcohol intake and tobacco chewing [Table 4].

We also did a multiple logistic regression analysis to see which among these variables would predict higher chances of developing CKD. Age, sex, hypertension and diabetes variables emerged as important risk factors for CKD with $P < 0.001$, 0.01, 0.009 and 0.034 respectively. An increase in 1 year in age carries 4% chance of getting CKD (95% confidence interval [CI]: 2.9-5.2%). Males are 1.69 times (95% CI: 1.135-2.527) more likely to get CKD than females. Patients with hypertension are 1.699 times (95% CI: 1.139-2.533) more likely to get CKD than those without hypertension. Similarly patients with diabetes are 2.05 times (95% CI: 1.054-3.991) more likely to get CKD compared to patients without diabetes [Table 4].

Discussion

Although there are several hospital based studies on the prevalence of CKD in India, population based studies are few and mostly done in urban India.[10,15] There is one large community based study from South India, which studied the prevalence of CKD in the rural population; however, the study was basically directed at screening for risk factors, treating them, following them up and studying the effect on prevention of CKD.[16] Our study differed from this study as we aimed at detection of CKD by screening the population with serum creatinine and studying the association with other risk factors such as diabetes and hypertension. The aim was to create awareness in the population regarding these killer diseases.

Table 4: Variables associated with CKD by logistic regression

Variable	Logistic regression			
	P value	OR	95% CI for OR	
			Lower	Upper
Age	*P*<0.001	1.040	1.029	1.052
Sex	0.01	1.693	1.135	2.527
Type of family	0.393	0.844	0.571	1.246
Hypertension	0.009	1.699	1.139	2.533
Diabetes	0.034	2.051	1.054	3.991
Abdominal obesity	0.312	0.799	0.517	1.235
Smoking	0.898	0.961	0.527	1.753

CKD: Chronic kidney disease, OR: Odds ratio, CI: Confidence interval

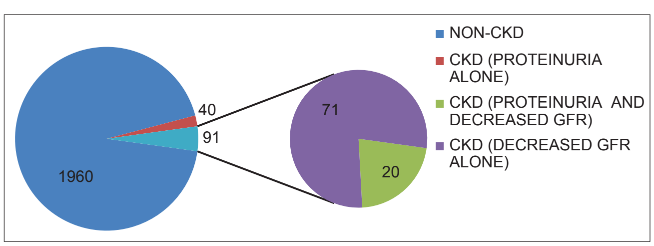

Figure 2: Relative distribution of proteinuric and non-proteinuric chronic kidney disease

Although it is perceived that the prevalence of CKD is increasing in India, the exact figures for the prevalence vary among the different studies. Studies have used different defining criteria and hence the figures of the prevalence vary widely. In a study done in urban Delhi, using criteria of serum creatinine more than 1.8 mg/dl as the cut-off, Agarwal *et al*. have recorded prevalence of 0.79%.[15] The study clearly underestimates kidney disease as serum creatinine of 1.8 mg/dl is definitely a higher cut-off for CKD. Moreover, the study records 4.41% of proteinuria and these subjects were not categorized as kidney disease. In a study of over 25000 individuals from 2 villages near Chennai, the prevalence of abnormal GFR was derived to be 1.39%, taking MDRD GFR of 80 ml/min to be cut-off for normal GFR.[16] In another study, Singh *et al*. employed random cluster sampling method to screen 5252 subjects aged more than 20 years across the city of New Delhi.[10] Using MDRD GFR of 60 ml/min/1.73 m^2, the prevalence of decreased GFR < 60/ml/min/1.73 m^2 was 4.2% while the prevalence with CG-BSA was 13.3%. The prevalence of MDRD GFR < 60 ml/min in our study was 4.35% while the prevalence as studied with CG-BSA was 15.6% and is comparable to the New Delhi study. Prevalence of CKD in our study was 6.3% including subjects with proteinuria and those with decreased GFR. This study points to a higher prevalence of CKD even in a rural setting where the prevalence of lifestyle diseases such as diabetes and hypertension are considered low. Unlike the earlier study by Mani, we studied all adults > 18 years with serum creatinine and this is probably the reason for the higher prevalence of CKD in our study.

Studies on the prevalence of CKD in India are hindered by the lack of a GFR estimating equation validated to

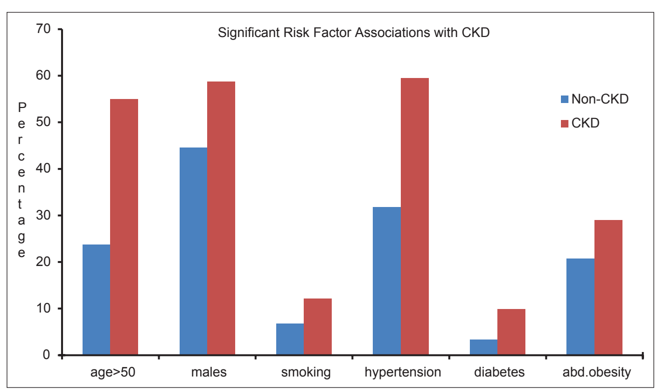

Figure 3: Distribution of characteristics between chronic kidney disease and non-chronic kidney disease

the Indian population. MDRD formula is not validated in the Indian population.[10] Many developing countries have derived a correction factor that can be applied to the GFR.[17,18] In India, no such correction factor or coefficient has been derived for modifying the MDRD formula to suit Indian population. There is no other creatinine based GFR prediction equation either that has been widely applicable to our population. Hence, we have used the MDRD 4-variable formula. However, this equation is known to result in underestimation of GFR in the healthy subjects.[19] On the other hand, using the CG equation gave unusually large numbers of CKD in the study. This has been seen in other studies also.[10,11] This is probably because the equation takes body weight into consideration and in our population with a significant number of underweight subjects, GFR may be estimated to be falsely low. Hence the value was corrected to the BSA of the subjects and after that, the figures reduced substantially. Thus, CG formula appears to be a poor estimate of GFR in our population and grossly underestimates renal function. Studies have shown that CKD-EPI equation using serum creatinine traceable to isotope dilution mass spectrometry (IDMS)[20] is probably the most accurate of all GFR estimating equations till date.[21,22]

NKF-KDOQI defines CKD as either decreased GFR < 60 ml/min/1.73 m^2 with or without kidney damage or presence of kidney damage without decreased kidney function for a period more than 3 months.[8] Proteinuria was defined as urine albumin to creatinine ratio > 30 mg/g.[23] Proteinuria can be tested either as albumin excretion rate (AER) or albumin-to-creatinine ratio (ACR). Alternatively proteinuria in excess of 30 mg/dl in spot urine samples is also indicative of kidney damage.[9] In this study, urinary AER and urine ACR was not tested due to the additional cost involved. Hence, we defined CKD as the presence of dipstick-positive proteinuria or eGFR < 60 ml/min/1.73 m^2 irrespective of evidence of kidney damage and studied the characteristics as well as associations. The figures of CKD prevalence would be higher if AER or ACR were to be tested. Varma *et al.*, in their study on apparently normal Central Government employees have recorded prevalence of 11.47% of deranged ACR (30-300 mg/g).[24] We had initially planned to recheck serum creatinine in all subjects after 3 months, this could not be done due to logistic reasons. We could recheck serum creatinine in the 91 subjects with decreased GFR and confirm their low eGFR.

The ideal method to screen the population for CKD is debated in many studies.[25] Screening the population as a whole is one strategy but yields lower results when compared with screening high-risk groups only.[26] On the contrary, results from our study indicate that restricting screening to the high-risk group alone would prevent the detection of more than half of the CKD group. Further door-to-door screening is easier to employ in a place with minimal resources. Hence we adopted this method of screening.

In our study, the mean age of subjects with CKD was 52.73 ± 17.08 years. There were 77 males and 54 females. 63 (48%) were either illiterate or had primary education only. 73 (55.72%) were unemployed or laborers. This translates to a tremendous burden of CKD in India in a segment of the population that is only barely capable of the huge twin socio-economic stress of future renal replacement and cardiovascular disease. This re-emphasizes the need for preventive model for decreasing CKD burden in India.

Diabetes was newly detected in 46 patients while 34 were aware of their diabetic status. Thus, the prevalence of diabetes was 3.82%. This was lower than that in several of the Indian studies in the rural population. However, age wise-stratification of diabetic individuals revealed that 7% were aged < 30 years. The prevalence of diabetes in most Indian studies from rural areas is around 6-7%, but most have been studied in the age group above 30 years.[27-29] Adjusting for age, the prevalence of diabetes in our study is 5.01%, which is comparable to that in the other studies from rural populations. Hypertension was seen in 33.57% of the subjects of whom 15.1% subjects only gave a history of hypertension indicating that nearly 84.9% were unaware of their hypertensive status. The hypertension prevalence varies between 20% and 35% in several studies from the rural population across different regions of India,[30-33] but all studies concur on the low level of awareness about the disease. It is difficult to explain the cause for the high prevalence in our study as the majority of our subjects had normal or low BMI. We speculate that socio-cultural practices including dietary intake of salt or possible presence of environmental toxins including pesticides may be the cause of high prevalence of hypertension in this area and this aspect needs to be studied further. This study also showed that abdominal obesity is more prevalent, even in the rural population. It also showed that there was no statistically significant association of CKD with obesity as measured by BMI criteria, but abdominal obesity was found be a significant association.

Another interesting observation is the low prevalence of proteinuria in this study. Most other studies have recorded higher number of proteinuria occurrence in CKD. Among 131 subjects with CKD, only 60 had proteinuria while it was absent in 71 (54.20%) subjects. However, the association of proteinuria was found to be statistically significant ($P < 0.001$). The low level of proteinuria is probably peculiar to this region and this is another aspect that is not seen in several other studies of CKD.[10,34] This emphasizes that the possibility of missing CKD patients in the early stages is very high, given that in most of these villages, the family physicians generally ask for urine analysis during the examination for various conditions, whereas serum creatinine is not generally tested.

This is the first study of its kind from this region of Karnataka. The recently concluded Screening and early evaluation of kidney disease-India study included around 1500 subjects from Bangalore and Mysore.[34] However that study included both urban and rural subjects. The design of that study is also different with the subjects being attendees of camps aimed at detecting kidney diseases. Hence the study involves some selection bias in that it is likely to have included many subjects who may have had more awareness about kidney diseases and even some who were already knowing about their kidney status. The higher prevalence of proteinuria in that study also is probably indicative of the CKD awareness of some of the camp attendees. Our study, being near-total coverage of the target population with minimal or no awareness about kidney diseases is thus more representative of the true prevalence of CKD. Another important attribute of our study is that the figures are obtained from a rural and predominantly uneducated population with the majority of them belonging to lower socioeconomic strata. India has nearly 70% people in the villages and there is a need to know the epidemiology of CKD in this background. This study reflects on the increasing numbers of diabetes, hypertension and CKD in the villages of India and highlights the need for education of the masses about these life-style diseases in addition to other preventive strategies.

There are a few limitations in this study. This study is not representative of the overall status of CKD in India as all religions and the socioeconomic strata are not represented in the study cohort. We employed simple door-to-door screening and did not study by cluster sampling or systematic random screening which would eliminate some of the biases. This method of screening was employed as the nursing volunteers who carried out the field work would find the method simpler and easy to follow which would result in more reliable data collection. This method also ensured a better participation from the villagers as they were likely to be suspicious of the motives and less likely to co-operate if certain members only were singled out. The problems with the GFR estimating equations in our population in whom these equations are not validated are alluded to previously. Serum creatinine was estimated in the local laboratory. it was not standardized to a central reference laboratory as in several other studies.[34] One could argue that this may have resulted in an overestimation of CKD cases. However ours was a single-center, single-investigator study with limited resources. Further, in a clinical setting, one would rely on the Creatinine tested in the local laboratory for detection of CKD. Hence the same method and the locally available resources were employed in the study too. It is recommended that in situations where serum creatinine is not standardized, GFR < 60 ml/min/1.73 m^2 alone be recognized as decreased GFR.[35] This was employed in our study. Proteinuria was also detected by single urine analysis in most of the cases. There are many physiological and pathological conditions that could result in a false positive test for proteins. Usage of ACR or AER would have picked up more number of cases of early CKD in stages 1 and 2. Further, for association studies to be meaningful, we should have had more number of CKD subjects.

Conclusions

This study points to the growing prevalence of CKD even in the rural areas in India. Prevalence of CKD taking both decreased GFR and proteinuria into consideration was found to be 6.3% by MDRD criteria and 16.69% by CG-BSA. There was a statistically significant relationship of CKD with gender, advancing age, abdominal obesity, presence of diabetes, hypertension and smoking by univariate analysis. On regression analysis, age, gender, diabetes and hypertension were found to be predictive for CKD.

Thus, this study attempts to highlight that one in every twenty individuals is suffering from CKD. There is a strikingly increasing prevalence of life-style diseases such as hypertension and obesity in the villages and there is a tendency for the younger people to be affected with these diseases. There is a dismally low awareness of CKD as well as hypertension. This study thus emphasizes the enormous proportion of morbidity that is likely to unfold in the coming years in India as CKD implies the twin burden of end stage renal disease as well as increased cardiovascular morbidity. Studies should also be designed that look at the probable causal role of kidney specific risk factors such as non-steroidal anti-inflammatory drug use, influence of herbal medicine and environmental toxins in these areas. For any study on the prevalence of diseases to be meaningful, there is a need to follow-up the population with preventive strategies and to stem further increase in the prevalence by regular surveillance. This will be the direction of our future involvement in this area.

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