

# Association of Ethnicity and Socioeconomic Status With COVID-19 Hospitalization and Mortality in Those With and Without Chronic Kidney Disease



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## INTRODUCTION

In the United Kingdom, as of December 2021, there have been more than 11.5 million confirmed cases of COVID-19 and more than 170,000 deaths caused by SARS-CoV-2.<sup>S1</sup> Data are being reported on subpopulations most at risk of COVID-19 and its most severe forms. Age, ethnicity, and socioeconomic position—fundamental components in health inequality—strongly influence health outcomes for both infectious and noncommunicable diseases, and COVID-19 has further exposed the strong association between these and adverse health outcomes.<sup>1</sup>

There is substantial evidence that a disproportionate impact of COVID-19 exists on Black and South Asian ethnic groups.<sup>S2</sup> Individuals from these groups are more likely to be infected by SARS-CoV-2 and have an increased risk of intensive care admission compared with those of White ethnicity.<sup>2</sup> The mortality risk from COVID-19 among Black and Asian ethnic minority groups is approximately twice that of White patients.<sup>1,3</sup> Socioeconomic status is also a key factor in COVID-19 outcome,<sup>4</sup> and mortality rates from COVID-19 in the most deprived areas are more than double that of least deprived areas.<sup>5</sup>

Many of the ethnic and socioeconomic disparities that increase susceptibility to COVID-19 also make individuals vulnerable to chronic kidney disease (CKD). The risk of CKD is higher in ethnic minority groups compared with White individuals at every CKD stage,<sup>6</sup> and CKD is associated with greater hospitalization and

mortality from COVID-19.<sup>7,S3,S4</sup> Although the etiology of CKD involvement is multifactorial,<sup>S3</sup> the interactions with ethnic and socioeconomic status have not been studied. Previous data suggest that inequalities in COVID-19 deaths by ethnic group exist among people with similar pre-existing conditions, including CKD<sup>7</sup>; however, to our knowledge, no study has investigated how ethnicity and socioeconomic status affect COVID-19 severity among those with CKD.

## SHORT METHODS

This study uses UK Biobank data.<sup>8,S5</sup> Participants with CKD were identified by a creatinine-derived estimated glomerular filtration rate of <60 ml/min per 1.73 m<sup>2</sup> and/or an albumin-to-creatinine ratio ≥ 3 mg/mmol. Participants without CKD were included as a non-CKD comparison group. Our exposure of interest was CKD status, with ethnicity (White, South Asian, and Black ethnic groups) and socioeconomic deprivation status<sup>S6–S8</sup> used as effect modifiers. The Townsend deprivation index was used as a composite measure of socioeconomic status (“least deprived,” “average,” and “most deprived”).<sup>8</sup> Public Health England provided SARS-CoV-2 test results. The primary outcome was “severe” COVID-19 defined as a composite of a positive SARS-CoV-2–related hospital admission or death from COVID-19 (International Classification of Diseases—10 code U07.1/U07.2).<sup>S9</sup> Covariates included the following: current age, sex, obesity, and number of cancer and noncancer reported illnesses. Analysis was based on a

whole population-level approach.<sup>S10</sup> Maximally adjusted complete-case logistic regression models were used to analyze the associations between ethnicity, socioeconomic status, and severe COVID-19. Results are reported as odds ratios (ORs) with 95% CI. Missing data can be found in [Supplementary Table S1](#). Additional methods can be found in the [Supplementary Methods](#).

## RESULTS

### Participant Characteristics

Data were available for 459,042 participants, of whom 10,480 (2.3%) had CKD at baseline. In those with CKD, the median (25th–75th percentile) age was 76.0 (72.0–79.0) years, and 47.9% were males. The median estimated glomerular filtration rate was 54.2 (45.5–57.1) ml/min per 1.73 m<sup>2</sup>. Most of the CKD participants were White (94.2%) ([Table 1](#)).

### Risk of Severe COVID-19 in Those With CKD and Without CKD

There were 5538 cases of severe COVID-19. Of these cases, 247 (4.5%) occurred in participants with CKD and 5291 (95.5%) in those without CKD ([Table 1](#)).

**Table 1.** Demographic and clinical characteristics of CKD and non-CKD participants included

Characteristics, N = 459,042	CKD	Non-CKD
n (% of total)	10,480 (2.3)	448,562 (97.7)
Age (yr)	76.0 (72.0–79.0)	69.0 (63.0–76.0)
Sex (male), n (%)	5024 (47.9)	135,557 (43.4)
Ethnicity		
White, n (%)	9748 (94.2)	423,765 (95.7)
Black, n (%)	345 (3.3)	8554 (1.9)
South Asian, n (%)	198 (1.9)	1371 (0.3)
Townsend deprivation index		
Least deprived, n (%)	5194 (49.6)	234,945 (52.4)
Average, n (%)	3279 (31.3)	141,498 (31.6)
Most deprived, n (%)	1998 (19.1)	71,688 (16.0)
eGFR (ml/min per 1.73 m <sup>2</sup> )	54.2 (45.5–57.1)	93.2 (82.8–100.0)
ACR (mg/mmol)	2.0 (1.0–6.0)	1.0 (0.0–2.0)
CKD stage 3, n (%)	8782 (95.2)	—
CKD stages 4–5, n (%)	415 (4.5)	—
No. of cancer illnesses	0.0 (0.0–0.0)	0.0 (0.0–0.0)
0 cancer illness, n (%)	8929 (85.2)	413,091 (92.1)
≥1 cancer illnesses, n (%)	1551 (14.8)	35,471 (7.9)
No. of noncancer illnesses	3.0 (2.0–5.0)	1.0 (1.0–3.0)
0 noncancer illness, n (%)	1128 (10.8)	117,954 (26.3)
1 noncancer illnesses, n (%)	1710 (16.3)	122,379 (27.3)
≥2 noncancer illnesses, n (%)	7642 (72.9)	208,229 (46.4)
Obesity, n (%)	6997 (69.5)	246,619 (56.2)
COVID-19 status		
Positive inpatient tests, n (%)	169 (1.6)	4338 (1.0)
Death from COVID-19, n (%)	78 (0.7)	953 (0.2)
Severe COVID-19, n (%)	247 (2.4)	5291 (1.2)

ACR, albumin-to-creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

The data are median and interquartile range (25th–75th percentile) for continuous and/or n (%) for categorical variables. Cancer illnesses included bowel, skin, prostate, and leukemia cancer; noncancer illnesses included cardiovascular disease, respiratory conditions, diabetes, and neurodegenerative disease.

Participants with CKD were 1.6 times more likely to have had severe COVID-19 (OR: 1.58; 95% CI: 1.38–1.82;  $P < 0.001$ ).

### Association of Ethnicity With Risk of Severe COVID-19

Differences in the crude frequency of severe COVID-19 cases across ethnic groups in the CKD and non-CKD are illustrated in [Figure 1](#). In all participants, severe COVID-19 was more prevalent across all ethnic groups compared with White participants. In participants with CKD, compared with the White group, Black ethnic individuals were approximately 2.3 times more likely to have had severe COVID-19 (OR: 2.26; 95% CI: 1.34–3.80;  $P = 0.002$ ) and those of South Asian ethnicity 2.1 times more likely (OR: 2.07; 95% CI: 1.07–4.00;  $P = 0.032$ ; [Figure 2a](#)). A similar pattern of association was observed in participants without CKD. Ethnicity did not modify the association of CKD with severe COVID-19 ( $P = 0.363$ ; [Figure 2a](#)).

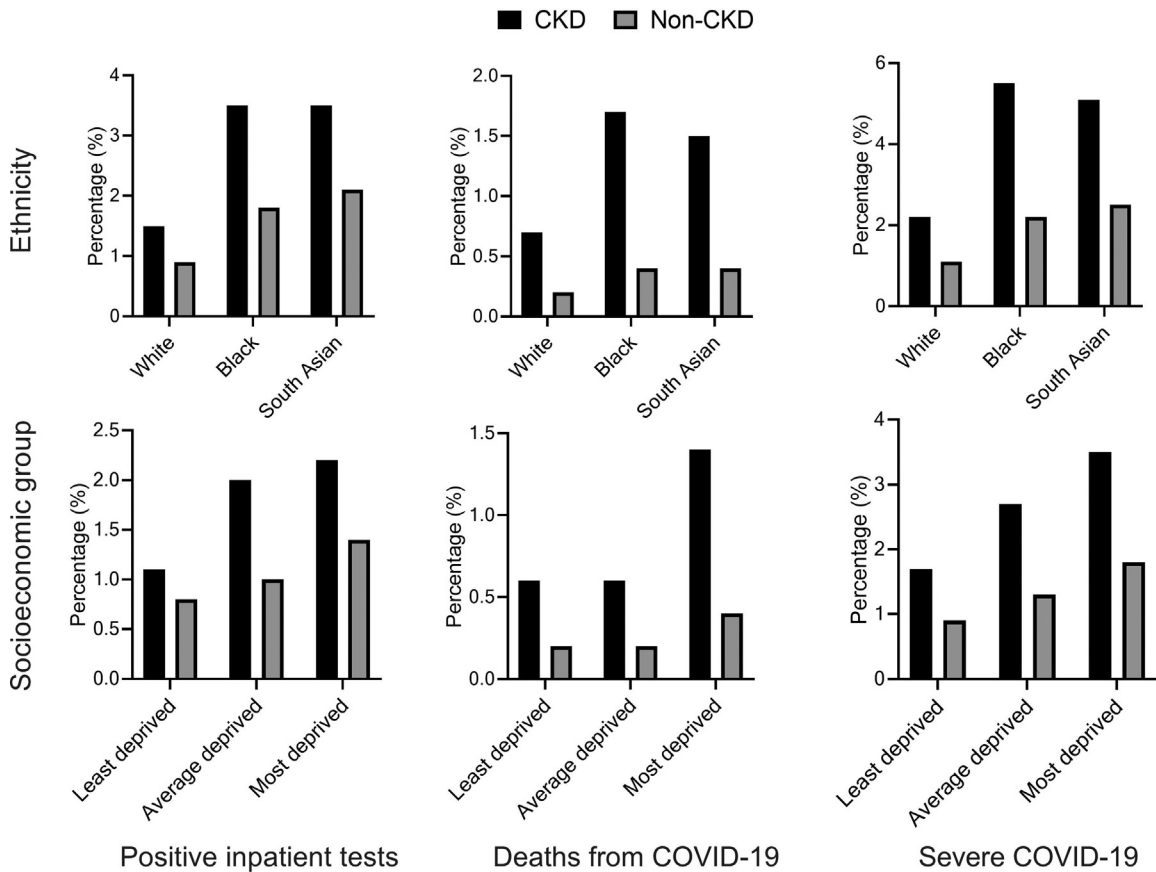
### Association of Socioeconomic Deprivation With Risk of Severe COVID-19

Across all participants, severe COVID-19 was more prevalent in those in the most socially deprived group ([Figure 1](#)). In participants with CKD, compared with the least deprived group, individuals in the most deprived group were 63% more likely to have severe COVID-19 (OR: 1.63; 95% CI: 1.15–2.31;  $P = 0.007$ ), whereas those in the average group were 50% more likely to have severe COVID-19 (OR: 1.50; 95% CI: 1.10–2.04;  $P = 0.011$ ; [Figure 2b](#)). A similar pattern of association was observed in participants without CKD. Socioeconomic status did not modify the association of CKD with severe COVID-19 ( $P = 0.559$ ).

## DISCUSSION

In a cohort study of almost half a million UK adults, we report a number of original findings. We found that in those with CKD, Black and South Asian ethnic groups were approximately twice as likely to have severe COVID-19 compared with White participants and the most socially deprived groups were at 50% to 60% increased risk of severe COVID-19. Nevertheless, although the frequency of severe COVID-19 cases was overall higher in participants with CKD compared with those without CKD, ethnicity or deprivation did not modify the association between CKD and severe COVID-19.

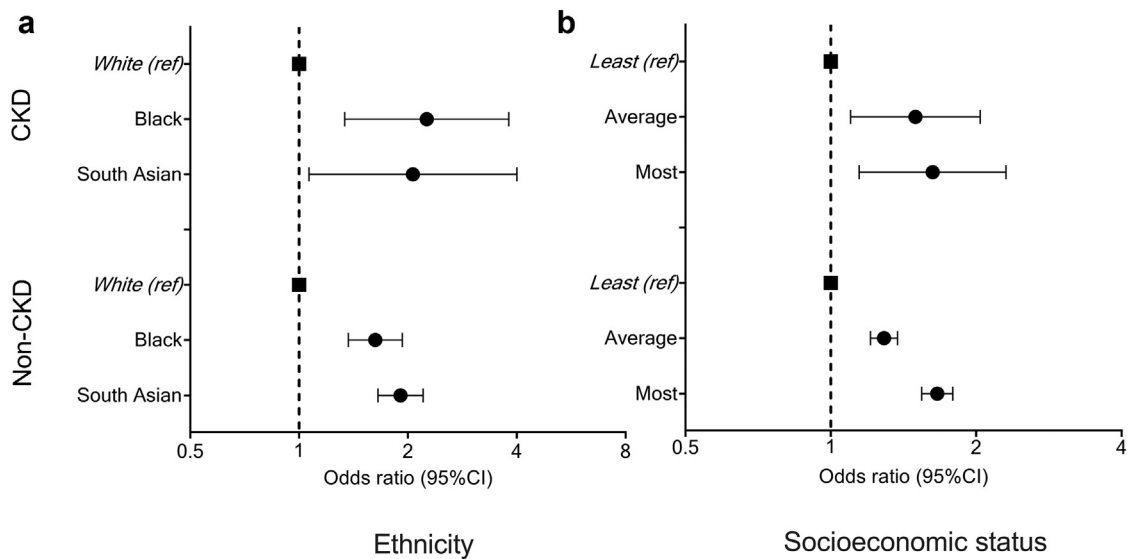
Although previous studies have revealed that CKD is associated with an increased risk of hospitalization and death from COVID-19,<sup>7,S4</sup> to our knowledge, no previous data have explored how ethnic and socioeconomic status may modify this risk in CKD. Our results



**Figure 1.** Proportion of COVID-19 positive inpatient tests, deaths, and severe COVID-19 across ethnic and socioeconomic deprivation groups in participants with and without CKD. Please note the different percentage scale across graphs. Data used to create figure can be found in [Supplementary Table S2](#). Severe COVID-19 was defined as a composite of a positive SARS-CoV-2-related hospital admission or death from COVID-19 (ICD-10 code U07.1/U07.2). CKD, chronic kidney disease; ICD, International Classification of Diseases.

are consistent with the stark ethnic inequalities evident in recent studies of COVID-19 mortality and outcomes,<sup>2,S2</sup> including an analysis of 17 million people in

England using the OpenSAFELY platform.<sup>3</sup> We found that the likelihood of severe COVID-19 was increased in the most deprived socioeconomic groups. This finding



**Figure 2.** Likelihood of severe COVID-19 across ethnic (a) and socioeconomic deprivation (b) groups in participants with and without CKD. Data presented as odds ratio with 95% CI; odds ratios were adjusted for current age, sex, obesity, and number of cancer and noncancer illnesses. Adjusted and unadjusted data used to create figure can be found in [Supplementary Table S3](#). CKD, chronic kidney disease.

supports previous reports in the general population.<sup>4,5,7,9,S8</sup> We did not find evidence that associations between CKD and severe COVID-19 were modified by ethnicity and socioeconomic status, suggesting the presence of CKD increased the relative risk of severe COVID-19 irrespective of ethnicity or deprivation.

The etiology of why kidney disease may exasperate COVID-19 is unclear and likely multifactorial, but it could be due to direct cytopathic effects on kidney tissue, deposition of immune complexes, hypoxia, shock, or rhabdomyolysis.<sup>S3</sup> Regarding the effect of ethnicity and social deprivation on risk of severe COVID-19, many explanations exist as to why there may be an elevated risk of SARS-CoV-2 infection in these groups. Possible reasons include living in deprived areas; working in high-exposure or frontline occupations; living in large, multigenerational households; a higher burden of comorbidity; discrimination; and poor access to health services.<sup>3,S2,S7</sup>

There are limitations to this analysis. The cohort consists of volunteers, meaning results may not be entirely generalizable to the whole United Kingdom.<sup>8</sup> We used data, particularly CKD classification, from the baseline assessments recorded >10 years ago and, as such, the current health status of participants (e.g., changes in kidney function) cannot be determined. Our CKD group had mild disease staging and findings may differ as disease severity increases. We were only able to categorize ethnicity into 3 broad categories, rather than considering disaggregated groupings. Disaggregation into specific ethnicity groups has revealed differences in COVID-19 outcomes.<sup>3</sup>

This study is the first to detail whether ethnicity and socioeconomic deprivation modify the risk of severe COVID-19 in those with and without CKD. These findings are of importance in informing interventions to reduce morbidity and mortality among these groups, and policy and practice improvements are needed to address the broad disparity among patients with CKD.

## DISCLOSURE

KK is the Director of the University of Leicester Centre for Ethnic Health Research, Trustee of the South Asian Health Foundation, and Chair of the Ethnicity Subgroup of SAGE. All the other authors declared no competing interests.

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## SUPPLEMENTARY MATERIAL

[Supplementary File \(PDF\)](#)

**Supplementary Methods.**

**Table S1.** Number of COVID-19-positive inpatient tests, deaths, and severe COVID-19 across ethnic and socioeconomic deprivation groups in subjects with and without CKD.

**Table S2.** Association of ethnicity and social deprivation index with severe COVID-19 in participants with and without CKD.

**Table S3.** Association of ethnicity and social deprivation index with severe COVID-19 in participants with and without CKD.

**Supplementary References.**

**Modified STROBE Statement.**

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