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Prevalence and risk factors of chronic kidney disease: a single day screening on World kidney day for four consecutive years in Varanasi

Abstract

Introduction: Chronic kidney disease is a major public health problem. The lack of community-based screening programs for chronic kidney disease, results in patient detection at advanced stages. The present study is a hospital camp-based screening for detecting patients with chronic kidney disease in Varanasi from 2008-11.

Methods: The study subjects constituted 645 apparently healthy adults (age ≥18 years) of Varanasi. Information on socio-demographic profile, personal characteristics and clinical investigations were recorded. Stepwise binary logistic regression analysis was applied to find the significant predictors of chronic kidney disease.

Results: Median age of the study subjects was 40 years. There were 60.8% males and 39.2% females. Chronic kidney disease was found in 46.7% subjects. Diabetes mellitus, hypertension and higher creatinine levels (≥1.30mg/dl) came out as significant predictors of chronic kidney disease.

Discussion: We screened apparently healthy individuals and found very high percentages of chronic kidney disease and its related predictors. Henceforth, early screening for chronic kidney disease case detection along with its co morbidities becomes a prerequisite to reduce the load of health care delivery system that are involved in renal replacement therapy and treatment of other chronic diseases.

Keywords: chronic kidney disease, serum creatinine, albuminuria, diabetes mellitus, hypertension

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Introduction

Chronic kidney disease (CKD) is an emerging public health problem due to associated adverse clinical outcomes, poor quality of life and high healthcare costs.[1,2] Delayed recognition and treatment of CKD may predispose patients to unfavorable future outcomes. Early detection of disease via screening programs is widely recommended.[3] The lack of community-based screening programs for CKD, results in patient detection at advanced stages.[4] We conducted a camp-based screening of general population on World Kidney Day in four consecutive years for detecting patients with CKD.

Methods

Data characteristics

The study subjects constituted 645 apparently healthy adults (age ≥18 years) of Varanasi. Screening was done as a part of World Kidney Day celebration, in the month of March, from 2008-2011, a total of four consecutive years, every year according to the theme of World Kidney day. Individuals aged ≥18 years of age were invited to participate in the study through electronic media and newspapers. Approval to conduct the screening camp was obtained from the Ethical and Research Committee of Opal Hospital. All the participants provided informed consent. Subjects with symptomatic acute kidney injury (AKI) or transplanted kidneys were excluded from the screening.

Information on socio-demographic profile and personal characteristics like, age, sex, height, weight, smoking status, history of diabetes mellitus (DM) and hypertension (HTN), familial history of kidney disease was extensively interrogated and clinical investigations like, random blood sugar (RBS), urinalysis and serum creatinine levels were recorded. Systolic and diastolic blood pressures (BP) were measured only on one occasion, i.e. on the day of screening.

Definitions of variables

Some of the variables were converted into categories for appropriate clinical interpretation. Age was divided into 3 categories (in complete years), e.g. young adults (<45), middle aged adults (45-65) and elderly (>65). Gender was classified into two, males and females. Body mass index (BMI) was calculated using height and weight and divided into 4 categories (in kg/m^2): underweight (<18.50), normal (18.50-24.99), overweight (25.00-29.99) and obese (>29.99).

Diabetes was defined as the use of glucose lowering medicine and/or RBS ≥200. HTN was defined as the use of any hypertensive and/or based on systolic (SBP >140) and/or diastolic BP (DBP >90). Smoking status, DM, HTN, family history of renal disease and albuminuria was dichotomized as: yes (present) and no (absent). Serum creatinine level (mg/dl) was divided in 2 groups: normal (<1.30) and abnormal (≥1.30).

A urine dipstick (Medi-Test Combi 9-Macherey Nagel, Duren, Germany) was performed for each individual. Two millilitres of blood sample was collected from each participant through venepuncture to investigate for serum creatinine level.

The outcome variable of interest was presence of CKD based on estimated glomerular filtration rate (eGFR) levels and albuminuria. GFR was calculated using the Modification of Diet in Renal Disease (MDRD) equation for adults.[5] All individuals with a positive (CKD) test result were referred to the nephrologists, but they were not followed up in future course of time.

Albuminuria was regarded as significant if 1+ and above.[6] CKD stages were defined as: stage 1 if eGFR ≥90 and albuminuria present; stage 2 if eGFR= 60 to 89 and albuminuria present; stage 3 if eGFR= 30 to 59; stage 4 if eGFR= 15 to 29; and stage 5 if eGFR <15 according to the National Kidney Foundation (NKF) Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines.[7,8]

Statistical analysis

All the statistical analysis was performed on Stata/IC V10.1 (StataCorp. College Station, TX, USA). Normality of the continuous variables was checked using Kolmogorov Smirnov test. For the continuous non-parametric data, medians (inter-quartile range (IQR)) were reported. Proportions were given for categorical variables. The continuous variables were categorized and the association of each variable with the outcome was seen separately using Pearson's chi square test.

Further, a two-step procedure was used to select the most appropriate and parsimonious predictive model for the predictors of CKD. Initially bi-variable binary logistic regression analysis was performed. The predictors significant in bi-variable analysis (at 10%) were taken into the final multi-variable binary logistic regression analysis. Predictors were also tested for presence of potential confounding and interaction. Stepwise backward likelihood Ratio logistic regression was performed to eliminate insignificant predictors of CKD in multi-variable logistic regression and p-value of 0.05 was used as a threshold for predictors to contribute significantly. 95% confidence intervals of the estimated odds ratio (OR) was also obtained along with the corresponding p-values.

Results

A total of 645 participants screened on a single day for 4 consecutive years were clubbed together for analyses. The profile of the study participants is presented in Table 1. Median age of the subjects was 40 (IQR= 30-50) years. There were 392 (60.8%) males and 253 (39.2%) females. The median BMI was 20.4 (IQR= 17.3-24.4) kg/m^2. Median SBP and DBP were 120 (110-140) and 80 (70-90) mm Hg respectively. CKD was determined in 46.7% subjects. GFR <60ml/min/1.73m^2 was seen in 16.7% subjects.

Table 1 Profile of participants according to chronic kidney disease outcome

Characteristics	N	% distribution	% CKD	Pearson's χ^2 p value
Age (years)				
<45	377	58.4	40.1	
45-65	235	36.4	53.2	<0.0001
>65	33	5.1	75.8	
Gender				
Male	392	60.8	44.4	0.149
Female	253	39.2	50.2	
BMI				
Underweight	224	34.9	50.9	
Normal	271	42.3	45.4	0.435
Overweight	89	13.9	41.6	
Obese	57	8.9	45.6	
Smoking				
Yes	50	7.8	54	0.279
No	595	92.2	46.1	
Family history of renal disease				
Yes	30	4.7	56.7	0.264
No	614	95.3	46.3	
DM				
Yes	90	14	72.2	<0.0001
No	555	86	42.5	
HTN				
Yes	294	45.6	55.4	<0.0001
No	351	54.4	39.3	
Albuminuria				
Yes	234	36.3	100	<0.0001
No	411	63.7	16.3	
Serum creatinine (mg/dl)				
<1.30	557	86.4	39.7	<0.0001
≥1.30	88	13.6	90.9	
eGFR (ml/min/1.73m^2)				
≥90	312	48.4	39.7	
60-89	225	34.9	30.7	
30-59	95	14.7	100	<0.0001
15-29	5	0.8	100	
<15	8	1.2	100	

Maximum CKD cases (75.8%) were lying in the elderly group (>65 years). CKD was significantly associated with age of the subjects (p<0.0001). Nearly half of the females (50.2%) and little lower number of males (44.4%) were suffering with CKD with no association with it (p= 0.149). Half (50.9%) of underweight subjects were suffering with CKD, followed by almost equal proportion in normal BMI (45.4%) and obese (45.6%) and little less (41.6%) in overweight subjects. BMI was not associated with CKD (p =0.435).

Smoking was not associated with CKD (p =0.279). 54% smokers were cases of CKD. Family history of renal disease was found in only 30 subjects (4.7%), of which more than half (56.7%) were cases of CKD but the association was insignificant (p= 0.264). Median RBS level was 110 (IQR= 97-136.3) mg/dL. 90 (14%) and 294 (45.6%)

subjects were having DM and HTN, of which 72.2% and 55.4% were cases of CKD respectively (p<0.0001 for each).

Median serum creatinine level was 0.90 (IQR= 0.70-1.10) mg/dl. Further, 13.6% subjects were having higher creatinine levels (≥1.30), of which 90.9% were the cases of CKD. Clearly, CKD was significantly associated with creatinine levels (p<0.0001). Albuminuria was found positive in 234 (36.3%) subjects, of which all were CKD cases. Median eGFR level was 88 (IQR= 67-118) ml/min/1.73m^2. It was further divided into 5 categories and was found highly associated with CKD (p<0.0001).

In the bi-variable logistic regression analysis age, DM, HTN and creatinine came out to be individual risk factors for CKD (Table 2). All these predictors were considered together in multi-variable analysis.

Through the multi-variable model (Table 2), we found that diabetes was associated with doubling the odds of developing CKD (OR: 2.707, 95% CI: 1.593-4.598) whereas, being hypertensive was associated with a 56% increase in the odds of developing kidney disease (OR: 1.563, 95% CI: 1.107-2.208). Subjects with higher serum creatinine levels were associated with a 13-fold increase in the odds of progressing to kidney disease (OR: 13.952, 95% CI: 6.570-29.628).

Table 2 Bi-variable and multi-variable predictors for the development of chronic kidney disease

Characteristics	P-values OR (95% CI of OR)	
	Bi-variable predictors	**Multi-variable predictors**
Age in years (Ref: <45)		
45-65	0.002 1.701 (1.224-2.363)	*
>65	0 4.677 (2.055-10.645)	*
Gender (Ref: Female)		
Male	0.149 .792 (.577-1.087)	*
BMI (Ref: Normal)		
Underweight	0.223 1.247 (.875-1.778)	*
Overweight	0.53 .856 (.527-1.390)	*
Obese	0.975 1.009 (.569-1.791)	*
DM (Ref: No)		
Yes	0 3.514 (2.151-5.742)	0 2.707 (1.593-4.598)
HTN (Ref: No)		
Yes	0 1.921 (1.403-2.630)	0.011 1.563 (1.107-2.208)
Smoking (Ref: No)		
Yes	0.281 1.375 (.771-2.454)	*
Family history of renal disease (Ref: No)		
Yes	0.267 1.520 (.725-3.183)	*
Creatinine (Ref: <1.30)		
≥1.30	0 15.204 (7.208-32.068)	0 13.952 (6.570-29.628)

Discussion

Chronic kidney disease is a worldwide public health problem with an increasing incidence and prevalence, poor outcome and high treatment costs. Due to its asymptomatic nature, CKD is frequently detected at an advanced stage, resulting in the loss of opportunities to influence its course and outcome. Progression of CKD to renal failure or other adverse outcomes can be prevented or delayed through early detection and treatment.[9] In the present study also, we recruited apparently healthy general population to describe the prevalence patterns and association with some known risk factors of CKD among general population of Varanasi in a cross sectional way, on those subjects who voluntarily participated in the hospital based screening camp on World Kidney Day for 4 consecutive years, which provided better insight about the asymptomatic disease in the society. Similar single center hospital, regional, population and community based studies have been performed on target population earlier.[4,6,9–12]

Our study reported overall a very high prevalence of CKD as 46.7% which is clearly an overestimate compared to global perspective.[13] In the community-level studies, based on available medium-quality and high-quality studies, the prevalence of CKD ranged from 2% to 41%.[14] Although higher prevalence (>41%) have been accounted for north Indian cities like Delhi, Kanpur whereas a very close number (46.8%) to ours was reported in Vishakhapatnam, Andhra Pradesh in the SEEK India cohort.[12] Indian researchers seem to follow varied diagnostic criteria for CKD[15] depending upon different cut-offs for serum creatinine[10] or proteinuria[16] and/or GFR[17] levels which could be a probable reason for the prevalence discrepancies. Prevalence of CKD stages 1, 2, 3, 4 and 5 was 19.2%, 10.7%, 14.7%, 0.8% and 1.2%, respectively i.e. prevalence of Stage-3 CKD or worse in the present study was 16.7%, which is higher than other published studies.[10,15]

Diabetes and hypertension are the main causes of CKD in all high-income and middle-income countries, and also in many low-income countries.[18] Our study indicated DM, HTN and serum creatinine as the risk factors of CKD. These risk factors were similar to those reported in earlier studies, thus adding on to the similar evidences.[2,11,12,19]

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Diabetes is a key risk factor for the development of ESRD.[20] Not surprisingly, our data also showed that diabetes is a risk factor for new-onset kidney disease. More than half of the diabetics (72.2%) were suffering with CKD. Diabetics were twice more likely to be a case of CKD (Table 2). Published literature prove DM accounts for 40–60% cases of CKD in India but most of the studies have looked at the affect of DM on severe kidney diseases.[15,21]

We indicated that hypertension is a predictor for the development of incident kidney disease concomitant to DM. 55.4% hypertensives were suffering with CKD. Hypertensives were nearly 56% more likely to be a case of CKD than normotensives (Table 2). Hypertension is also an established as well as preventable predictor of CKD worldwide[2,22] as well as in Indian context.[12] High prevalence of CKD in the present study could be partly explained by the high prevalence of risk factors like DM and HTN in the screened population (14.0% and 45.6%, respectively). Almost similar risk estimates for both DM and HTN were obtained in community based study for finding predictors of new-onset kidney disease.[20] In the epidemiological literature, relationship exists between blood pressure and kidney disease.[24] However, the MDRD Study showed no effect on GFR decline in rigorous blood pressure control compared with a usual blood pressure goal, although further research is needed to better characterize the effects of blood pressure on disease progression among people with mild to moderate kidney disease.[23]

Serum creatinine is an important biomarker of kidney function.[25] In the present study, 13.6% subjects had serum creatinine level ≥1.30 mg/dl, of which majority (90.9%) were identified with CKD. Logistic regression analysis also depicted more than 13-fold risk of CKD in subjects with higher serum creatinine levels, which is in consensus with published literature.[26] Henceforth, such cases with elevated serum creatinine are suggested for frequent health checkups to monitor and intervene adequately to prevent new onset CKD.

Age itself is the biggest non-modifiable risk factor for most of the chronic diseases. There always stays a question about the distinction between early CKD and normal age related decline in renal function.[27] CKD in the elderly population (75.8%) was higher than those compared to their younger counter parts (40.1% in young adults), further, bi-variable analysis showed middle aged adults and elderly were more likely to be a case of CKD compared to younger adults (Table 2), which clearly depicted that aging is a factor strongly associated with the occurrence of CKD, however age was excluded in the multi-variable analysis.[16,28] In present study, subjects were between 18-86 years comprising 5.1% elderly subjects (>65 years) and therefore, vulnerable to the age related glomerulosclerosis and decline in kidney function. Moreover, Age category of the subjects was significantly associated with DM, HTN ($p < 0.0001$ for both) thus acting as confounder and influencing the occurrence of CKD. Further work is required to determine whether renal impairment in elderly subjects is associated with or causes other conditions.

The situation of asymptomatic CKD is growing up. Progression of CKD and other adverse outcomes can be prevented or delayed through early detection and treatment modalities.[9] We screened apparently healthy individuals who volunteered to participate in the screening camps and found very high percentages of CKD and its related predictors. Henceforth, early screening for CKD detection along with these co morbidities becomes a prerequisite to reduce the load of health care delivery system that are involved in renal replacement therapy and treatment of other chronic diseases. Such screening programs not only detects missed cases of CKD but also promote public awareness and education, encourage physician adherence to clinical practice guidelines and serve as medical outreach to underserved populations.[29]

Limitations

A case of CKD was detected based on KDOQI guidelines and presence of albuminuria. The data collection was not ongoing, instead every year it was collected as a part of World Kidney Day celebration based on its theme every year. Hence, the subjects were screened in a cross sectional way on a single day measure and it was not possible to determine whether participants who fulfilled outcome criteria did so for at least a 3-month period. Further, there was no follow up of the cases. Researchers have used varied definitions, cut-offs and diagnostic criterion for CKD case detection under different settings. The GFR was estimated by using the MDRD study equation. The study was conducted at hospital based health camp hence, the study results may not be generalized for the community based settings. Our study sample is not nationally representative or ethnically diverse.

Conclusion

CKD is a major public health issue. Understanding its risk factors like: higher creatinine, diabetes, hypertension is important and implementing screening of risk populations will increase early detection, initiate treatment of modifiable risk factors for ESRD, along with appropriate treatment for CKD. Additionally the economic burden caused by the cost of renal replacement therapy might be mitigated by early detection of CKD risk factors especially in developing countries like India.

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Conflict of interest

The authors report no conflicts of interest.

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