Prevalence of early stages of chronic kidney disease in apparently healthy central government employees in India

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Abstract
Background. Chronic kidney disease (CKD) is associated with significant morbidity and mortality. US data showed that 11–15.6% of population has CKD, but there is no data from India on early stages of CKD. The aim of this study was to estimate the prevalence of early stages of CKD in...
ing the Kidney Disease Quality Outcomes Initiative (KDOQI) guidelines in an Indian population.

**Methods.** A cross-sectional study of Indian central government employees over 18 years of age was carried out. Data on anthropometric profile and investigations including routine urine exam, semi-quantitative microalbuminuria (MAU), serum creatinine, lipid profile and fasting blood glucose (FPG) were collected. Estimated glomerular filtration rate (eGFR) was calculated using the Modification of Diet in Renal Diseases (MDRD) and Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equations.

**Results.** A total of 3398 subjects, with 2244 (66.04%) males and 1154 (33.96%) females, were studied. Of the subjects, 9.96% (n = 284) were found to have MAU >30 mg/L, and 11.47% (n = 327) had a deranged albumin:creatinine ratio (ACR) of 30–300 mg/g. Mean GFR was 98 mL/min/1.73 m² (± 25.25) by the MDRD equation, and 100 mL/min/1.73 m² (± 19.48) by CKD-EPI. Using the MDRD equation for GFR, 189 (6.62%) had stage I CKD, 154 (5.40%) had stage II CKD and 86 (3.02%) had stage III CKD. By using the CKD-EPI equation, the corresponding percentages were 192 (6.73%), 122 (4.28%) and 60 (2.11%), respectively. Age >40 years, FPG >126 mg/dL and hypertension were found to be independent risk factors for CKD.

**Conclusions.** Of the apparently healthy adult Indian central government employees, 15.04% and 13.12% were found to have early stages of CKD using the MDRD and CKD-EPI criteria for GFR, respectively.

**Keywords:** chronic kidney disease; India; microalbuminuria; prevalence

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**Introduction**

Changing demographics, increasing affluence and sedentary lifestyles have led to the increasing prevalence of non-communicable lifestyle diseases like diabetes mellitus (DM), obesity, hypertension (HTN), cardiovascular disease (CVD) and chronic kidney disease (CKD), even in developing countries like India. It is estimated that 80% of chronic disease deaths now occur in low- and middle-income countries [1]. CKD is important among this group as, apart from its own morbidity, mortality and high risk for progression to end-stage renal disease (ESRD), it has also been found to be an important independent risk factor for CVD [2,3]. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure (JNC-7) guidelines recommend that glomerular filtration rate (GFR) <60 mL/min/1.73 m² or the presence of microalbuminuria (MAU) be considered cardiovascular disease equivalents [4]. Data from the US population studies like the Third National Health and Nutrition Examination Survey (NHANES III) and the Kidney Early Evaluation Program (KEEP) show that 11–15.6% of adult US population has chronic kidney disease [5,6]. Comparison of the NHANES 1994–98 and 1999–2004 data shows an increase in prevalence from 10.03% to 13.07% [7]. In the absence of a proper registry and paucity of population-based studies, exact prevalence of CKD in India is not known. Based on data from major tertiary care centres, the presumptive estimates of incidence of ESRD in India are 100 per million population (p.m.p.) [8]. Till recently, there were only three population-based studies on the prevalence of CKD in India. Modi et al. studied end-stage renal disease (ESRD) in a captive draining population of a tertiary care centre [9]. Mani et al. used an initial screening with questionnaire and dipstick urine analysis [10], and Agarwal et al. used serum creatinine value >1.8 mg/dL as cutoff for defining CKD [11]. These studies estimated prevalence of overt CKD or ESRD in India as 0.79–1.39%. A recent community-based study found 4.2% with low estimated GFR (eGFR) in a North Indian population. Even this study estimates only stages III–V of CKD suggesting that actual prevalence may be much higher than previously estimated [12]. The aim of the present study was to screen a population of apparently healthy central government employees (CGEs) from India for early stages of CKD.

**Materials and methods**

**Study design**

This cross-sectional study was carried out in Agra city in North India from March 2008 to July 2009. CGEs and their families were invited to participate in a ‘Comprehensive Health Survey Camp for Detection of Life Style Diseases’ after a series of health lectures on lifestyles diseases like obesity, DM, HTN, CVD and CKD. These camps were organized at the local hospital or close to the workplace of the employees. CGEs have transferable jobs and are comprised of a mix of people from all regions and ethnicities of India. Our sample is comprised of individuals from 23 states and one union territory (UT). The study protocol was approved by the Ethics Committee of Military Hospital Agra.

The study population included all healthy adults above 18 years of age. The participants were asked to report after an overnight fast to the survey location where, after obtaining informed consent, they were administered a pre-structured, standardized questionnaire covering demographic data, risk factors, detailed personal, family and medical history, and lifestyle habits. Anthropometric parameters were assessed using standardized techniques. Body weight and height were measured in light clothes without footwear on a dedicated calibrated weighing scale and stand-alone stadiometer. For waist and hip circumference, a standardized clinician’s tape measure was used to measure the widest part of the hips and then the narrowest part of the waist at or above the umbilicus. Every participant underwent a sitting right arm blood pressure measurement after 10–15 min rest by two separate nurses at an interval of at least 10 min using two dedicated calibrated mercury sphygmomanometers, and the mean of two measurements was used for all analysis. A spot, early morning urine sample was obtained. Assessment for proteinuria, haematuria and leucocyturia was done using dipsticks (M10SG Multisticks®, Siemens® Corp, India), and the results were read on Clinitek® 50 semi-automated urine analyser (Siemens® Corp, India). A reading of ‘small’ or greater for blood and leucocytes, corresponding to >0.03 mg/dL of blood and >5–15 leucocytes per high-power field (hpf) in urine, respectively, was considered positive for haematuria and leucocyturia. Semi-quantitative urinary microalbumin and albumin:creatinine ratio (ACR) was obtained using Clinitek® Microalbumin strips read on Clinitek® 50 semi-automated urine analyser (Seimens® Corp, India). Semi-quantitative results for urinary microalbumin were obtained in four classes: 10, 50, 100, 200 or 300 mg/dL. ACR was calculated by the analyser from the actual reflectance values of albumin and creatinine reaction pads and given in three categories: <30, 30–300, >300 mg/g. ACR value of 30–300 mg/g was considered as MAU, while values <30 mg/g and >300 mg/g were considered as normal and macroalbuminuria, respectively.
A 5-mL sample of fasting venous blood was taken for assessing biochemical variables which included creatinine, lipid profile and fasting plasma glucose (FPG). Serum creatinine (Scr), total cholesterol, high-density lipoprotein (HDL) cholesterol, triglycerides and FPG were measured on Erba Chem 5 biochemistry analyser (Transasia® Corp, India) using standardized kits from Siemens Diagnostics, India. Scr was estimated by modified Jaffe's kinetic assay (Siemens® Corp, India). Control samples were included in each run, and daily quality checks were carried out for all analytes. All samples were tested on the day of collection in a single lab for the entire duration of the study.

Inclusion/exclusion and assessment criteria

Hypertension  Subjects with self-reported HTN or on anti-hypertensive drugs were excluded. In the included study population, HTN was defined as per JNC-7 guidelines [4]. Systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg was considered HTN.

Diabetes mellitus  Patients with history of DM or use of anti-diabetic medication were excluded. In the included study population, subjects having FPG >126 were considered to have DM.

Obesity  Body mass index (BMI) was calculated as weight in kilograms divided by height in metres squared. Waist-to-hip ratio (WHR) was calculated as waist circumference divided by hip circumference in centimetres. Overweight and obesity on BMI were defined as ≥ 23 and ≥ 25, respectively. Truncal obesity by WHR was defined as > 0.9 for men and > 0.8 for women. These definitions were based on the Association of Physicians of India consensus statement for obesity for an Asian Indian population [13].

Other exclusions  Women during menstrual periods and pregnancy were excluded.

Chronic kidney disease  The Modification of Diet in Renal Diseases (MDRD) equation and the Chronic Kidney Disease Epidemiology Collaborative (CKD-EPI) equation were used to calculate eGFR. The MDRD formula used was \[ \frac{186 \times (\text{Scr})^{1.154} \times (\text{age})^{0.203} \times (0.742 \text{ for females})}{\text{BMI}^{1.210}} \] ml/min/1.73 m². The CKD-EPI calculations were based on tables given in the original article [14]. The formula in short is \[ \frac{141 \times (\text{Scr} / \text{κ})^{1.083} \times (1.018 \text{ if female})}{\text{BMI}^{0.267}} \] ml/min/1.73 m². The CKD-EPI formula was used to calculate eGFR. The MDRD and CKD-EPI definitions were based on Kidney Disease Quality Outcomes Initiative (KDOQI) guidelines [15]. MAU, haematuria and/or leucocyturia was considered as an indicator of renal damage (RD) in those with eGFR >60 ml/min/1.73 m². As only healthy individuals were included in the study with an aim to identify early kidney disease, we classified patients from stage 1 to stage 3. Stage 1 was defined as eGFR >90 ml/min/1.73 m² and RD, stage 2 as eGFR of 60–90 ml/min/1.73 m² and RD, and stage 3 as eGFR of 30–59 ml/min/1.73 m². Patients with stage 4/5 (ESRD) were not included in the CKD analysis.

Statistical analysis

All data were tabulated on Microsoft Excel worksheets and analysed using statistical software SPSS version 15.0. Chi-square test was used for comparing the prevalence rates between the subgroups and for determining the relationship between various risk factors and CKD at 95% confidence interval (CI). Yates correction was applied where necessary. To compare intergroup differences for the quantitative variables of age and GFR, t-test was used. Multiple logistic regression analysis was carried out to determine the independent association of various risk factors on CKD. A P-value of <0.05 was taken as statistically significant.

Results

A total of 3398 subjects were examined. State/region data were available for 2595 subjects. Of these 2595 subjects, 923 (35.57%) were from the home state of Uttar Pradesh. The remaining 1672 (64.43%) were from other regions of India. Region-wise distribution of subjects is summarized in Table 1.

Mean age of the population was 35.64 ± 8.72 years with a range of 18–76 years of which 2244 (66.04%) were males and 1154 (33.96%) females. Assessment of obesity using BMI revealed 979 (28.81%) overweight subjects (BMI >23), and 735 (21.63%) were obese (BMI >25). Using WHR, 1941 (57.12%) subjects had truncal obesity (>0.9 for males and >0.8 for females). HTN was found in 447 subjects (13.15%). Only 52 (1.53%) were found to be diabetic (see Supplementary data). Three hundred and eight (9.06%) subjects had hypercholesterolaemia (serum cholesterol >200 mg/dL).

For further analysis of evidence of CKD, 162 subjects were excluded due to pre-existing disease, and 386 patients could not undergo test for MAU due to logistic reasons and were thus not included. A total of 2850 subjects were thereby evaluated for CKD. While evaluating for CKD, 284 subjects (9.96%) had urinary microalbumin >30 mg/1, and 327 (11.47%) subjects had deranged ACR of 30–300 mg/g. Haematuria and/or leucocyturia was seen in 88 (3.09%) subjects (Table 2). Mean GFR was 98 ± 25.25 ml/min/1.73 m² by the MDRD equation and 100 ± 19.48 ml/min/1.73 m² by the CKD-EPI equation. As per GFR (MDRD), 1735 (60.88%) had GFR >90 ml/min/1.73 m² of which 189 (6.62%) had RD and hence classified as stage I CKD; 1029 (36.11%) had GFR of 60–90 ml/min/1.73 m² with 154 (5.40%) having RD and therefore stage II CKD. Eighty-six subjects (3.02%) had GFR 30–59 ml/min/1.73 m² and were classified as stage III CKD; 39 of these 86 (45.35%) subjects had MAU. As per GFR (CKD-EPI), 2008 (70.46%) had GFR >90 ml/min/1.73 m² of which 192 (6.73%) had RD and hence classified as stage I CKD; 782 (27.44%) had GFR of 60–90 ml/min/1.73 m² with 122 (4.28%) having RD and therefore stage II CKD. Another 60 subjects (2.11%) had GFR 30–59 ml/min/1.73 m² and were classified as stage III CKD; 25 of these 60 (41.67%) subjects had MAU.

On examination of population subgroups of males and females, there were 2244 males and 1154 females with mean age of 35.73 ± 8.44 and 35.44 ± 9.23 years, respectively. The comparative data between the population sub-

<table>
<thead>
<tr>
<th>Region</th>
<th>Number</th>
<th>Percent (subgroup)</th>
<th>Percent (total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North India</td>
<td>605</td>
<td>36.18</td>
<td>23.31</td>
</tr>
<tr>
<td>West India</td>
<td>387</td>
<td>23.15</td>
<td>14.91</td>
</tr>
<tr>
<td>South India</td>
<td>308</td>
<td>18.42</td>
<td>11.87</td>
</tr>
<tr>
<td>East India</td>
<td>372</td>
<td>22.25</td>
<td>14.34</td>
</tr>
<tr>
<td>Subtotal—all regions</td>
<td>1672</td>
<td>46.43</td>
<td></td>
</tr>
<tr>
<td>Uttar Pradesh</td>
<td>923</td>
<td>35.57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2595</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

*North India includes Bihar, Chandigarh, Delhi, Haryana, Himachal Pradesh, Jammu and Kashmir, and Punjab.

*West India includes Gujarat, Maharashtra and Rajasthan.

*South India includes Andhra Pradesh, Karnataka, Kerala, Madhya Pradesh and Tamilnadu.

*East India includes Assam, Chattisgarh, Jharkhand, Manipur, Nagaland, Orissa, Tirupura, Uttaranchal and West Bengal.
groups for the various risk factors and stages of CKD are represented in tabular form in Table 3. Chi-square test was used to determine the differences in the observed characteristics between males and females. There was a highly significant difference observed in the occurrence of overweight individuals, obesity, truncal obesity, HTN and hypercholesterolaemia between the subgroups. No significant difference could be found for FPG. For quantitative variables of mean age and mean GFR, difference between males and females was compared using the t-test, and the difference was found to be not significant for mean age and significant (P < 0.05) for GFR using both MDRD and CKD-EPI equations. While evaluating for CKD, a significant difference was observed for deranged ACR and stage III CKD, whereas no significant difference was observed for MAU, stage 1 CKD and stage 2 CKD. For overall prevalence of CKD, there was a significant difference seen with the MDRD equation but not with CKD-EPI.

To evaluate the independent association of the risk factors of CKD, multiple logistic regression was carried out for the entire population as well as the subgroups. It was observed that, for the total population, age >40 years [OR = 1.86 (95% CI 1.42–2.43), P < 0.00001], FPG >126 mg/dL [OR = 4.18 (95% CI 2.16–8.12), P < 0.00001] and HTN [OR = 1.4 (95% CI 1.01–1.93), P < 0.05] had an independent effect on CKD. In the subpopulation of males, age >40 years [OR = 2.34 (95% CI 1.66–3.3), P < 0.00001], FPG >126 mg/dL [OR = 5.12 (95% CI 2.3–11.4), P < 0.0001] and HTN [OR = 1.49 (95% CI 1.03–2.15), P < 0.05] had an independent effect on CKD. In the subpopulation of females, no independent association could be found for any of the risk factors for CKD.

Discussion

Our study shows that 13.12–15.04% of CGEs have early stages of CKD. This is the first study in India on early stages of CKD based on KDOQI guidelines using MAU as a marker for kidney damage. Previously available studies from tertiary care centres as well as community surveys have looked at the late stages of CKD and/or ESRD and estimated the CKD burden in India as 0.79–1.39% [9–11]. However, studies in other parts of the world have shown much higher prevalence. The NHANES II and III cohorts show that 10.03% and 13.07% of the US population had CKD in the 1988–94 and 1999–2004, respectively [7]. Tillin et al. found 8.7% MAU in an ethnically South Asian population of Britain who were predominantly first generation migrants of Indian origin [16], and in Singapore, Nang et al. found 27% CKD in ethnic Indians [17]. A community-based study around Delhi using eGFR by MDRD and Cockroft–Gault (CG) equations found 4.2%

Table 2. Haematuria and leucocyturia in relation to MAU and CKD stages

<table>
<thead>
<tr>
<th>CKD stage (MDRD)</th>
<th>Total MAU positive</th>
<th>MAU status</th>
<th>Haematuria only</th>
<th>Leucocyturia only</th>
<th>Haematuria and leucocyturia</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKD stage 1</td>
<td>154</td>
<td>MAU positive</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAU negative</td>
<td>28</td>
<td>7</td>
<td>0</td>
<td>35</td>
</tr>
<tr>
<td>CKD stage 2</td>
<td>132</td>
<td>MAU positive</td>
<td>8</td>
<td>3</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAU negative</td>
<td>10</td>
<td>11</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>CKD stage 3</td>
<td>39</td>
<td>MAU positive</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MAU negative</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>30</td>
<td>3</td>
<td>–</td>
<td>–</td>
<td>88</td>
</tr>
</tbody>
</table>

Table 3. Comparison of studied characteristics between subgroups of males and females

<table>
<thead>
<tr>
<th>Characteristic studied</th>
<th>Males (n = 2244)</th>
<th>Females (n = 1154)</th>
<th>Total (n = 3398)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean + SD)</td>
<td>35.73 ± 8.44</td>
<td>35.44 ± 9.23</td>
<td>35.64 ± 8.72</td>
<td>NS</td>
</tr>
<tr>
<td>Overweight (BMI &gt;23)</td>
<td>753 (33.56%)</td>
<td>226 (19.58%)</td>
<td>979 (28.81%)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Obesity (BMI &gt;25)</td>
<td>406 (18.09%)</td>
<td>329 (28.51%)</td>
<td>735 (21.63%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Abnormal WHR</td>
<td>975 (43.45%)</td>
<td>966 (83.71%)</td>
<td>1941 (57.12%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Hypertension (SBP ≥140 and/or DBP ≥90)</td>
<td>360 (16.04%)</td>
<td>87 (7.54%)</td>
<td>447 (13.15%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Diabetes (FPG ≥126 mg/dL)</td>
<td>35 (1.56%)</td>
<td>17 (1.47%)</td>
<td>52 (1.53%)</td>
<td>NS</td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>254 (11.32%)</td>
<td>54 (4.68%)</td>
<td>308 (9.06%)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Microalbuminuria (&lt;30 mg/L)</td>
<td>192 (10.06%)</td>
<td>92 (9.78%)</td>
<td>284 (9.96%)</td>
<td>NS</td>
</tr>
<tr>
<td>Albumin:creatinine ratio (ACR) (3.4–33.9)</td>
<td>198 (10.37%)</td>
<td>129 (13.71%)</td>
<td>327 (11.47%)</td>
<td>&lt;0.005</td>
</tr>
<tr>
<td>GFR (mean + SD) (mL/min/1.73 m²)</td>
<td>MDRD</td>
<td>249 (13.04%)</td>
<td>241 (12.62%)</td>
<td>180 (19.13%)</td>
</tr>
<tr>
<td>CKD—total</td>
<td>102 ± 18.22</td>
<td>93 ± 24.40</td>
<td>98 ± 21.64</td>
<td>100 ± 19.48</td>
</tr>
<tr>
<td>Stage 1</td>
<td>137 (7.17%)</td>
<td>52 (5.53%)</td>
<td>43 (4.56%)</td>
<td>189 (6.04%)</td>
</tr>
<tr>
<td>Stage 2</td>
<td>94 (4.93%)</td>
<td>60 (6.37%)</td>
<td>46 (4.89%)</td>
<td>154 (5.40%)</td>
</tr>
<tr>
<td>Stage 3</td>
<td>18 (0.94%)</td>
<td>68 (7.23%)</td>
<td>44 (4.68%)</td>
<td>86 (3.02%)</td>
</tr>
</tbody>
</table>

NS, not significant.
of the population had low eGFR (<60 mL/min/1.73 m²) [12]. This corresponds to KDQI stage 3 and above and is comparable to our data (2.11–3.02% stage III CKD). Our study therefore shows that the burden of CKD, even in a low-risk population of apparently healthy CGEs, is much higher in India than previously estimated. However, since we have carried out only one spot sample for MAU, some of our subjects may have only transient MAU. Further studies with a more inclusive and representative sample including high-risk groups would be required to find the true prevalence of CKD in India.

There are ethnic and racial variations in the prevalence of CKD and MAU. Even within one nation/ethnicity, wide variations by ethnic subgroups in the prevalence of dipstick proteinuria were demonstrated in studies from Pakistan [18] and Southeast Asia [19]. Similar ethnic-/region-wise variations are likely in a large country like India. One of the strengths of our study is the inclusion of subjects from all regions of the country giving a better representation of CKD prevalence than studies from one geographic region or city. However, due to the migratory nature of the study population and small sample size of individual ethnic groups, region-/ethnicity-based conclusions were not possible.

The MDRD study equation was developed by studying people with CKD, and its major limitations are imprecision and systematic underestimation of measured GFR at higher values [20]. The validity of using equations developed on a small cohort of CKD patients for calculating eGFR in healthy subjects in epidemiological studies has been questioned. The CKD-EPI equation was developed to address these shortcomings and claims to have better performance over the MDRD equation especially at higher GFR, with less bias, improved precision and greater accuracy [14]. On comparing the CKD-EPI equation vs the MDRD equation on the NHANES 1999–2006 cohort, the authors report that CKD-EPI equation yields a higher mean eGFR (93.2 ± 0.39 mL/min/1.73 m² vs 86.3 ± 0.40 mL/min/1.73 m²) and lower estimated prevalence of CKD (11.5% vs 13.1%). This was mainly due to lower prevalence of stage 3 disease (6.3% vs 7.8%). Reclassification to higher estimated GFR also resulted in a higher prevalence of stage 1 disease and a lower prevalence of stage 2. In our study, although the increase in mean eGFR by CKD-EPI vs MDRD was marginal (100 ± 19.48 mL/min/1.73 m² vs 98 ± 25.25 mL/min/1.73 m²), the overall prevalence showed a similar reduction (13.12% vs 15.04%). Similar comparisons of stage-wise prevalence for CKD-EPI vs MDRD showed that the prevalence increased for stage 1 CKD (6.73% vs 6.62%), and was reduced for stage 2 (4.28% vs 5.40%) and stage 3 CKD (2.11% vs 3.02%). Evaluation on the NHANES cohort also showed that the CKD-EPI equation leads to a lower prevalence in women. In our study, the prevalence for stage 3 CKD in females showed a significant reduction with the CKD-EPI in comparison to MDRD (4.68% vs 7.23%). Performance of the CKD-EPI equation was as expected in our study and may be suitable for use in Indian population. However, studies comparing the measured GFR with the CKD-EPI equation would be required for proper validation. Furthermore, as both MDRD and CKD-EPI use the same variables, such as age, sex and serum creatinine, any systemic bias due to ethnicity is likely to affect both MDRD and CKD-EPI, and ethnicity- and sex-based correction factors may be required.

In India, access to renal replacement therapy (RRT) for CKD and ESRD patients is limited and prohibitively expensive. India has about 700 nephrologists, 400 dialysis units (1000 dialysis stations) and 100 renal transplant centres catering to an estimated 100,000 new cases of ESRD annually [21]. The annual cost of haemodialysis and continuous ambulatory peritoneal dialysis (CAPD) is 8500 and 9900 USD, respectively, which is 10 times the per capita gross national product of India. In the absence of state-funded medical support or medical insurance facilities, only 3–5% of ESRD patients get some form of RRT. In developed countries, over 80% of the cost of RRT is borne by the state. In India, such a subsidy would amount to 25% of the total health-care budget catering to just 0.01% of the population [8]. While screening for CKD in high-risk patients is established practice in developed countries, it is known from several epidemiologic studies that, for every patient with known HTN or diabetes, there is one individual in the population for whom this diagnosis has not yet been made but who already can have considerable associated end-organ damage [22,23]. In developing countries, this is even worse, and many individuals with diabetes, HTN or proteinuria may never seek medical care. Preventive measures to postpone ESRD consist of rigid BP control, preferably with angiotensin-converting enzyme inhibitors or angiotensin receptor blockers. Patients with known diabetes or HTN frequently are already on these regimens. Consequently, the number of individuals identified by targeted screening and for whom such screening results in a change of medical treatment may be limited. While data from the Prevention of Renal and Vascular End-stage Disease Intervention Trial (PREVEND) study showed that screening for albuminuria and subsequent pharmacological intervention was cost-effective when calculated to prevent cardiovascular end points [24], Palmer et al. calculated that the earlier the individual at risk is detected and preventive treatment is started, the more cost-effective such treatment will be [25]. A study in the UK estimated that cost of screening for CKD could be recouped by delaying dialysis requirement by just 1 year for one individual per 10,000 patients treated [26]. In our study, previously undiagnosed DM and HTN were found in 1.53% and 13.15%, respectively. Structural kidney damage in the form of MAU, haematuria or leucocyturia in subjects with GFR >60 mL/min/1.73 m² was found in 10.01% (CKD-EPI) to 12.02% (MDRD) and hence could be classified as stage I and II CKD. It is in this subset of patients in whom early institution of risk modification behaviour, lifestyle changes and therapeutic intervention may delay or interrupt progression to higher stages of CKD.

Examination of various risk factors for CKD and MAU showed positive correlations for age >40 years, BMI >25, FPG >126 mg/dL and HTN. Singh et al. have observed a positive association between BMII [12] and renal impairment. Sanches et al. have shown a correlation between waist circumference (WC) and between WHR and reduced GFR [27]. These studies have evaluated patients with later stages of CKD and GFR <60 mL/min/1.73 m². Our study has shown that the correlation of these factors can be seen
even in early stages of CKD and in apparently healthy individuals. The correlation of risk factors may become stronger as the disease process progresses.

Our study has shown 28.81% overweight, 21.63% obese and 48.53% with abnormal WHR. These figures are much higher than western data and are due to application of much more stringent criteria of the Association of Physicians of India consensus statement for obesity for Asian Indian population [13]. Based on percentage body fat and morbidity data, it was found that limits of normal BMI are narrower and lower in Asian Indians than in white Caucasians, and the use of these new guidelines results in an additional 10–15% of Indian population being labelled as obese or overweight.

There are a few limitations to our study. Our sample comprised salaried class in central government service, and therefore, all socioeconomic classes, especially lower socioeconomic population, and the affluent are not adequately represented. The retirement age in central government service is 60 years, and hence, the sample has only a few dependents \( n = 11 \) of age over 60 years who are at higher risk of CKD. We have also done only spot sampling of MAU, although, ideally, two out of three samples should be positive to label an individual as MAU positive. The logistics of a camp approach that we had followed made a repeat sampling extremely difficult. However, spot sampling has been routinely used as a screening tool in many studies including the initial NHANES cohort and the Singapore Prospective Study Programme [16].

### Conclusion

This study shows 13.12–15.04% of Indian CGEs who have early stages of CKD, and previous figures were gross underestimates of the true prevalence of CKD. The use of markers of structural kidney damage has identified 10.01–12.02% of subjects with stages I and II of CKD. Screening of a general population rather than just targeted populations for CKD is likely to identify more subjects in whom early diagnosis and prevention due to such screening programmes will be beneficial and cost-effective.

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### Supplementary data

Supplementary data is available online at http://ndt.oxfordjournals.org.

### References


Cardiovascular risk factors underestimate atherosclerotic burden in chronic kidney disease: usefulness of non-invasive tests in cardiovascular assessment

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Abstract
Background. Cardiovascular risk scoring (Score) does not specifically address chronic kidney disease (CKD) patients. The aim of our study is to quantify atherosclerosis using carotid ultrasound and ankle–brachial index (ABI) and to assess its additional value in risk scoring.
Methods. In this cross-sectional, observational study, patients were studied according to a standardized protocol including carotid ultrasound and ABI to determine the atherosclerosis score (AS), ranging from absence of to severe atherosclerosis (AS 0 to AS 3).
Results. We included 409 CKD-affected patients (231 on dialysis, 99 in CKD Stages IV–V and 79 in CKD Stages I–III) and 851 subjects with normal renal function. The presence and severity of atherosclerosis was significantly higher in the CKD group than in the controls at every decade of age studied. Among the CKD-affected subjects, the prevalence of carotid plaques was significantly higher in the dialysis group (78.3%) than in the group in CKD Stages I–III (55.6%, P < 0.001). We identified 174 patients at low–intermediate risk. Among them, 110 (63.2%) presented either moderate (AS 2) or severe (AS 3) atherosclerosis. Variables significantly (P < 0.05) and positively related to atherosclerosis were being on dialysis [OR = 3.40, 95% CI (1.73–6.78) vs CKD Stages I–III], age [OR = 1.08, 95% CI (1.06–1.11)] and C-reactive protein [OR = 1.04, 95% CI (1.01–1.08)]. Conversely, female sex was negatively related to atherosclerosis [OR = 0.40, 95% CI (0.23–0.71), P = 0.002].
Conclusion. The use of carotid ultrasound and ABI identifies atherosclerosis in a population of CKD patients in which risk scoring underestimates atherosclerosis burden.
Keywords: ankle–brachial index; atherosclerosis; carotid ultrasound; chronic kidney diseases

Introduction
The most prominent cause of mortality among chronic kidney disease (CKD)-affected patients is cardiovascular events [1] and, therefore, cardiovascular disease (CVD) prevention is of paramount relevance. However, most of the existing data on cardiovascular risk scores (Framingham score) come from the general population and might not be equally applied to CKD patients [2]. In a study of 936 patients on haemodialysis, neither serum total cholesterol nor systolic blood pressure was associated with coronary heart disease, cerebrovascular disease or peripheral vascular disease, and the authors concluded that using the Framingham score in haemodialysis patients is inadequate in predicting coronary heart disease [3]. Furthermore, variables involved in the pathogenesis of atherosclerosis of...