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Epidemiology & attributing factors for chronic kidney disease: Finding from a case–control study in Odisha, India

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***Background & objectives*: Chronic kidney disease (CKD) is one of the leading causes of mortality in developing countries, however, evidence from some geographical areas of India is scantly available on its risk factors. Other than diabetes and hypertension, several personal and environmental factors are also associated with CKD.**

***Methods*: A population-based case–control study was conducted over a period of 12 months in two high CKD reporting districts of Odisha, India. A total of 236 participants, 1:2 age- and sex-matched cases (83):controls (153), were included. Various factors were modelled with univariate and multivariable conditional logistic regression and analyzed using the Bayesian method in STATA SE v.12.**

***Results*: Among the study cases, about 81 per cent were male and about 25 per cent were aged <40 yr. CKD-associated risk factors were hypertension for more than five years [adjusted odds ratio (aOR)=4.24; 95% credible interval: 1.23-10.05], scheduled tribe/caste (aOR=2.81; 1.09-5.95), use of tube well/bore well water for drinking (aOR=1.21; 1.02-1.43), consumption of locally made alcohol (aOR=1.09; 1.02-1.17) and eating red meat and vegetarian diet with (aOR=1.24; 1.12-1.39) and (aOR=1.09; 1.04-1.14), respectively.**

***Interpretation & conclusions*: The presence of CKD among younger age groups and association of multiple factors including personal and environmental suggest for more research to establish the cause and effect relation of these factors.**

Key words Case–control - chronic kidney disease - India - Odisha - risk factor

Over the years, chronic kidney disease (CKD) has emerged as a major public health problem and a significant contributor to the overall non-communicable disease burden globally[1,2]. Worldwide, the prevalence of CKD varies from eight to 16 per cent representing over 750 million cases, of which 78 per cent (387.5 million) are from low-middle-income countries (LMICs)[1,3]. According to a systematic analysis study for global burden of disease, CKD contributes significantly to global morbidity and also as a risk factor to cardiovascular disease[4]. Limited awareness on CKD in most LMICs has caused a large proportion of patients seeking medical care at a later stage, thereby creating a major burden on health system. The true magnitude of CKD/end-stage renal disease (ESRD) in India is largely unknown.

Other than diabetes and hypertension, factors such as occupational stress, exposure to heat and chemicals and medicinal side effects have also been found to contribute to CKD [called CKD of unknown aetiology (CKDu)][5]. Over the years, there have been increasing reports of CKD cases from the State of Odisha[6], however, limited research exploring the contributing factors from this region is available. Hence, the present study aimed to explore various contributing factors for CKD, particularly in the State of Odisha, eastern India.

Material & Methods

A population-based case–control study was carried out over a period of 12 months (from May 2016 to April 2017) in two districts (Jajpur and Keonjhar) of Odisha, India. Both the districts were purposively selected considering the increased reporting of CKD cases and concern by the State health system. The study was approved by the Institutional Ethics Committee of Indian Institute of Public Health, Bhubaneswar, and State Research and Ethics Committee, Department of Health and Family Welfare, Government of Odisha, India. Written informed consent was also obtained from each participant before recruiting them for study.

A total of 496 CKD cases from both the districts were line listed based on the patient information collected from hospital records of each of the district headquarter hospitals, magistrate office, and four major tertiary referral hospitals (one government and three private). Cases were geographically mapped to understand their distribution in both the study districts. Block- and village-wise list of cases was prepared (case villages) and their adjacent villages having no reported cases were enlisted as control villages. Due to limited literature available from the study region, previously published CKD prevalence data from other parts of India were used to compute the sample size. Considering diabetes as one of the leading factors for CKD in India [odds ratio (OR)=2.5][7], anticipated proportion of controls with diabetes was 40 per cent and CKD cases with diabetes was 62.5 per cent. The sample size of cases was determined to be 64 (assuming 80 per cent power of the study, 95 per cent two-sided confidence level and the ratio of controls to cases was 2:1). Considering 20 per cent non-response rate, the minimum sample size for cases was estimated to be 80. In this study, 83 cases from 13 villages were selected randomly among the total line listed cases. Out of the total 166 controls contacted, collect complete information could be collected from 153 participants from 12 villages. For two case villages, only one control village could be identified after following the selection criteria.

For study purpose, 'CKD case' was defined as a person already diagnosed as having CKD or ESRD from a hospital with kidney damage and a glomerular filtration rate (GFR) of <60 ml/min/1.73 m^2 for three months or more irrespective of the cause[8]. To ascertain their case status, prescriptions were reviewed during data collection. Controls were selected after age (±3 yr) and sex matching. Matched persons with no evidence of CKD and tested negative for urine albumin testing (done during the study) were included as controls. Participants having symptoms of weight loss, poor appetite, swollen ankles or feet, shortness of breath, blood in urine, increased frequency in voiding, difficulty in sleeping, skin itching, muscle cramps and other known illnesses were excluded as controls.

Data collection: Primary data were collected from the cases and controls using a standardized pre-designed, pre-tested and validated schedule in the local vernacular language (*Odia*). Experts including nephrologists, public health and environmental scientists were consulted while finalizing the tools. Tools were validated using Cronbach alpha value of 0.78 before data collection by trained researchers. The schedule had three major constructs, namely (*i*) sociodemographic information: age, gender, religion, marital status, education, dietary habits, present occupation, poverty level and insurance status; (*ii*) exposure assessment: agriculture, radiation, industry and heat, and (*iii*) disease history: a history of past illnesses, present health conditions and health facilities visited.

Data analysis: For analysis purpose, the duration of exposure to various factors was used as a covariate than only the presence or absence of it. Exposure to smoking and alcohol was calculated as cumulative exposure (amount consumed each time×frequency in months), consumption of vegetable and meat as servings per month (number of servings per day×30 days) and exposure to sun at workplace was estimated as 'hours per day'. Recordings of hypertension, diabetes and acid peptic disease were done as present or absent through clinical history, prescription and medication

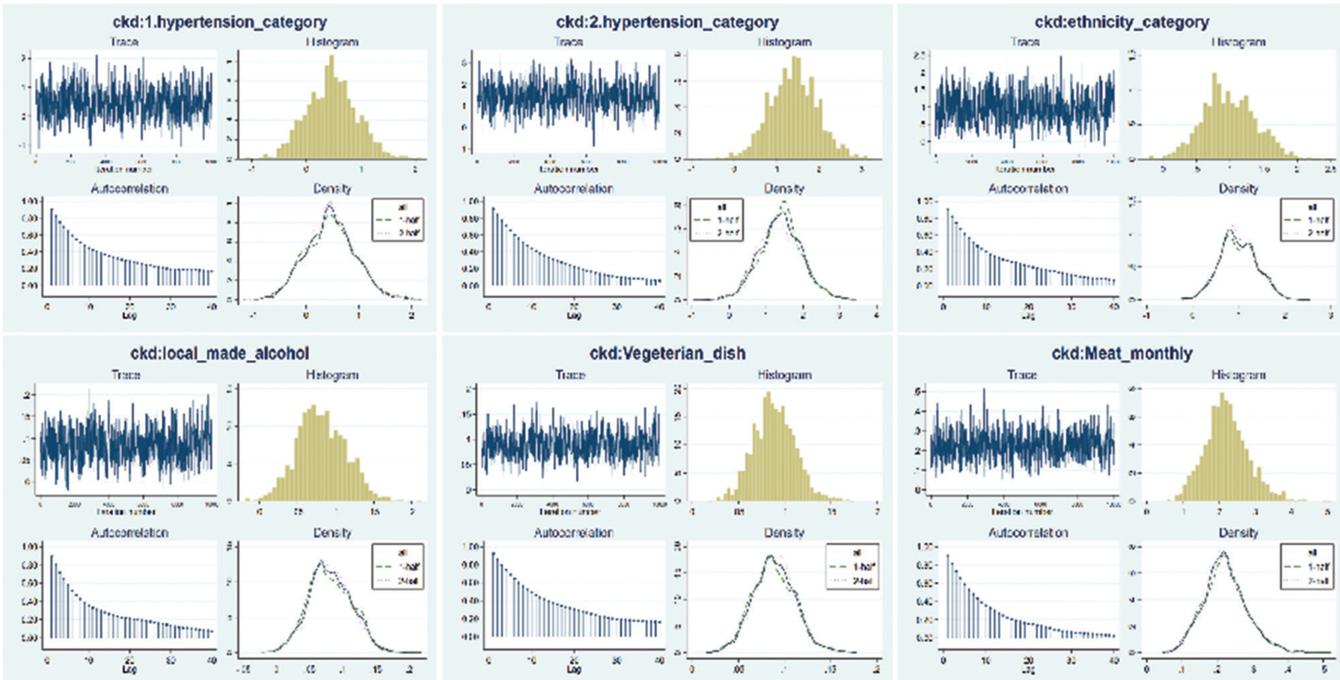

Fig. 1. Posterior distribution of the Bayesian model.

history and were categorized as 'never', '<five years' and '>=five years' for analysis.

Categorical variables were expressed as proportion and frequencies, while quantitative variables were expressed as mean and standard deviation (SD). The risk factors were modelled with univariate and multivariable conditional logistic regression using the Bayesian method[9]. A normal prior distribution [N(m,s)] was used to estimate the log (OR) in the conditional logistic regressions. The results from previous studies were used to provide informative Bayesian priors and define the values of m and s in the prior log-odds distribution for hypertension, diabetes[10,11] and educational status[12]. For the univariate analysis, the priors were less informative [normal distribution N (mean±SD) for the log-OR ¼ N(0; 10)]. In the multivariable analysis, prior distributions were derived from the OR confidence interval of the references. For other variables, non-informative prior method was used.

For each potential predictor the study results were presented as OR with a 95 per cent credible interval. Statistical analysis was carried out using the Bayesian method in STATA SE 12 (STATA Corp., Texas, USA). The estimations were made using Markov chain Monte Carlo with Gibbs sampling. For each model, 100,000 iterations were drawn after a burn-in of 5,000 updates, and convergence was checked using trace plots of the sampled values for each iteration (Fig. 1). The results of conditional logistic regression model using 'frequentist' method are provided in Supplementary Table I. Both the models were compared based on their Bayesian information criteria, which indicates smaller the value, better is the fitting of the model. A Directed Acyclic Graph (DAG) to depict the possible linkage between the risk factors using 'ggdag' package was created from R v 3.5.2 (R Software, Vienna).

Results

The mean age of the 83 cases was 49±10.62 yr, and 20 (24.2%) were ≤40 yr. About 81 per cent of cases were male. A significant difference with respect to marital status (P=0.019), ethnicity (P=0.009), current occupation status (P<0.001) and source of drinking water (P=0.003) was observed between case and control groups. Among the cases, 47.4 per cent were unemployed mostly because of their present disease condition. A significant difference was observed with respect to family history of CKD (P=0.001) and medical conditions like joint pain (P=0.023) and hypertension (P=0.011) between cases and control groups. Difference in terms of education, socio-economic status, family history of hypertension and diabetes and personal habits such as smoking, drinking alcohol and disease conditions such as diabetes and acid peptic

Table I. Study characteristics across the groups

Variables	Cases (n=83) (%)	Controls (n=153) (%)	Total (n=236) (%)
Age (yr)			
≤40	24.2	25.3	24.6
40-60	56.9	60.2	58.1
>60	18.9	14.5	17.4
Gender			
Male	81.1	84.3	82.2
Marital status			
Single	7.2	1.3	3.4*
Married	85.5	95.4	91.9
Widow/er	7.3	3.3	4.7
Ethnicity			
Schedule caste	22.9	15.1	17.8**
Schedule tribe	21.7	10.5	14.4
Others	55.4	74.4	67.8
Highest education			
Illiterate	47.0	34.6	39.1
Primary completed	28.9	37.2	34.3
Secondary completed	20.5	26.1	24.1
Tertiary and above	3.6	2.1	2.5
Socio-economic status			
Above poverty line	50.6	44.4	46.6
Below poverty line	49.4	55.6	53.4
Current occupation			
Paid work	28.2	50.3	42.4***
Self-employed	13.1	19.3	16.5
Non-paid work	2.2	2.6	2.5
Home maker	9.1	17.3	13.6
Unemployed (health issue)	47.4	10.5	20.8
Current source of drinking water			
Tubewell/borewell	80.7	62.3	68.7**
Well/river	19.3	32.7	31.3
Exposure to sun at work	69.9	75.9	72.0

P *<0.05, **<0.01, ***<0.001

disease were not found to be significant between the groups. Details of socio-demographic characteristics of the study participants and their medical history are presented in Tables I and II, respectively.

During the preceeding ten years of this study, borewell water as a drinking source among the cases had increased from 14.5 to 24.1 per cent and the same among controls had reduced from 10.5 to 5.2 per cent. CKD was found to be significantly associated among borewell/tubewell water users as compared to well/river water (Armitage trend test, P=0.003). This changing trend on usage of different sources for drinking water over the years (last 20 yr for tubewell and river water and last 10 yr for borewell water) is appended in Fig. 2A-C.

The variables that were found to be significantly associated among cases through univariate analysis model were further considered for multivariable analysis. According to the adjusted odds ratios (aOR), the statistically significant association of risk factors with CKD were hypertension for more than five

Table II. Medical history, family history and personal practices of participants

Medical history	Cases (n=83) (%)	Controls (n=153) (%)	Total (n=236) (%)
Joint pain			
Never	42.1	43.8	43.2
<5 yr	43.4	40.5	41.5*
≥5 yr	14.5	15.7	15.3
Diabetes			
Never	77.1	81.7	80.1
<5 yr	12.1	6.6	8.5
≥5 yr	10.8	11.7	11.4
Hypertension			
Never	55.4	71.9	66.1
<5 yr	24.1	18.9	20.8**
≥5 yr	20.5	9.1	13.1**
Acid peptic disease			
Never	28.9	28.1	28.4
<5 yr	42.2	54.2	50.0
≥5 yr	28.9	17.7	21.6
Family history of medical conditions			
Family history of diabetes	28.4	29.5	28.4
Family history of hypertension	23.5	33.6	29.2
Family history of CKD	9.9	0.01	3.8**
Personal habits			
Smoking	63.9	82.4	75.8
Chewing tobacco	30.1	28.2	28.9
Local alcohol	19.3	11.8	14.4
Any alcohol	34.0	43.4	37.3

P *<0.05, **<0.01. CKD, chronic kidney disease

years (aOR=4.24; 95% credible interval: 1.23-10.05), scheduled tribe/caste (aOR=2.81; 1.09-5.95), use of tubewell/borewell water for drinking (aOR=1.21; 1.02-1.43), consumption of locally made alcohol (aOR=1.09; 1.02-1.17) and dietary factors such as eating red meat and vegetarian diet with aOR=1.24; 1.12-1.39 and aOR=1.09; 1.04-1.14, respectively. The detailed multivariable analysis (Bayesian conditional logistic regression) findings are presented in Table III and findings from conditional logistic regression using frequentist method are given in Supplementary Table I.

Discussion

To our knowledge, this is one of the first studies from India analyzing the association of different risk factors for CKD using the Bayesian approach[9] rather than the frequentist approach. The mean age among the cases was 49±10.62 yr. A study done among a rural population of Karnataka reported the mean age of CKD cases to be 52.73±17.08 yr[7] and another study among farmers in Sri Lanka reported the mean age of patients with CKDu was 45.5 yr in males and 47.4 yr in females[13]. It is a common notion that increased age escalates the chances of CKD because of associated chronic conditions such as hypertension or diabetes[14,15]. Nearly one-fourth of the cases in the present study were ≤40 yr suggesting that besides the chronic conditions, there are also other personal and environmental factors contributing to CKD. CKDu dominates the research arena in developing countries, including India[16]. Focal evidences from some parts of the country support the fact that most of the patients diagnosed with CKDu are exposed to the water resources contaminated with heavy metals, heat, various drugs and disease conditions[15,17,18].

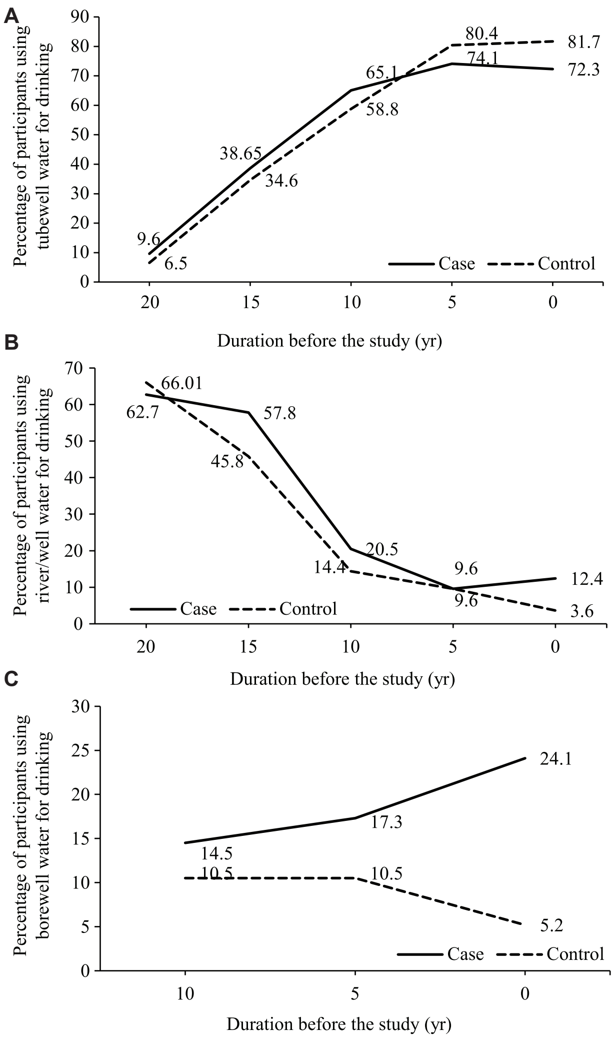

Fig. 2. Percentage of participants using (**A**) tubewell, (**B**) well/river, (**C**) borewell water as the drinking water source at different time points. Some of the participants used multiple sources of water, thus have been counted multiple times in each group.

A significant association between the drinking of borewell or tubewell water and CKD cases along with a gradual shift in drinking source from river/well water to borewell/tubewell water over a decade was observed. This indicates the possibility of contamination of tubewell/borewell water with heavy metals in our study areas.

The male cases were about four times in number compared to females in this study. Research shows gender differences as standard predictors for the decline in renal function, namely proteinuria among males and poor glycaemic control among females[14,19]. High CKD cases among males in our study could be associated to their socio-behavioural and occupational practices such as more exposure to sunlight, working in the agriculture land, exposure to pesticides and habitual consumption of locally made alcohol. In our study areas, 57.1 per cent of alcohol consumers were found to consume the locally prepared alcohol, which is prepared using many herbal ingredients in its processing. No study has been done so far to understand the intrinsic properties of these ingredients. About 47 per cent of our cases were illiterate and 43.4 per cent were unemployed. Manavalan *et al*[20] had observed among the CKD cases, 36.3 per cent as illiterate and 80.9 per cent unemployed.

We found hypertension to be independently associated with CKD, while no such association could be observed for diabetes or acid peptic disease. In India, diabetes and hypertension account for 40-60 per cent cases of CKD[21]. Singh *et al*[17] reported hypertension to be associated with low estimated GFR. In contrast to our findings, other studies have reported an increased presence of APD or peptic ulcer among CKD patients[22], proton-pump inhibitors to increase the risk of CKD[23].

A significant association between the consumption of red meat with CKD was observed in this study. Various studies had shown that consumption of processed foods containing high sugar, salt and protein was associated with CKD[24,25]. According to Rebholz *et al*[26], higher plant protein intake was associated with a lower risk of incident of CKD. In contrast to it, we found a significant association between the consumption of green leafy vegetables with CKD. Association with green leafy vegetables is due to increased proportion of CKD cases consuming green leafy vegetables compared to controls. Whether this association is true or a spurious one requires further research.

Family history of CKD and people belonging to SC/ST were significantly associated with CKD. Other research studies have shown that family history of CKD was significantly associated with CKD cases[15] and family history of kidney failure or dialysis is associated with an increased incidence of ESRD[27]. Research studies from other countries suggest that some minor ethnic groups are more susceptible for chronic diseases including CKD[28], this information is limited from India. The present study suggests for genetic and molecular studies to test this hypothesis. Rajapurkar *et al*[29] in their study had shown that patients with CKD of unknown aetiology were younger, poorer and more likely to present with advanced CKD which correlates with the present study findings.

Table III. Multivariable analysis (Bayesian conditional logistic regression)

Variables	Unadjusted OR	95% credible interval	Adjusted OR	95% credible interval
Education				
Illiterate	Reference			
Primary	0.51	0.23-0.93		
Secondary and above	0.55	0.22-1.06		
Socioeconomic status				
Above poverty line	Reference			
Below poverty line	0.79	0.44-1.28		
Ethnicity				
Others	Reference		Reference	
Schedule Caste/Tribe	2.34	1.28-4.05	2.81	1.09-5.95
Joint pain				
Never	Reference			
<5 yr				
≥5 yr				
Diabetes				
Never	Reference			
<5 yr	2.23	0.82-4.98		
≥5 yr	1.04	0.33-2.36		
Hypertension				
Never	Reference		Reference	
<5 yr	1.62	0.74-2.95	1.76	0.60-4.40
≥5 yr	3.22	1.37-6.76	4.24	1.23-10.05
Acid peptic disease				
Never	Reference			
<5 yr	0.83	0.38-1.56		
≥5 yr	1.84	0.78-3.72		
Family history of diabetes				
No	Reference			
Yes				
Family history of hypertension				
No	Reference			
Yes	0.64	0.31-1.17		
Tobacco/alcohol consumption				
Chewing tobacco (numbers per wk)	0.99	0.98-1.01		
Smoking (Since, in yr)	0.94	0.86-1.02		
Local alcohol (Since, in yr)	1.04	1.01-1.09	1.09	1.02-1.17
Food consumption				
Leafy green vegetables	1.01	0.99-1.04		
Chicken per month	0.91	0.86-0.95		
Vegetables per month	1.08	1.04-1.12	1.09	1.04-1.14
Red meat per month	1.27	1.15-1.41	1.24	1.12-1.39

Contd...

Variables	Unadjusted OR	95% credible interval	Adjusted OR	95% credible interval
Exposure to sun (reference - No)	1.66	0.73-3.43		
Source of drinking water				
Well/river	Reference		Ref	
Tubewell/borewell	2.52	1.25-4.75	1.21	1.02-1.43
The Bayesian Information Criteria for the model was 110.99 indicating the best fit model. Family history of CKD was dropped from the model because of the collinearity				

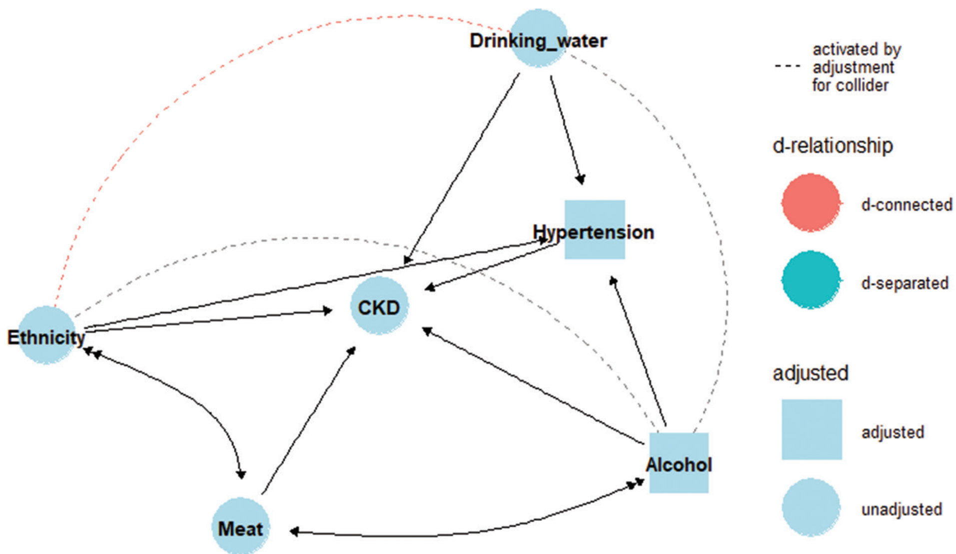

Fig. 3. Direct Acyclic Graph (DAG) explaining the relationship of various factors associated with chronic kidney disease (CKD).

In the present study factors such as presence of hypertension for more than five years, consumption of locally made alcohol, consumption of leafy vegetables and/or red meat and drinking water from tubewell/borewell were found to be independently associated with CKD. A comparison of the present study findings with other published reports is presented in Supplementary Table II.

Despite these shortcomings the present study was intended to explore various factors associated with CKD. Some of the limitations of this study include its inability to establish the cause and effect relationship. It limits in understanding the detailed intrinsic properties of the factors such as the locally made alcohol, the tubewell/borewell water, duration and usage of various medicines, *etc*. The cases were not studied according to their stages of CKD and their clinical details such as the oliguric status, differentiation of cases as glomerular or interstitial nephritis. More hospital and laboratory based studies could address these gaps.

DAG (Fig. 3) was constructed by the authors using R software[30] and this explains the relationship of various associated factors with CKD. After adjusting for hypertension and alcohol, drinking water was found to be associated with CKD and also connected to the ethnicity. However, hypertension could be a mediating factor between drinking water and CKD. The direct association of hypertension with CKD could have been because of the presence heavy metals in the drinking water. Based on the findings, the present study suggests to relook into the established risk factors for CKD and carry out more research to establish the causal relationship of such environmental and personal factors for CKD.

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***Conflicts of Interest*:** None.

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Supplementary Table I. Conditional logistic regression, frequentist method

Variables	Unadjusted OR	95% CI	Adjusted OR	95% CI
Education				
Illiterate	Reference			
Primary	0.48	0.24-0.97		
Secondary and above	0.52	0.24-1.12		
Socioeconomic status				
Above poverty line	Reference			
Below poverty line	0.77	0.45-1.31		
Ethnicity				
Others	Reference		Reference	
Schedule Caste/Tribe	2.21	1.24-3.97	2.55	1.13-5.75*
Joint pain				
Never	Reference			
Since last 5 yr				
Since last 5-10 yr				
Diabetes				
Never	Reference			
Since last 5 yr	1.96	0.8-4.76		
Since last 5-10 yr	0.96	0.36-2.52		
Hypertension				
Never	Reference		Reference	
Since last 5 yr	1.53	0.79-2.98	1.53	0.61-3.82
Since last 5-10 yr	2.92	1.34-6.36	3.78	1.27-11.26*
Acid peptic disease				
Never	Reference			
Since last 5 yr	0.79	0.39-1.59		
Since last 5-10 yr	1.69	0.79-3.59		
Family history of diabetes				
No	Reference			
Yes	0.92	0.45-1.66		
Family history of hypertension				
No	Reference			
Yes	0.62	0.32-1.19		
Chewing tobacco (Numbers per week)	0.99	0.99-1.00		
Smoking (Since, in yr)	0.95	0.88-1.02		
Local alcohol (Since, in yr)	1.04	1.01-1.08	1.08	1.02-1.16*
Leafy green vegetables	0.91	0.78-1.06		
Chicken per month	0.96	0.88-1.04		
Veg dish per month	1.07	1.04-1.11	1.08	1.04-1.13*
Red meat per month	1.26	1.14-1.39	1.21	1.09-1.35*

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Variables	Unadjusted OR	95% CI	Adjusted OR	95% CI
Exposure to sun (reference - No)	1.53	0.71-3.27		
Source of drinking water				
Well/river	Reference		Ref	
Tube well/boring	2.28	1.19-4.38	1.19	1.01-1.41*

P^*<0.05; Akaike Information Criteria for the model was 111.16 and Bayesian Information Criteria was 135.26. OR, odds ratio; CI, confidence interval

Supplementary Table II. Comparing finding of present study with other study findings

Our study findings	Other study findings	Authors (Title)
The mean age among the cases was 49±10.62 yr	A study among rural population of Karnataka had found the mean age of CKD cases to be 52.73±17.08 yr	Anupama YJ, Uma G. (Prevalence of CKD among adults in a rural community in South India)
	Study among farmers in Sri Lanka had found the mean age of the male patients with CKDu was 45.5 yr while it was 47.4 yr in females	Jayasumana C, Paranagama P, Agampodi S, Wijewardane C, Gunatilake S, Siribaddana S. (Drinking well water and occupational exposure to Herbicides is associated with CKD, in Padavi-Sripura, Sri Lanka)
The male cases were about four times in number compared to females in our study	Gender-wise difference in CKD showed decline in renal function *viz.* proteinuria among males and poor glycaemic control among females to be associated with CKD	Chang P-Y, Chien L-N, Lin Y-F, Wu M-S, Chiu W-T, Chiou H-Y. (Risk factors of gender for renal progression in patients with early CKD)
		Iseki K. (Gender differences in CKD)
A significant association between drinking of borewell or tubewell water and CKD was observed	Most of the CKDu patients are exposed to the water resources contaminated with heavy metals	Orr SE, Bridges CC. (CKD and Exposure to Nephrotoxic Metals)
About 47 per cent of our cases were illiterate and 43.4 per cent were unemployed	Among the CKD cases, 36.3 per cent as illiterate and 80.9 per cent unemployed	Manavalan M, Majumdar A, Harichandra Kumar K, Priyamvada P. (Assessment of health-related quality of life and its determinants in patients with CKD)
Hypertension to be independently associated with CKD, while no such association was found for diabetes or acid peptic disease	In India diabetes and hypertension account for 40-60 per cent cases of CKD	Varma PP. (Prevalence of CKD in India - Where are we heading?)
	Hypertension to be associated with low eGFR	Singh NP, Ingle GK, Saini VK, Jami A, Beniwal P, Lal M, *et al*. (Prevalence of low glomerular filtration rate, proteinuria and associated risk factors in North India using Cockcroft-Gault and Modification of Diet in Renal Disease equation: an observational, cross-sectional study)
	Increased presence of APD or peptic ulcer among CKD patients	Liang C-C, Muo C-H, Wang I-K, Chang C-T, Chou C-Y, Liu J-H, *et al*. (Peptic ulcer disease risk in CKD: 10 yr incidence, ulcer location and ulcerogenic effect of medications)
Family history of CKD was significantly associated with CKD	Other research studies had showed family history of CKD was significantly associated with CKD cases	Kazancioğlu R. (Risk factors for CKD: An update)
	Family history of kidney failure or dialysis is associated with increased incidence of ESRD	Drawz PE, Sedor JR, Hostetter TH. (Family History and Kidney Disease)
Scheduled caste and Tribe people were significantly associated with CKD	Some minor ethnic groups are more susceptible for chronic diseases including CKD	Harawa NT, Norris KC. (The Role of Ethnic Variation and CKD)
Consumption of locally made alcohol was independently associated with CKD	Not available	NA
Consumption of leafy vegetables was independently associated with CKD	Higher plant protein intake was associated with lower risk of incident of CKD	Rebholz CM, Coresh J, Grams ME, Steffen LM, Anderson CAM, Appel LJ, *et al*. (Dietary Acid Load and Incident CKD: Results from the ARIC Study)

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Our study findings	Other study findings	Authors (Title)
Consumption of red meat is independently associated with CKD	Consumption of processed foods containing high sugar, salt and protein were associated with CKD	Odermatt A. (The Western-style diet: a major risk factor for impaired kidney function and CKD) Kramer H. (Dietary patterns, calories and kidney disease)

CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; ESRD, end-stage renal disease; APD, acid peptic disorder; NA, not available; CKDu, chronic kidney disease of unknown aetiology; ARIC, atherosclerosis risk in communities