Prevalence of chronic kidney disease in two major Indian cities and projections for associated cardiovascular disease

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India is experiencing an alarming rise in the burden of noncommunicable diseases, but data on the incidence of chronic kidney disease (CKD) are sparse. Using the Center for Cardiometabolic Risk Reduction in South Asia surveillance study (a population-based survey of Delhi and Chennai, India) we estimated overall, and age-, sex-, city-, and diabetes-specific prevalence of CKD, and defined the distribution of the study population by the Kidney Disease Improving Global Outcomes (KDIGO) classification scheme. The likelihood of cardiovascular events in participants with and without CKD was estimated by the Framingham and Interheart Modifiable Risk Scores. Of the 12,271 participants, 80% had complete data on serum creatinine and albuminuria. The prevalence of CKD and albuminuria, age standardized to the World Bank 2010 world population, was 8.7% (95% confidence interval: 7.9–9.4%) and 7.1% (6.4–7.7%), respectively. Nearly 80% of patients with CKD had an abnormally high hemoglobin A1c (5.7 and above). Based on KDIGO guidelines, 6.0, 1.0, and 0.5% of study participants are at moderate, high, or very high risk for experiencing CKD-associated adverse outcomes. The cardiovascular risk scores placed a greater proportion of patients with CKD in the high-risk categories for experiencing cardiovascular events when compared with participants without CKD. Thus, 1 in 12 individuals living in two of India's largest cities have evidence of CKD, with features that put them at high risk for adverse outcomes.

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Prevalence of obesity and type 2 diabetes mellitus is rising rapidly in low- and middle-income countries.[1,2] Prevalence of chronic kidney disease (CKD) would be expected to rise in parallel but has been infrequently studied.[3] Even in its early stages, CKD is associated with a two- to fourfold increase in the risk of death from cardiovascular causes.[4] For patients who progress to end-stage renal disease, CKD is associated with enormous economic costs and early mortality.[5]

India has experienced an explosion of noncommunicable diseases, and several studies point to a high prevalence of cardiovascular disease and diabetes, even among younger individuals.[6,7] Yet, data on the burden of CKD in India remain scarce. Previous studies of CKD in India failed to apply a standard definition, were missing an assessment of albuminuria, or were not population based.[8–10]

To fill this gap, we analyzed data from the Center for Cardiometabolic Risk Reduction in South Asia (CARRS) surveillance study—a population-based survey of two major cities in India (Delhi and Chennai)—and estimated overall and age-, sex-, city-, and diabetes-specific prevalence of CKD using a standardized definition from the 2012 Kidney Disease International Global Outcomes (KDIGO) CKD guidelines.[11] We also estimated the impact of CKD on predicted risks for cardiovascular disease using the Framingham (FRS) and Interheart Modifiable Risk Scores (IHMRS).[12,13]

RESULTS

Table 1 describes the sociodemographic, anthropometric, and laboratory characteristics of participants ($n = 9797$). Mean age of participants was 41.4 (±12.7) years for Chennai and 44.4 (±13.9) years for Delhi. A majority of participants received 5 years or more of education. More than 80% of women in each city were not employed in jobs outside of the home. There was a high prevalence of obesity as measured by waist-to-hip ratio or waist-to-height ratio.

Table 1 | Characteristics of Chennai and Delhi participants, the CARRS study (*N* = 9797)

	Chennai *N* = 5744		Delhi *N* = 4053	
	Mean ± s.d. or *N* (%)		Mean ± s.d. or *N* (%)	
	Men	Women	Men	Women
	2553 (44)	3191 (56)	2006 (49)	2047 (51)
Demographics				
Mean age (years)	42.6 ± 13.0	40.4 ± 12.1	45.8 ± 13.5	44.4 ± 12.7
20–44	1511 (59)	2093 (66)	977 (49)	1070 (52)
45–64	881 (35)	967 (30)	821 (41)	819 (40)
⩾65	161 (6)	131 (4)	208 (10)	158 (8)
Education (years)				
<1–4	123 (5)	431 (14)	166 (8)	491 (24)
5–12	1845 (72)	2243 (70)	1171 (59)	1019 (50)
⩾12	402 (16)	280 (9)	584 (29)	465 (23)
Occupation				
Not working[a]	358 (14)	2630 (82)	312 (16)	1801 (88)
Unskilled and semiskilled	1077 (42)	360 (11)	605 (30)	360 (4)
Skilled	1058 (42)	186 (6)	881 (44)	143 (7)
White collar	60 (2)	15 (1)	208 (10)	15 (1)
Asset index				
Low	1083 (42)	1444 (45)	553 (27)	606 (29)
Medium	963 (38)	1168 (37)	495 (25)	504 (25)
High	507 (20)	579 (18)	958 (48)	936 (46)
Current tobacco use	979 (38)	112 (4)	757 (38)	137 (7)
Anthropometry				
Abnormal WC[b]	197 (8)	873 (27)	286 (14)	916 (45)
Missing	290 (11)	138 (4)	50 (2)	53 (3)
Abnormal WHR[c]	1729 (77)	1301 (41)	1497 (75)	1222 (60)
Missing	293 (12)	139 (4)	58 (3)	62 (3)
Abnormal WHtR[d]	1250 (49)	1884 (59)	1213 (61)	1341 (66)
Missing	707 (28)	619 (19)	317 (16)	327 (16)
BMI (kg/m^2)				
<18.5	150 (6)	119 (4)	140 (7)	106 (5)
18.5–<25	901 (35)	832 (26)	771 (38)	571 (28)
25–<30	612 (24)	991 (31)	523 (26)	569 (28)
⩾30	136 (5)	595 (19)	201 (10)	429 (21)
Missing	750 (30)	654 (31)	371 (19)	372 (18)
Laboratories and BP				
Fasting glucose (mg/dl)				
<100	1666 (65)	1901 (60)	838 (42)	882 (43)
100–<126	410 (16)	710 (22)	751 (37)	815 (40)
⩾126[e]	477 (19)	580 (18)	414 (21)	348 (17)
Missing	-	-	3 (0.1)	2 (0.1)
Hemoglobin A1c (%)				
<5.7	1096 (43)	1211 (38)	556 (28)	593 (29)
5.7–6.4	836 (33)	1238 (39)	794 (40)	790 (39)
⩾6.5[e]	611 (24)	737 (23)	641 (32)	644 (32)
Missing	10 (0.4)	5 (0.2)	15 (0.8)	20 (1)
BP (mm Hg)				
Sys and/or Dias				
<120 and <80	704 (28)	1469 (46)	417 (21)	707 (35)
120–139 or 80–89	847 (33)	866 (27)	728 (36)	616 (30)
⩾140 or ⩾90[e]	737 (29)	756 (24)	848 (42)	716 (35)
Missing	265 (10)	100 (3)	13 (0.6)	8 (0.4)

Abbreviations: BMI, body mass index; BP, blood pressure; CARRS, Center for Cardiometabolic Risk Reduction in South Asia; Dias, diastolic; Sys, systolic; WC, waist circumference; WHR, waist-to-hip ratio; WHtR, waist-to-height ratio.
[a]Not working category includes homemakers or retired participants.
[b]Abnormal waist circumference: >102 cm for men and >88 cm for women.
[c]Abnormal waist-to-hip ratio: >0.9 for men and >0.85 for women.
[d]Abnormal waist-to-height ratio: >0.5.
[e]The highest blood pressure, fasting glucose, and A1c category include participants who self-reported the condition and were on medications.

CKD prevalence

Chronic kidney disease was evident in 817 participants, corresponding to prevalence in the two cities of 7.5% (95% confidence interval (CI): 6.8–8.2%). After age standardization to the World Bank 2010 world population structure, the prevalence was 8.7% (95% CI: 7.9–9.4%) for CKD and 7.1% (95% CI: 6.4–7.7%) for albuminuria (Table 2). A large majority (77.4% in men, 79.9% in women) of participants with CKD had stage 1 or 2 CKD (that is, albuminuria with normal or near-normal kidney function).

Overall prevalence of CKD was higher among older age categories in both cities (Figure 1a–f). However, the age-related prevalence difference was more pronounced in stage 3–5 CKD than in stage 1 or 2 CKD (prevalence difference 11.9% (95% CI: 8.8–15.0%) vs. 5.4% (95% CI: 2.4–8.4%) when comparing the 20–64 and ⩾65 year age groups). Only 2.0% of participants identified to have CKD had self-reported a history of kidney disease.

In a sensitivity analysis, the combined cystatin C and creatinine-based formula for estimated glomerular filtration rate (eGFR) yielded 182 participants with CKD as having eGFR <60 ml/min per 1.73 m^2 compared with 187 participants when using the CKD-Epidemiology Collaboration Equation (CKD-EPI) creatinine-based formula.[14]

CKD and diabetes mellitus

Chronic kidney disease prevalence among participants with diabetes mellitus was 15.4% (95% CI: 13.5–17.4%), substantially higher than that of participants without diabetes (prevalence difference: 10.5% (95% CI: 8.4–12.6%)). Prevalence was also higher among participants with study-diagnosed diabetes mellitus than among participants without diabetes (prevalence difference: 6.9% (95% CI: 4.6–9.2%)). The prevalence difference between diabetes and nondiabetes was of similar magnitude whether diabetes was defined using fasting glucose or glycated hemoglobin (HbA1c) criteria. Supplementary Figure S2 online provides prevalence data according to whole blood HbA1c and fasting glucose categories after stratification by city and sex. Only 14% of participants with CKD did not have an accompanying abnormal A1c (⩾ 5.7) and/or hypertension (Figure 2).

We also found the prevalence of CKD to be modestly higher among participants with obesity by body mass index criteria (9.6% (95% CI: 7.8–11.4%)) compared with those in the normal body mass index category (prevalence difference: 3.0% (95% CI: 1.0–5.1%)). Prevalence differences of similar magnitudes—between 3.8 and 4.8%—were observed among participants with abnormal waist-to-hip ratio, abnormal waist circumference, and abnormal waist-to-height ratio when compared with participants in the normal category for each measure. Supplementary Figure S3 online provides prevalence data according to several obesity indices after stratification by city and sex. Sensitivity analyses incorporating multiple imputation yielded similar prevalence data.

CKD and association with cardiovascular risk scores

On the basis of KDIGO criteria, 6.0%, 1.0%, and 0.5% of CARRS participants were at moderate, high, or very high risk, respectively, for experiencing adverse outcomes associated with CKD (Table 3). Thus, 20% of participants with CKD were at high or very high risk of an adverse outcome. The FRS and IHMRS placed a greater proportion of patients with CKD