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# Understanding racial disparities in renal cell carcinoma incidence: Estimates of population attributable risk in two U.S. populations

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## Abstract

**Purpose:** Renal cell carcinoma (RCC) incidence is higher among black than white Americans. The reasons for this disparity remain unclear.

**Methods:** We calculated race- and sex-specific population attributable risk percentages (PAR%) and their 95% confidence intervals (CI) for hypertension and chronic kidney disease (CKD) among black and white subjects ≥50 years of age from the US Kidney Cancer Study (USKC; 965 cases, 953 controls), a case-control study in Chicago and Detroit, and a nested case-control study in the Kaiser Permanente Northern California health care network (KPNC; 2,162 cases, 21,484 controls). We also estimated PAR% for other modifiable RCC risk factors (cigarette smoking, obesity) in USKC.

**Results:** In USKC, the PAR% for hypertension was 50% (95%CI 24-77%) and 44% (95%CI 25-64%) among black women and men, respectively; and 29% (95%CI 13-44%) and 27% (95%CI 14-39%) for white women and men, respectively. In KPNC, the hypertension PAR% was 40%

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(95%CI 18-62%) and 23% (95%CI 2-44%) among black women and men, and 27% (95%CI 20-35%) and 19% (95%CI 14-24%) among white women and men, respectively. The PAR% for CKD in both studies ranged from 7-10% for black women and men but was negligible (<1%) for white subjects. In USKC, the PAR% for current smoking was 20% and 8% among black and white men, respectively, and negligible and 8.6% for black and white women, respectively. The obesity PAR% ranged from 12-24% across all race/sex strata.

**Conclusions:** If the associations found are causal, interventions that prevent hypertension and CKD among black Americans could potentially eliminate the racial disparity in RCC incidence (hypothetical black:white RCC incidence ratio of 0.5).

### Keywords

Kidney cancer; African Americans; hypertension; chronic kidney disease; population attributable risk

## Introduction

The incidence of renal cell carcinoma (RCC), which accounts for 90% of kidney cancers, increased in the United States over the past several decades. The rise in RCC incidence has been more pronounced among black Americans than white Americans. The percent change in RCC incidence from 2000-2007 for black Americans was 4.1% compared to 3.4% among whites, but the incidence of RCC for both races has recently stabilized.[1] Black Americans also have lower rates of RCC survival.[2] The racial disparity in RCC incidence may be partly attributable to a higher prevalence of RCC risk factors such as hypertension,[3] chronic kidney disease (CKD),[4] and obesity[5] among black than white Americans. Additionally, hypertension and CKD have been reported to be more strongly associated with RCC risk among black Americans, possibly due to racial differences in severity of these diseases.[6-9] For instance, the odds ratio (OR) for hypertension and RCC has been reported to be 1.9 (95%CI 1.5-2.4) among whites and 2.8 (95%CI 2.1-3.8) among blacks.[7]

Earlier reports from the US Kidney Cancer Study (USKC), a population-based case-control study conducted in Detroit, Michigan and Chicago, Illinois, indicated that the population attributable risk (PAR) for hypertension was higher among blacks than whites (for men, 35% and 44%, respectively),[7] whereas obesity likely accounts for a similar fraction of RCC incidence in both racial groups.[10] In the current investigation, we expanded on our previous analyses by comprehensively assessing differences by race in the proportions of RCC incidence that may be attributable to these and other risk factors, including cigarette smoking and history of CKD. We confirmed our findings regarding the proportions of RCC incidence attributable to hypertension and CKD in a large nested case-control study of RCC within the Kaiser Permanente Northern California (KPNC) health care network; characteristics of this study, including its large sample size and the availability of prospectively collected electronic medical records, complement those of the USKC.

## Methods

### US Kidney Cancer Study

The design of the USKC and methods of recruitment and data collection have been described elsewhere.[7] Briefly, incident cases of RCC who were between 20-79 years of age and diagnosed during the ascertainment period were identified in Detroit via the Metropolitan Detroit Cancer Surveillance System from February 2002 until July 2006 (white cases) or January 2007 (black cases). In Chicago, incident cases between 20-79 years of age diagnosed in 2003 were identified through a review of pathology reports from Cook County hospitals. All black cases and an age- and sex-stratified sample of white cases were recruited. Controls were identified through Department of Motor Vehicles records (age 20-64) or Medicare eligibility files (age 65-79). Controls were frequency matched to the cases on sex, age (five-year intervals), and race. Black controls were matched at a 2:1 ratio to increase statistical power in analyses restricted to black participants, and white controls were matched at a 1:1 ratio. Census block groups with a high density of black residents were intentionally oversampled using stratified cluster sampling.[7]

Trained interviewers conducted computer-assisted personal interviews in participants' homes that collected information on a broad range of lifestyle, occupational and medical factors. Participants were asked about their height, weight, smoking history, and whether they had been diagnosed with certain medical conditions (e.g. hypertension or chronic renal failure) at least two years prior to interview. In this analysis, CKD was defined as a report of chronic renal failure and/or end-stage renal disease necessitating dialysis or kidney transplantation.

The study was approved by Institutional Review Boards at all institutions, and written informed consent was obtained from all participants.

**USKC Inclusion and Exclusion Criteria—**We identified 1,571 potentially eligible cases in Detroit and Chicago; of these, 1,217 participated in this study (77%). We attempted to enroll 2,269 controls in Detroit and Chicago and 1,235 participated (54%).[7] For this analysis we restricted to subjects age 50 years or older (965 cases and 953 controls) because of the low incidence of RCC and the low prevalence of hypertension and CKD among younger individuals.

### Kaiser Permanente Northern California nested case-control study of RCC

KPNC has collected information from inpatient and outpatient visits in an electronic medical record system since 1995. Using these electronic medical records, as described previously,[9] 3,136 patients with a histologically confirmed incident diagnosis of RCC between 1998 and 2008 were identified using the Kaiser Permanente Cancer Registry, which links with the California Cancer Registry and the Surveillance Epidemiology and End Results (SEER) program. Controls (n=31,031) were selected from KPNC members who were free of RCC on the date of diagnosis of the corresponding matched case. Up to ten controls were individually matched to each case on age (±1 year), sex, race/ethnicity (black, white, Hispanic, Asian/Pacific Islander), duration of KPNC membership prior to the index date (±1

year; for cases, RCC diagnosis date; for controls, diagnosis date of matched case), and the medical center of diagnosis.

To ascertain history of diagnosed hypertension or CKD at least two years prior to the RCC diagnosis/index date for each subject, information on diagnoses of hypertension (ICD-9 401–405) or CKD (ICD-9 585) recorded between January 1996 and June 2006 was extracted from KPNC electronic medical records. Subjects were defined as having a history of hypertension or CKD using a two-year lag (i.e., the condition was diagnosed at least two years prior to the index date). History of diabetes (ICD-9 250) and smoking status (smoker, non-smoker) were also obtained from medical records. Information on body mass index (BMI) was only available for a subset of KPNC subjects and was not used in this analysis.

**KPNC Inclusion and Exclusion Criteria—**We restricted analyses to white and black subjects age 50 years or older (KPNC: 2,162 cases, 21,484 controls).

## Statistical analysis

In both the USKC and KPNC studies, we computed race- and sex-specific population attributable risk percentages (PAR%) for history of hypertension and CKD. Estimates of PAR% and their 95% confidence intervals (CI) were generated using the Interactive Risk Attributable Program (National Cancer Institute, Bethesda, MD).[11] These estimates were calculated using the Bruzzi method,[12] as recommended by Benichou for estimating adjusted PAR%.[13] USKC estimates were based on unconditional logistic regression models adjusted for age (50-54, 55-64, 65-74, ≥75 years), family history of cancer among first-degree relatives (none, kidney cancer, other cancer, or missing), years of education (<12y, high school graduate, some college, college graduate), study center (Chicago or Detroit), hypertension, CKD, BMI, and smoking status. Sample weights, developed to account for the race-specific sampling methods among cases and controls,[7] were included in these models. The stratified cluster sample design for selecting controls and sample weighting was taken into account in the computation of the PAR% and their 95%CIs.[14] Estimates of PAR% for hypertension and CKD in the KPNC study were based on logistic regression models conditioned on the matched sets and further adjusted for smoking (non-smoker vs. ever smoker) and history of diabetes. Two-sample t-tests were used to test for differences in PAR % by race. We also calculated PAR% restricting to clear cell RCC cases and cases diagnosed with stage II or greater RCC.

To evaluate the proportion of the excess incidence of RCC among blacks compared with whites that may be attributable to hypertension and CKD, we estimated age- and sex-specific RCC incidence rates from the SEER nine registries for 2002-2006, age-adjusted to the 2000 U.S. standard population.[15]

In USKC, which had more detailed information available, we also computed PAR% for overweight (BMI 25-29.9kg/$m^2$), obesity (BMI ≥30kg/$m^2$), former smoking, and current smoking. Using the methods described by Bruzzi et al.,[12] in USKC we also calculated summary PAR% for established RCC risk factors (obesity, smoking, hypertension) and, additionally, for those risk factors as well as chronic kidney disease.

## Results

Descriptive characteristics of cases and controls in the USKC and KPNC studies are presented in Table 1. In each study, cases and controls were similar in terms of the matching characteristics (age, race, and sex). In the USKC study, cases were more likely than controls to be smokers, to be obese, to have a history of hypertension, and to have a history of CKD. In the KPNC study, cases were more likely than controls to have histories of hypertension, CKD, and smoking.

Estimates of PAR% for history of hypertension and CKD in the USKC and KPNC studies are presented in Table 2. The odds ratios (OR) used to calculate the PAR% estimates are presented in Supplemental Table 1. In USKC, the largest observed PAR% for all race/sex strata was for hypertension among black women, at 50.1% (95%CI 23.5%, 76.7%); corresponding PAR% estimates for black men, white women and white men were 44.4% (95% CI 24.7%, 64.1%), 28.5% (95%CI 13.4%, 43.6%) and 26.6% (95%CI 14.2%, 39.0%), respectively. Similar hypertension PAR% findings were observed in the KPNC study, with estimates of 39.8% (17.5%, 62.2%) for black women, 22.8% (1.6%, 44.1%) for black men, 27.4% (20.3%, 34.5%) for white women, and 18.9% (13.7%, 24.1%) for white men, respectively. In each study, the estimated PAR% for CKD ranged from 6.9% to 10.1% for black men and women, but was less than 1% for white subjects. The PAR% for CKD was negative among white females (−0.3%, 95%CI −0.8%, 0.1%) in KPNC because an inverse association between CKD and RCC was observed (OR = 0.5, 95%CI: 0.1, 2.0). Results were generally similar when we restricted the race-stratified analyses to clear cell RCC cases (Supplemental Table 2).

The hypothetical incidence of RCC in the absence of CKD and hypertension is presented in Table 3. Assuming the associations with RCC are causal, if hypertension and CKD were eliminated, the black:white ratio of RCC incidence would be 0.8 for females and 0.9 for males in Detroit/Chicago, and 0.9 for females and 1.1 for males in San Francisco/Oakland.

As shown in Table 4, overweight (BMI 25-29.9 $kg/m^2$) did not contribute to RCC incidence among any race/sex category in the USKC study. Obesity (BMI ≥30 $kg/m^2$) was associated with excess RCC incidence in all race/sex strata, with PAR% ranging from 12.8% (−3.7%, 29.4%) for black men to 24.4% (11.9%, 37.0%) for white women, however the confidence intervals were wide. Former smoking did not contribute to excess RCC incidence. Current smoking was associated with excess RCC incidence only among men of either race (white men 7.8%, 95%CI 0.1%, 15.5%; black men 20.4%, 95%CI 8.2%, 32.5%).

The summary PAR% in the USKC study for established RCC risk factors (hypertension, obesity, and smoking) and CKD in addition to established RCC risk factors are presented in Table 5. Among whites, the summary PAR% for established risk factors were 47.7% (95%CI 23.9%, 71.5%) among men and 55.4% (95%CI 35.9%, 75.0%) among women. These estimates were similar when CKD was incorporated (men 48.4%, 95%CI23.7%, 73.2%; women 56.4%, 95%CI 35.5%, 77.3%). Among blacks, the summary PAR% for established risk factors were 75.9% (95%CI 54.5%, 97.3%) and 63.4% (19.5%, 107.2%) among men and women, respectively. When CKD was incorporated among blacks, these

estimates were 86.5% (95%CI 60.0%, 112.9%) and 72.8% (95%CI 22.9%, 122.8%) among men and women, respectively. If established RCC risk factors were to be eliminated, the black:white ratio of RCC incidence overall would hypothetically be 0.7 and if CKD and established RCC risk factors were eliminated the black:white ratio of RCC incidence would hypothetically be 0.5.

## Discussion

History of hypertension and CKD accounted for the majority of RCC incidence among black subjects in both studies; these same factors accounted for a smaller proportion of RCC incidence among whites. In the USKC study, other established RCC risk factors (i.e. obesity and current smoking) accounted for a considerable portion of RCC incidence regardless of race. The hypothetical elimination of these exposures, especially hypertension and CKD, could lead to lower incidence of RCC among blacks compared with whites.

We observed that smoking, obesity, CKD, and hypertension accounted for about 50% of RCC incidence among white subjects, which is consistent with prior US-based studies that did not stratify by race.[16,17] Among black subjects, smoking, obesity, CKD and hypertension accounted for over 80% of RCC. To the best of our knowledge, there are no previous published studies with which to compare our summary PAR% estimates for black subjects. Characterizing the contributions of modifiable risk factors to the incidence of RCC can help to inform efforts to reduce the incidence of this malignancy, possibly through targeted intervention efforts. These efforts may also have broader public health relevance for prevention of other adverse health outcomes related to these factors.

Confirmation of our findings for hypertension and CKD in the KPNC study is particularly noteworthy; the two case-control studies included in this investigation had distinct strengths and limitations. The USKC study is a large population-based case-control study that intentionally recruited many black participants, which allowed for stratification by race and sex. We were also able to adjust for several potential confounders, including modifiable risk factors and family history of cancer. A centralized histologic confirmation of cases by an expert urologic pathologist is an additional strength. However, because USKC relied on participant interviews conducted after case diagnosis and had a relatively low participation rate among controls, there is a potential for information bias and selection bias. In contrast, the KPNC study was based on prospectively collected medical records, and is not susceptible to such biases, although its reliance upon electronic data decreased the detail of risk factor information available for analysis (e.g. current smoking and obesity). The consistency of our findings across two studies with complementary designs suggests that biases from the limitations in USKC and KPNC are unlikely to account for our results. Although the studies included diverse, community-based samples from two regions in the United States, they may not be generalizable to other populations. Overall, we observed the same patterns by race in both studies, but the point estimates for PAR% differed between studies.

The prevalence of histologic subtypes of RCC also vary by race, with papillary RCC tending to be more common among black Americans. We have previously observed that obesity is

associated with clear cell and chromophobe RCC, but not papillary RCC, in both the USKC and KPNC, but no differences by subtype were observed for the associations between RCC and hypertension or CKD. [18,19] It is unlikely that our findings are attributable to differences in histologic subtype frequencies by race.

We also note that, despite our large sample sizes, analyses of some exposures of interest had limited statistical power in race- and sex-specific subgroups. For example, given that CKD is relatively rare in the general population, our estimates of PAR% for CKD had wide confidence intervals.

Another limitation of our study is that the summary PAR% estimates may be confounded by other unmeasured factors or other RCC risk factors, such as occupational or environmental exposures. However, most occupational exposures that are associated with RCC have a low prevalence of exposure, suggesting that the PAR estimates for these factors would be negligible. For instance, in USKC, the third tertile of cumulative hours exposed to perchloroethylene was associated with a 3-fold increased risk of RCC, but only 1.4% of study subjects were exposed to this level of perchloroethylene. Furthermore, hypertension, CKD, smoking, and obesity are important risk factors for other adverse health outcomes that are more prevalent among blacks than whites (e.g. heart disease)[20]; thus targeted interventions addressing these risk factors may benefit the public health with regards to reducing the incidence of RCC and other adverse health outcomes.

In conclusion, assuming our observed associations are causal, interventions that reduce the prevalence of hypertension and CKD would have an especially beneficial impact on RCC prevention among black Americans and may eliminate the black:white disparity in incidence.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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**Table 1.**

Descriptive characteristics of renal cell carcinoma cases and controls age 50 and older in the US Kidney Cancer Study (USKC) and Kaiser Permanente Northern California (KPNC)

| | USKC | | | | | | | | KPNC[a] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Characteristic** | **White** | | | | **Black** | | | | **White** | | | | **Black** | | | |
| | **Cases n = 678** | | **Controls n = 570** | | **Cases n = 287** | | **Controls n = 383** | | **Cases n = 1923** | | **Controls n = 19188** | | **Cases n = 239** | | **Controls n = 2296** | |
| Sex | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) | n | (%) |
| Male | 392 | (58) | 358 | (63) | 180 | (63) | 181 | (47) | 1252 | (65) | 12487 | (65) | 140 | (59) | 1327 | (58) |
| Female | 286 | (42) | 212 | (37) | 107 | (37) | 202 | (53) | 671 | (35) | 6701 | (35) | 99 | (41) | 969 | (42) |
| Age | | | | | | | | | | | | | | | | |
| 50-54 | 113 | (17) | 96 | (17) | 69 | (24) | 71 | (19) | 185 | (10) | 1850 | (10) | 35 | (15) | 344 | (15) |
| 55-64 | 255 | (38) | 205 | (36) | 117 | (41) | 145 | (38) | 583 | (30) | 5830 | (30) | 79 | (33) | 764 | (33) |
| 65-74 | 221 | (33) | 196 | (34) | 82 | (29) | 133 | (35) | 625 | (33) | 6250 | (33) | 77 | (32) | 741 | (32) |
| >75 | 89 | (13) | 73 | (13) | 19 | (7) | 34 | (9) | 530 | (28) | 5258 | (27) | 48 | (20) | 447 | (20) |
| History of hypertension | | | | | | | | | | | | | | | | |
| No | 268 | (40) | 319 | (56) | 66 | (23) | 160 | (42) | 896 | (47) | 11208 | (58) | 73 | (31) | 958 | (42) |
| Yes | 403 | (59) | 246 | (43) | 219 | (76) | 221 | (58) | 1027 | (53) | 7980 | (42) | 166 | (70) | 1338 | (58) |
| Missing | 7 | (1) | 5 | (1) | 2 | (1) | 2 | (1) | | | | | | | | |
| History of CKD | | | | | | | | | | | | | | | | |
| No | 671 | (99) | 566 | (99) | 258 | (90) | 376 | (98) | 1911 | (99) | 19073 | (99) | 215 | (90) | 2265 | (99) |
| Yes | 7 | (1) | 4 | (1) | 29 | (10) | 7 | (2) | 12 | (1) | 115 | (1) | 24 | (10) | 31 | (1) |
| History of diabetes | | | | | | | | | | | | | | | | |
| No | 566 | (84) | 495 | (87) | 217 | (76) | 298 | (78) | 1597 | (83) | 16887 | (88) | 191 | (80) | 1778 | (77) |
| Yes | 112 | (17) | 74 | (13) | 70 | (24) | 85 | (22) | 326 | (17) | 2301 | (12) | 48 | (20) | 518 | (23) |
| Missing | | | 1 | | | | | | | | | | | | | |
| Smoking status | | | | | | | | | | | | | | | | |
| Never smoker | 240 | (35) | 222 | (39) | 92 | (32) | 122 | (32) | 1434 | (75) | 15024 | (78) | 165 | (69) | 1739 | (76) |
| Ever smoker | | | | | | | | | 489 | (25) | 4164 | (22) | 74 | (31) | 557 | (24) |
| Occasional smoker | 26 | (4) | 17 | (3) | 19 | (7) | 25 | (7) | | | | | | | | |
| Former smoker | 263 | (39) | 244 | (43) | 91 | (32) | 145 | (38) | | | | | | | | |
| Current smoker | 149 | (22) | 87 | (15) | 85 | (30) | 91 | (24) | | | | | | | | |
| Study center | | | | | | | | | | | | | | | | |
| Detroit | 587 | (87) | 492 | (86) | 224 | (78) | 311 | (81) | | | | | | | | |
| Chicago | 91 | (13) | 78 | (14) | 63 | (22) | 72 | (19) | | | | | | | | |
| Years of education | | | | | | | | | | | | | | | | |
| <12 years | 88 | (13) | 61 | (11) | 84 | (29) | 80 | (21) | | | | | | | | |
| High school graduate | 252 | (37) | 176 | (31) | 82 | (29) | 128 | (33) | | | | | | | | |
| Some college | 172 | (25) | 143 | (25) | 80 | (28) | 126 | (33) | | | | | | | | |
| College graduate | 166 | (25) | 190 | (33) | 41 | (14) | 49 | (13) | | | | | | | | |
| BMI ($kg/m^2$) | | | | | | | | | | | | | | | | |

| Characteristic | USKC | | | | | | | | KPNC[a] | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | White | | | | Black | | | | White | | Black | |
| | Cases n = 678 | | Controls n = 570 | | Cases n = 287 | | Controls n = 383 | | Cases n = 1923 | Controls n = 19188 | Cases n = 239 | Controls n = 2296 |
| <25 | 122 | (18) | 157 | (28) | 53 | (19) | 94 | (25) | | | | |
| 25-29.9 | 256 | (38) | 243 | (43) | 101 | (35) | 153 | (40) | | | | |
| ≥30 | 293 | (43) | 169 | (29) | 128 | (45) | 133 | (35) | | | | |
| Missing | 7 | (1) | 1 | (0) | 5 | (2) | 3 | (1) | | | | |
| Family history of cancer | | | | | | | | | | | | |
| None | 242 | (36) | 203 | (36) | 135 | (47) | 198 | (52) | | | | |
| Other | 406 | (60) | 349 | (61) | 131 | (46) | 175 | (46) | | | | |
| Kidney | 26 | (4) | 13 | (2) | 15 | (5) | 5 | (1) | | | | |
| Missing | 4 | (1) | 5 | (1) | 6 | (2) | 5 | (1) | | | | |
| Histologic subtype | | | | | | | | | | | | |
| Clear cell | 491 | (72) | | | 158 | (55) | | | 1635 | (85) | 175 | (73) |
| Papillary | 71 | (10) | | | 60 | (21) | | | 102 | (5) | 33 | (14) |
| Chromophobe | 32 | (5) | | | 18 | (6) | | | 42 | (2) | 10 | (4) |
| Other | 44 | (6) | | | 24 | (8) | | | 144 | (8) | 21 | (9) |
| Missing | 40 | (6) | | | 27 | (9) | | | | | | |

Abbreviations: USKC, US Kidney Cancer Study; KPNC, Kaiser Permanente Northern California; CKD, chronic kidney disease; BMI, body mass index.

[a]Information on current or former smoking, education, BMI, and family history of cancer was not available for KPNC subjects.

**Table 2.**

The proportion of renal cell cancer incidence attributable [a] to hypertension and CKD among adults age 50 years or older by race and sex in the USKC and KPNC studies.

| | | USKC | | | KPNC | | |
|---|---|---|---|---|---|---|---|
| **Exposure** | **Sex/Race** | **PAR% (95%CI)** | | **P-value[b]** | **PAR%(95%CI)** | | **P-value[b]** |
| Hypertension | Female | | | | | | |
| | White | 28.5 | (13.4, 43.6) | 0.14 | 27.4 | (20.3, 34.5) | 0.31 |
| | Black | 50.1 | (23.5, 76.7) | | 39.8 | (17.5, 62.2) | |
| | Male | | | | | | |
| | White | 26.6 | (14.2, 39.0) | 0.13 | 18.9 | (13.7, 24.1) | 0.72 |
| | Black | 44.4 | (24.7, 64.1) | | 22.8 | (1.6, 44.1) | |
| CKD | Female | | | | | | |
| | White | 0.4 | (−1.5, 2.3) | 0.02 | −0.3 | (−0.8, 0.1) | 0.009 |
| | Black | 8.4 | (1.9, 14.9) | | 6.9 | (1.5, 12.4) | |
| | Male | | | | | | |
| | White | 0.6 | (−0.5, 1.6) | 0.002 | 0.0 | (−0.6, 0.5) | 0.0003 |
| | Black | 9.4 | (4.0, 14.8) | | 10.1 | (4.6, 15.5) | |
| CKD or hypertension | Female | | | | | | |
| | White | 29.7 | (15.0, 44.4) | 0.15 | 27.2 | (20.0, 34.4) | 0.17 |
| | Black | 51.2 | (25.6, 76.8) | | 43.0 | (22.2, 63.8) | |
| | Male | | | | | | |
| | White | 27.0 | (14.7, 39.3) | 0.04 | 18.9 | (13.7, 24.1) | 0.28 |
| | Black | 49.2 | (32.0, 66.3) | | 29.4 | (10.5, 48.3) | |

Abbreviations: USKC, US Kidney Cancer Study; KPNC, Kaiser Permanente Northern California; PAR, population attributable risk; CI, confidence interval; CKD, chronic kidney disease.

[a] USKC PAR% were calculated from unconditional sample weighted logistic regression models, adjusted for hypertension, CKD, body mass index, smoking status, education, age, study center and family history of cancer. KPNC PAR% were calculated using conditional logistic regression models, conditioned on the matched sets and adjusted for hypertension, CKD, smoking status, and diabetes.

[b] P-value estimated from two sample t-test of difference by race.

**Table 3.**

Hypothetical RCC incidence in absence of hypertension and/or CKD among adults age 50 years or older by race and sex.

| Exposure | Sex/Race | SEER RCC incidence 2002-2006 | Hypothetical RCC incidence in absence of exposure[a] (95%CI) | | | |
|---|---|---|---|---|---|---|
| | | | USKC | | KPNC | |
| Hypertension | Female | | | | | |
| | White | 24.8 | 17.7 | (14.0, 21.5) | 18.0 | (16.2, 19.8) |
| | Black | 27.2 | 13.6 | (6.4, 20.8) | 16.4 | (10.3, 22.4) |
| | Male | | | | | |
| | White | 49.7 | 36.5 | (30.3, 42.6) | 40.3 | (37.7, 42.9) |
| | Black | 60.7 | 33.8 | (21.8, 45.7) | 46.9 | (33.9, 59.8) |
| CKD | Female | | | | | |
| | White | 24.8 | 24.7 | (24.3, 25.2) | 24.9 | (24.8, 25.0) |
| | Black | 27.2 | 24.9 | (23.2, 26.7) | 25.3 | (23.8, 26.8) |
| | Male | | | | | |
| | White | 49.7 | 49.4 | (48.9, 50.0) | 49.7 | (49.4, 50.0) |
| | Black | 60.7 | 55.0 | (51.7, 58.3) | 54.6 | (51.3, 57.9) |
| CKD or hypertension | Female | | | | | |
| | White | 24.8 | 17.4 | (13.8, 21.1) | 18.1 | (9.8, 21.2) |
| | Black | 27.2 | 13.3 | (6.3, 20.3) | 15.5 | (16.3, 19.8) |
| | Male | | | | | |
| | White | 49.7 | 36.3 | (30.2, 42.4) | 40.3 | (37.7, 42.9) |
| | Black | 60.7 | 30.9 | (20.5, 41.3) | 42.8 | (31.4, 54.3) |

Abbreviations: USKC, US Kidney Cancer Study; KPNC, Kaiser Permanente Northern California; PAR, population attributable risk; CI, confidence interval; CKD, chronic kidney disease.

[a]Renal cancer incidence rate per 100,000 per year in the absence of exposure = [SEER incidence rate at ages 50-79*(1-PAR%)] by race and sex; 95% CI's were derived from the 95% CI's of the PAR%. PAR% are presented in Table 2.

**Table 4.**

The proportion of renal cell cancer incidence attributable to selected exposures by race and sex among adults age 50 years or older in the USKC study

| Exposure | Sex and Race | | PAR%[a] (95%CI) | | Pvalue[b] | SEER RCC Incidence 2002-2006 | Hypothetical RCC incidence in absence of exposure[c] (95%CI) | |
|---|---|---|---|---|---|---|---|---|
| BMI 25-29.9kg/m$^2$ | | | | | | | | |
| | Female | White | 7.9 | (−3.4, 19.1) | 0.54 | 24.8 | 22.9 | (20.1, 25.7) |
| | | Black | 0.3 | (−21.0, 21.6) | | 27.2 | 27.1 | (21.3, 33.0) |
| | Male | White | 11.2 | (−3.6, 26.0) | 0.78 | 49.7 | 44.2 | (36.8, 51.5) |
| | | Black | 14.9 | (−1.4, 31.2) | | 60.7 | 51.9 | (41.9, 61.8) |
| BMI ≥30kg/m$^2$ | | | | | | | | |
| | Female | White | 24.4 | (11.9, 37.0) | 0.90 | 24.8 | 18.8 | (15.6, 21.9) |
| | | Black | 22.7 | (−3.4, 48.8) | | 27.2 | 21.1 | (13.9, 28.2) |
| | Male | White | 21.1 | (10.3, 31.8) | 0.40 | 49.7 | 39.2 | (33.9, 44.6) |
| | | Black | 12.8 | (−3.7, 29.4) | | 60.7 | 52.9 | (42.9, 62.9) |
| Former smoking | | | | | | | | |
| | Female | White | −10.0 | (−24.8, 4.8) | 0.63 | 24.8 | 27.3 | (23.6, 31.0) |
| | | Black | −3.4 | (−27.8, 21.1) | | 27.2 | 28.2 | (21.5, 34.8) |
| | Male | White | 7.9 | (−7.1, 23.0) | 0.14 | 49.7 | 45.8 | (38.3, 53.3) |
| | | Black | 1.2 | (−19.0, 21.5) | | 60.7 | 60.0 | (47.7, 72.3) |
| Current smoking | | | | | | | | |
| | Female | White | 8.6 | (−0.8, 17.9) | 0.09 | 24.8 | 22.7 | (20.4, 25.0) |
| | | Black | −11.2 | (−32.1, 9.8) | | 27.2 | 30.2 | (24.6, 36.0) |
| | Male | White | 7.8 | (0.1, 15.5) | 0.09 | 49.7 | 45.8 | (42.0, 49.7) |
| | | Black | 20.4 | (8.2, 32.5) | | 60.7 | 48.3 | (41.0, 55.7) |

Abbreviations: USKC, US Kidney Cancer Study; PAR, population attributable risk; CI, confidence interval; BMI, body mass index.

[a] PARs adjusted for hypertension, chronic kidney disease, body mass index, smoking status, education, age, study center and family history of cancer.

[b] P-value estimated from two sample t-test of difference by race.

[c] Renal cancer incidence rate per 100,000 per year in the absence of exposure = [SEER incidence rate*(1-PAR%)] by race and sex.

**Table 5.**

Summary population attributable risks (PAR) for established RCC risk factors and chronic kidney disease by race and sex in the USKC study

| | Established[a] RCC risk factors | | | Established[a] RCC risk factors and chronic kidney disease | | |
|---|---|---|---|---|---|---|
| | PAR%[a] | (95% CI) | Hypothetical RCC incidence in absence of exposure[b] (95% CI) | PAR%[a] | (95% CI) | Hypothetical RCC incidence in absence of exposure[b] (95% CI) |
| **Race and sex** | | | | | | |
| White females | 55.4 | (35.9, 75.0) | 11.1 (6.2, 15.9) | 56.4 | (35.5, 77.3) | 10.8 (5.6, 16.0) |
| White males | 47.7 | (23.9, 71.5) | 26.0 (14.2, 37.8) | 48.4 | (23.7, 73.2) | 25.6 (13.3, 37.9) |
| White overall | 52.0 | (35.5, 68.4) | 17.5 (11.5, 23.5) | 52.7 | (35.5, 70.0) | 17.2 (11.0, 23.5) |
| Black females | 63.4 | (19.5, 107.2) | 10.0 (−2.0, 21.9) | 72.8 | (22.9, 122.8) | 7.4 (−6.2, 21.0) |
| Black males | 75.9 | (54.5, 97.3) | 14.6 (1.6, 27.6) | 86.5 | (60.0, 112.9) | 8.2 (−7.9, 24.3) |
| Black overall | 70.5 | (53.2, 87.7) | 12.4 (5.1, 19.6) | 80.5 | (59.6, 101.5) | 8.1 (−0.6, 16.9) |

Abbreviations: USKC, US Kidney Cancer Study; PAR, population attributable risk; CI, confidence interval.

[a]Established RCC risk factors are hypertension, smoking, and obesity.

[b]PARs were calculated using sample weighted unconditional logistic regression models adjusted for education, age, study center and family history of cancer.

[c]Renal cancer incidence rate per 100,000 per year in the absence of exposure = [SEER incidence rate*(1-PAR%)] by race and sex. SEER incidence rates of microscopically-confirmed cases of adenocarcinoma of the kidney (renal parenchyma) among individuals ages 50-79 from 2002-2006 were: white females 24.8, white males 49.7, white overall 36.5, black females 27.2, black males 60.7, black overall 41.8 per 100,000 per year.