# Emerging Evidence on COVID-19

# Evidence Brief on Ethnicity and COVID-19

## Introduction

*This evidence brief aims to summarize the literature on associations of ethnicity with risk of COVID-19 infection, severity, and mortality in Canada and globally.*

This evidence brief contains literature up to September 7, 2020. Ethnicity in the included studies is mostly defined by the census bureaus of the included countries and is a self-reported variable based on the individual's identification with a social/cultural group from a predefined list. For consistency in this document the main categories of reported ethnicities will be referred to as Black, White, Asian, and Hispanic. Others or more specific minority ethnic group categories e.g. East Asian, South Asian, indigenous people and Pacific Islanders were also reported and are specified in the summary tables. Please see the Appendix for a table of acronyms and additional definitions.

This review summarizes observational studies (including cohort, cross-sectional, case control and case series) analysing individual-level data where examination of ethnicity was an objective of the study rather than just a potential confounder that was used in the multivariate model. Ecological studies, studies that use aggregate data, were excluded from summarization because these studies may suffer from a high risk of bias and the results cannot be extrapolated to the individual level. In an effort to collect all the available Canadian studies and reports, grey literature and ecological studies on the Canadian population were included in this review.

## Key Points

- Regarding ethnicity and COVID-19, two systematic reviews with literature up to May 15 and June 15, sixty-seven individual studies published since May 15 and four of five Canadian studies or reports were identified in the grey literature and are included in this review. There were 34 studies that assessed COVID-19 risk of infection, 31 on severity of disease and 22 studies on mortality (Table 1 & 2). Most of the research came from the USA and UK. There were two studies from France and one study from Brazil. Studies from Canada included a prepublication of an ecological study and two cross-sectional surveys and two relevant surveillance reports were identified in the grey literature (Table 3).
- This is the second version of this review. The first included a systematic review that summarized studies to May 15 and primary research published May 15 -30. This update added studies published between June 1 and Sept 7 including an additional systematic review with studies up to June 15. Analysis of studies captured in the tables and the new systematic review identified 15 studies which are marked with an asterisk (Tables 1 & 2).

Risk of Infection

- One systematic review included risk of infection and concluded across studies Blacks, Asians and Hispanics were more likely to test positive for COVID-19 compared to Whites (D. Pan, 2020).

- Twenty-nine studies examined risk of infection among different ethnic groups from people tested by RT-PCR for active infection (Table 1) and four seroprevalence studies measured risk of exposure (Table 2). Multivariable analyses with age, sex, comorbidities and socioeconomic variables attenuated associations with specific ethnicities, but in many studies the association was still significant:
    - Among twenty studies from the USA, compared to Whites, a higher risk of infection among Blacks (six adjusted and three univariate results) and Hispanics (six adjusted and six univariate results) were reported and conflicting data on Asians (two adjusted, and one univariate association and two no association results). One USA study reported a higher risk of infection among American Indians and Alaskan natives (Hatcher, 2020).
    - Fourteen studies from the UK, compared to Whites, consistently identify Black (nine adjusted results), South Asian (four adjusted results), Asian (three adjusted results) and more generally BAME groups (one adjusted and two univariate and one no association result) at higher risk of infection, whereas the results for other ethnicities were rarely reported.

COVID-19 Severity Outcomes

- Outcomes of COVID-19 severity (hospitalization, ICU admission and mechanical ventilation) were reported in two systematic reviews and thirty one studies reported associations for different ethnicities compared to Whites (Table 1).
    - For hospitalization: The systematic review reports meta-analyses of univariate associations compared to Whites for Blacks (overall countries) and for Asians (UK only), with a significantly higher magnitude association from UK studies and the adjusted analyses (age, sex and comorbidities) reported no association. Across individual studies from the USA, Blacks were found to have higher risk of hospitalization; for Asians and Hispanics there were mixed results. Mixed results from two USA studies reported on the proportion of American Indians, Alaskan Natives hospitalized (Alvarez Retamales, 2020; Karaca-Mandic, 2020). No association with Pacific Islander hospitalizations was reported in two studies (Alvarez Retamales, 2020; McPadden, 2020). In the UK, Blacks and South Asians had a higher risk of hospitalization; for Asians, mixed ethnicity or BAME groups the findings were inconsistent.
    - For ICU admission: The systematic review findings reported Asian and BAME ethnicities in UK studies were over-represented in the ICU, however the meta-analyses reported no association in adjusted analysis for Blacks, Hispanics and Asians (USA only). New studies in the USA had conflicting results for Blacks and Hispanics. In the UK, Blacks, South Asians and BAME had higher risk of admission.
    - For mechanical ventilation: Eighteen studies in the systematic review reported no association for Blacks and Hispanics, however Asians (four studies) had an association with ventilation that persisted with age and sex adjusted analysis. Few recent studies looked at the risk of ventilation by ethnicity; one from the USA reported no association for Blacks and Hispanics

and a study from the UK indicated Blacks and Asians were at increased risk compared to Whites.

- Multisystem Inflammatory Syndrome in Children (MIS-C) and ethnicity was reported in three studies one prospective cohort (ISARIC study, (Swann, 2020)) and two small case series from the UK and France (Riphagen, 2020; Toubiana, 2020). Across these studies a disproportionate number of MIS-C cases occurred in non-White ethnicities. No further analysis was conducted in these studies.

COVID-19 Mortality

- The systematic reviews reported no association with Blacks or Asians, and a protective association identified for Hispanics in univariate analyses, however the association did not persist in models adjusted for age, sex and comorbidities. An association with Asians who required mechanical ventilation due to COVID-19 was reported (4 studies). It is important to note there was high heterogeneity across studies and both reviews describe approximately 50% of studies reporting an association and the others report no association.
- In the USA and the UK twenty-two studies analysed mortality among hospitalized patients and did not report an association with ethnicity. However, when considering a population level denominator, certain ethnic groups were more likely to acquire COVID-19 disease, so proportionally they represent a higher than expected number of COVID-19 deaths. In UK studies that identified an association across all COVID-19 cases, there was an increased risk of mortality among BAME, Blacks, South Asians and Asians compared to Whites (Table 1).

Canadian studies

Despite an additional grey literature search, limited Canadian evidence was identified. Available Canadian data suggest non-White ethnicities, with the exception of East Asians, are disproportionately infected with COVID-19. The analyses largely did not adjust for comorbidities or socio-economic factors that attenuated results in other studies in this review. No Canadian data on ethnicity and hospitalizations, severity or mortality was identified.

- A cross-sectional survey designed to compare COVID-19 impacts on Black Canadians to a representative "national" sample reported a higher likelihood of COVID-19 among Black Canadians individually and among people they know. Black Canadians had a higher frequency of risk factors such as taking public transportation and having a job that requires face-to-face interactions with people. They also had a higher frequency of severe financial impacts associated with the pandemic. These data are consistent with similar studies published in the USA (Table 1).
- Toronto Public Health dashboard shows that a higher proportion of COVID-19 cases than the representation in the community was seen for Black, Hispanic, Southeast Asian, South Asian/ Indo-Caribbean and Middle Eastern ethnic groups.
- The ecological study analysed population data on number of COVID-19 cases and deaths in Canada by population level demographic information including proportion Black, proportion foreign-born,

proportion over 65 years, population density and median income. Findings from their multivariable analysis include:

- 1% increase in the proportion Black in a health unit was associated with double the case count. A 1% increase in the proportion foreign-born residents was associated with a 3% increase in the case count.
- A 1% increase in the proportion of Black residents in the health region was associated with 2.1x increase in COVID-19 death rates.

## Overview of the Evidence

Seventy-four studies, including two systematic reviews published up to September 7, 2020 were included in this review. Two systematic reviews were evaluated using the AMSTAR tool, they were of moderate to high quality. One ecological study from Canada was included to allow for awareness of Canadian research, ecological studies use aggregated data for analysis, they have a high risk of bias and ecological fallacy and their findings are cannot be extrapolated to the individual level.

This review focused on studies with datasets at the individual level, this included a range of observational study designs: moderate-high quality large prospective cohorts, moderate to low quality retrospective cohorts and cross-sectional studies and low quality retrospective case series.

This literature has evolved quickly, the more recent large cohort studies have sufficient power to control for many potential confounding variables. These studies provide better estimates of the association than studies reporting crude or minimally adjusted estimates. The large cohort studies are in moderate agreement across studies and offer some confidence that future research will not change the conclusions of this review. Knowledge gaps remain on this topic, such as why some ethnic groups may be at a higher risk of infection given that confounding variables such as socio-economic factors and co-morbidities do not entirely account for this association. Potential genetic factors, related to comorbidities, ACE2 activity, pro-inflammatory cytokine response or other differences in immune system function that may be associated with the immune profile of high risk ethnic groups have been suggested, but not been explained in the literature (Tal, 2020).

## CONTENTS

# ETHNICITY AND COVID-19 RISK OF INFECTION, SEVERITY OF DISEASE AND MORTALITY

Two systematic reviews and sixty-one observational studies are included in the table below and report on the risk of COVID-19, hospitalizations, severe disease, ICU admission, ventilation, acute kidney injury or mortality.

The systematic reviews include studies published up to May 15 and June 15 (D. Pan, 2020; Raharja, 2020). Only 15 studies overlap the results in Table 1 and the systematic review (Raharja, 2020), the systematic review included ecological studies (results not summarized), as well as studies that did not focus on the association between ethnicity and COVID-19 were included in their meta-analyses.

Most of the research on ethnicity has come from the USA and UK, with two studies from France and Canada, and one study from Brazil (Table 1). Increasingly studies have focused on exploring why ethnicity may be associated with the risk of COVID-19 infection, severity or mortality. Potentially confounding or mediating variables included in multivariable models are age, sex, comorbidities, and socioeconomic factors. The actual variables used for socio-economic factors varied from study to study e.g. income, neighbourhood status, and other composite indices and in some studies they were more complex measures of societal factors that result in barriers to access to medical care, health seeking behaviors or other disparities. The variability in the risk factors tested in the models, and differences in the final model across studies makes direct comparison of results difficult, as seen in the meta-analyses that frequently had high between study heterogeneity. It is also notable that in studies that control for age, sex, comorbidities and socio-economic factors in their analysis, some ethnic groups are still at higher risk of COVID-19 disease.

Table 1 below lists the studies on COVID-19 infection, severity and mortality by country. A summary of their contents is briefly listed below.

- Risk of infection or likelihood of testing positive was assessed in the USA (n=18 studies), UK (n=11) and France (n=1) and one systematic review.
    - Black, Asian and Hispanic ethnicity were shown to have a higher likelihood of testing positive in one systematic review (D. Pan, 2020).
    - Sixteen studies examined testing data in the USA and analysed the probability of testing positive. There was a range of analyses and outcomes were often adjusted for a range of individual, health and socio-economic factors. Despite this, significantly more test positives (in the magnitude of 1.5-3.5 times higher risk) compared to Whites were reported for Blacks in nine studies, Hispanics in eleven studies, Asians in two studies, Native American/Alaskan in one study (Table 1).
    - Eleven studies examined testing data in the UK and reported higher probability of testing positive compared to Whites among BAME groups (3/4 studies), Blacks (seven studies), South Asians (two studies) and Asian (one study).
    - One survey of US and UK populations reported an adjusted (sex, comorbidities, BMI, smoking) higher risk of being COVID-19 positive among Black and Hispanics, not Asian or other

ethnicities compared to Whites in the USA. In the UK, different ethnicity categories were used; higher risk was reported in Black, South Asian, Chinese, Middle Eastern and Other, not East Asian or Hispanic (Lo, 2020).

- One study in France of kidney transplant recipients reported that non-white ethnicity was associated with higher odds of COVID-19 disease after adjusting for age, sex and comorbidities (Elias, 2020).

- Risk of severe disease was measured as hospitalizations, ICU admission or mechanical ventilation was reported, and across studies, mixed results were often identified. The summaries listed below have been grouped by the denominator for the sampling frame, the entire population, the number of positive COVID-19 cases or hospitalized for COVID-19, as this was considered a potential source of heterogeneity. The analysis, univariate vs. adjusted results is also a source of heterogeneity across studies as estimates adjusted for comorbidities or socio-economic factors usually resulted in the association with ethnicity attenuated towards the null.
  - For hospitalization: The systematic review reported an association with Blacks (RR: 1.68 [95%CI: 1.28-2.20], $I^2$=98, k=13) in univariate analysis and subgrouping by country RR UK 5.47 [95%CI: 2.51; 12.06] vs. RR USA 1.36 [95%CI: 1.08; 1.72] showed higher magnitude in the association among UK studies. In studies that adjusted for age, sex and comorbidities no association was reported. No association with Hispanics (RR: 1.00 [95%CI: 0.95-1.06], $I^2$=0, k=8) in the univariate analysis, but there was an association in the adjusted analysis. No association with Asians was determined overall or in adjusted analyses. However, when sub-grouped by country an association with Asians was seen in UK studies: RR UK: 2.95 [95%CI: 1.55-5.53] vs. RR USA: 0.90 [95%CI: 0.82-1.66]. No association with ICU admission and mechanical ventilation was identified in adjusted meta-analyses, except for UK studies that identified an increased risk among Asians and over-representation of BAME groups.
  - Eight USA studies provided analysis of ethnicity by severity in a population. Hospitalizations compared to Whites were higher for Blacks (n=4/4 studies), Hispanics (n=3/4), Native American/Alaskans (n=1/2), Pacific Islanders (0/2) and other ethnicities (n=1/1). Whereas in one study lower than expected hospitalization was reported for Asian ethnicity. More severe outcomes were reported for Blacks (n=2/2), Hispanic (n=2/2) and Asians (n=2/2) compared to Whites. ICU admittance was significantly more common in Blacks (n=2/3) and Hispanics (n=1/2) and ventilation was reported to be more common for Black and Hispanics in one study.
  - Ten USA studies looked at hospitalization and risk of ICU among confirmed cases of COVID-19. Hospitalizations occurs significantly more among Blacks (n=5/7 studies), Hispanics (n=3/5), Asian (n=1/2), mixed ethnicity and overall (n=1 each). There was no association with ethnicity and risk of ICU admittance among the hospitalized COVID-19 cases.

  - Two UK studies noted higher hospitalization rates for children of BAME groups compared to Whites and similarly a second study reported higher risk of hospitalization among Black and mixed ethnicity groups, but not for Asians.
  - Eight UK studies report on hospitalizations and ICU admittance among confirmed cases of COVID-19. The UK results found no association among BAME groups (n=2/2 studies) and high risk associations with Blacks (n=2/2), S. Asians (n=2/2) and Asians (n=1/1). ICU admission were also associated with BAME groups (n=4/4), South Asian (n=2/3) and Blacks (n=2/2). Higher odds of mechanical ventilation was reported for Blacks and Asians in one study.
- MIS-C, multisystem inflammatory syndrome in children, and a potential association with ethnicity was reported in three studies, two from the UK and one from France. Across these studies, higher frequency of non-white ethnicities diagnosed with MIS-C was reported; this difference was significant in the largest study.
- Mortality was reported similar to severity where the denominators were either the general population or a hospitalized population of COVID-19 cases.
  - The systematic reviews report no association with mortality for Blacks and Hispanics in adjusted analyses, and a higher risk among Asians who were mechanically ventilated compared to Whites with significant heterogeneity between studies and a notable higher mortality risk among different ethnic groups from the UK studies (Raharja, 2020).
  - Seven USA studies reported an analysis of mortality among hospitalized COVID-19 cases and ethnicity. One reported higher odds among Blacks, one reported lower odds among Hispanics and most reported no associations with Blacks (n=5), Hispanics (n=4) or all minority ethnic groups (n=1).
  - One study in the US reported mortality across all positive COVID-19 cases and found no association with Black ethnicity.
  - Seven UK studies report an analysis of mortality among hospitalized COVID-19 cases and ethnicity. An association with higher risk of mortality was reported for South Asians (n=2/3 studies), Blacks (n=1/4), Asians (n=2) and no association was reported for East Asians (n=1), Mixed ethnicity (n=2) and BAME groups (n=1).
  - Six UK studies report COVID-19 mortality across the general population. Higher associations were noted for Blacks (n=3/4 studies), South Asians (n=2/2), mixed ethnicity (n=1/2), BAME (n=1/1) and Asians (n=1/2), where the studies for Asians and mixed ethnicity were conflicting results reporting both protective and higher risk associations compared to Whites across two studies each.
  - A single study from Brazil reported an association with higher mortality among mixed and Black ethnicities.

**Table 1: The association of ethnicity and risk of COVID-19 infection, severity and mortality in systematic reviews (n=2) and observational studies (n=61)**

| Reference | Study information | Key Outcomes |
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| **Susceptibility, Clinical Severity and Mortality associated with COVID-19** | | |
| **Systematic Review** | | |
| (Raharja, 2020) preprint new | A systematic review and meta-analysis on the association between ethnicity and poor outcomes. (AMSTAR – high quality)<br><br>Data up to June 15, 2020. 72 articles (13 ecological) from the USA (54), UK (15), Brazil (1) and Israel (1) were included, although the data from the later two are not presented in the results.<br><br>Outcomes included mortality, hospitalization, ICU, respiratory and kidney failure.<br><br>Analysis results focus on Black, Asian and Hispanic as there were very few studies for other native ethnic groups or studies outside the USA and UK.<br><br>Random effects meta-analysis was conducted on quantitative outcomes in 45 studies. Studies not included in the meta-analyses were descriptively summarized. Their results are also noted if an association was identified and/or is different than the meta-analysis. | The evidence does not confirm ethnicity is an independent risk factor for poor outcomes in COVID-19 patients.<br>Meta-analyses generally had high heterogeneity ($I^2$ > 60%) and where examined, adjusted analyses for age, sex and comorbidities attenuated univariate associations.<br>Significant associations are shown below, other results of analysis are available in the paper.<br><br>Hospitalization (20 studies): Compared to Whites,<br>- Associated with Blacks (RR: 1.68 [95%CI: 1.28-2.20], $I^2$=98, k=13) in univariate analysis (RR UK 5.47 [95%CI: 2.51; 12.06] vs. RR USA 1.36 [95%CI: 1.08; 1.72] was significantly different). Studies that adjusted for age, sex and comorbidities report no association.<br>- No association with Hispanics (RR: 1.00 [95%CI: 0.95-1.06], $I^2$=0, k=8) in the univariate analysis, but was significant in the adjusted analysis.<br>- No association with Asians was determined overall or in adjusted analyses. However, when sub-grouped by country an association was seen in UK studies: RR UK: 2.95 [95%CI: 1.55-5.53] vs. RR USA: 0.90 [95%CI: 0.82-1.66].<br><br>ICU (18 studies): Compared to White ethnicity,<br>- A univariate association with Blacks (RR: 1.51 [95%CI: 1.11-2.04], $I^2$=94, k=10) was observed, however there |

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| | | was no association after adjusted for age, sex and comorbidities.<br>- The unadjusted and adjusted association with ICU admission not significant for Asian or Hispanic in the US. The UK studies reported an increased risk of ICU in Asians.<br>- 5 UK studies not included in the meta-analysis, reported over-representation of BAME communities in ICU cohorts. 2 USA studies did not find an association with Blacks.<br><br>Mortality (51 studies): Compared to Whites,<br>- A protective association with overall mortality was observed across the unadjusted data: Hispanics (RR: 0.69 [95%CI: 0.57-0.84], $I^2$=76, k=11), however the association did not persist in models adjusted for age, sex and comorbidities.<br>- Asians who were mechanically ventilated cases were at higher risk of mortality in four studies (RR: 1.39 [95%CI: 1.07-1.80], $I^2$=14, k=4).<br>- No other associations with mortality was found in the meta-analysis conducted on overall mortality, hospitalized cases, ICU cases, mechanical ventilation cases or acute kidney injury cases and Black, Asian or Hispanic ethnicity.<br><br>Mechanical Ventilation (18 studies): Compared to Whites,<br>- An association with Asians (RR: 1.39 [95%CI: 1.07-1.80], $I^2$=14, k=4) was seen in the univariate and age/sex adjusted analysis. |

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| | | - No association with risk of ventilation was observed for Blacks or Hispanics, even in adjusted analysis (age, sex and comorbidities).<br><br>Acute Kidney Injury (AKI) (8 studies): Compared to Whites,<br>- No association with AKI was observed for Asians.<br>- An association was reported for Blacks (RR: 1.35 [95%CI: 1.04-1.76], $I^2$= 92%, k=5) in the univariate analysis that did not persist in adjusted (age, sex and comorbidity) analysis. |
| (D. Pan, 2020) | A systematic review of ethnicity and clinical outcomes of COVID-19. (AMSTAR rating – medium quality: registered protocol may or may not have been done *a priori*, studies included for each outcome is not clearly reported and no discussion of heterogeneity).<br><br>Data up to May 15, 2020<br>162 studies (80 in preprint) Supplementary files 2-6 describe each of the studies included in this SR.<br>Searches included primary literature, clinical trials, preprints and grey literature.<br><br>Analysis was descriptive and does not report the results of individual studies, number of studies or which studies contribute to each outcome.<br><br>Few studies that examined ethnicity were published as of May 15, 2020. | Compared to Whites, several studies reported Blacks, Asians and Hispanics are more likely to:<br>1. Test positive for COVID-19<br>Mixed evidence was identified for<br>1. Hospitalization<br>2. Intubation<br>3. ICU<br>4. Mortality<br>- Ethnicity and risk of infection with SARS-CoV-2: in one published study (S. de Lusignan, 2020b) Blacks were more likely to test positive and similarly in preprints higher susceptibility was reported in 14 studies for Blacks, 3 for Asians and 3 for Hispanics compared to Whites.<br>- Hospitalization, intubation and ICU rates by ethnicity were conflicting across studies. A large cohort in the UK report higher proportion of non-white patients admitted to the ICU.<br>- Mortality: 8 studies found no association with mortality, and others recorded an association for |

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| | | Blacks (n=6), Asian (n=3) compared to Whites. Grey literature in the US and UK are reporting higher mortality in non-White ethnicities (mainly Black and Asian). |
| **United States (USA)** | | |
| (Petrilli, 2020) | USA, New York, multi-center health network, prospective cohort, case data up to Apr 8, follow-up to May 5.<br>N=5279 admitted to hospital for COVID-19<br>COVID-19 positive tests n=5279<br>Hospitalizations n=2741<br>Hospice or death n=665<br>Ventilation n=647 | - Risk of hospitalization among COVID-19 positive cases was significantly higher in Hispanic aOR 1.63 (95%CI 1.35-1.97) and other/mixed aOR 1.6 (95%CI 1.21 – 2.11) compared to Whites. Multivariable logistic regression adjusted for age, sex, smoking, week of outbreak and BMI. |
| (Goldfarb, 2020) | Single medical center, prospective cohort of pregnant women. Mar 6- May 4, 2020.<br>65 Hispanic (represent 18% of the population) and 127 non-Hispanic women presented with COVID-19 symptoms – not everyone was tested.<br><br>No statistical analysis was performed due to sample size. Ethnicity was not shown to be a factor in this disparity which may be explained by socio-economic factors. | - Hispanic women were more likely to test positive (72%) 39/54 vs. 27% (22/82) for non-Hispanic women ($p<0.001$). This mirrored the increasing number of cases in the Hispanic population vs. non-Hispanic population in the general public after social distancing interventions were introduced.<br>- Of those that tested positive, a similar proportion were admitted to hospital. 13/39 Hispanic and 8/22 non-Hispanic women. Of these, 5 Hispanic and 1 non-Hispanic case were admitted to ICU. No deaths. |
| (Bandi, 2020) | USA, Chicago, prospective cohort single hospital, pediatric COVID-19 cases. All children tested for SARS-CoV-2 were enrolled Mar 12- Apr 20, 2020. N=474 children examined, 5.2% (25) were COVID-19 positive. (n=5 children were hospitalized.)<br>Proportion in sample:<br>White 25.1% | - Compared to Whites, Blacks had a significantly higher positive test rate (6.8% vs. 1.7%, p=0.046).<br>- Blacks had a higher adjusted odds aOR 3.1 (95%CI 1.23-5.34) of a positive test, adjusted age and sex.<br>- Hispanics were similar by not significant. |

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| | Black 43.2%<br>Hispanic 24.7%<br>Asian 1.5% | - Hospitalizations: 80% (20/25) were Black, which is higher than expected, but this outcome was not further analysed by the author. |
| (Lo, 2020) preprint new | Longitudinal survey targeting the general population in the USA and UK using an app that prompts input from users daily.<br><br>Data collected March 24- May 25, 2020. All self reported. Respondents: USA = 179 873, UK= 2 234 728<br>Multivariable model by country: Adjusted for sex, history of diabetes, heart disease, lung disease, kidney disease, and current smoker status (each yes/no), and body mass index (17-18.4, 18.5-24.9, 25-29.9, and ≥30 kg/m2).<br>Multivariable model combined USA and UK: also adjusted for isolation, frontline healthcare worker, community exposure to COVID-19, population density, income, and education. | - Risk of reporting a positive COVID-19 test (Odds Ratio and 95%CI):<br>o USA: Black 2.49 (1.68-3.69), Hispanic 1.66 (1.18-2.34), Asian 1.42 (0.86-2.35) Other 1.32 (0.67-2.61).<br>o UK: Black 1.97 (1.47-2.64), Hispanic 1.71 (0.89-3.27), South Asian 1.68 (1.43-1.97), Chinese 1.79 (1.08-2.96), East Asian 1.02 (0.55-1.87), Middle Eastern 2.10 (1.52-1.87), Other 2.10 (1.52-2.91)<br>o USA and UK data combined compared to Whites: Blacks 1.17 (1.10-1.25), Hispanic 1.11 (1.00-1.23), Asian 1.06 (1.03-1.10), Other 1.21 (1.17-1.25)<br>- Risk Factors: Black and Hispanic participants were more likely to be obese and have diabetes.<br>- All ethnic minorities reported lower social isolation, were over-represented by front line health care workers and reported a higher likelihood of contact with a case of COVID-19. |
| (Martinez, 2020) new | Longitudinal study of the general population serviced by Johns Hopkins Health System (5 hospitals and 30 clinics) from March 11- May 25, 2020.<br><br>Data represents 32 727 people tested by RT-PCR for SARS-CoV-2 (over time this increased from only high risk to all symptomatic individuals). | - The positivity rate was significantly different ($p<0.001$) across groups compared to the Hispanic ethnicity 42.6% (95% CI, 41.1%-44.1%), Whites (8.8% [95% CI, 8.4%-9.2%]), Blacks (17.6% [95% CI, 16.6%-18.3%]), or other ethnicity (17.2% [95% CI, 16.2%-18.3%]). It is unclear whether high positivity in Hispanics is due to |

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| | Statistics: proportion positive and hospitalized was analysed by ethnic category using omnibus ANOVA with a correction for multiple comparisons. | higher prevalence of disease or lower rates of using healthcare.<br>- Hospitalizations was lower for Hispanics (29.1% [95% CI, 27.0%-31.2%]) than Whites (40.1% [95% CI, 37.6%-42.5%]) or Blacks (41.7% [95% CI, 39.5%-43.8%]). |
| (Lee, 2020) preprint new | USA, retrospective cohort analysis of patient records from 12 Midwest hospitals and 60 clinics between March 4, and August 19, 2020.<br><br>The primary outcome was COVID-19 severity using hospitalization within 45 days of diagnosis. 5,577 COVID-19 patients were included and 866 (n=15.5%) were hospitalized within 45 days of diagnosis.<br>Of those hospitalized,<br>43.9% (n=381) were White<br>19.9% (n=172) were Black<br>18.6% (n=161) were Asian<br>11.8% (n=102) were Hispanic<br><br>Model was adjusted for age, gender, comorbidity, relationship status, and rurality/ urbanity. | Independent of neighborhood deprivation, minority race/ethnicity of patients was associated with increased COVID-19 disease severity.<br>- Hispanic (OR 3.8, 95% CI 2.72–5.30)<br>- Asians (OR 2.39, 95% CI 1.74–3.29)<br>- Blacks (OR 1.50, 95% CI 1.15–1.94) |
| (Hatcher, 2020) new | USA, retrospective cohort analysis of COVID-19 among the American Indian and Alaska Native (AI/AN) populations from 23 states (n=345,093). Findings on incidence of SARS-CoV-2 infection reported between January 22 and July 3, 2020 show a 3.5 times increased incidence of COVID-19 among AI/AN persons. | Cumulative incidence of COVID-19:<br>- AI/AN persons: 594 (95%CI 203–1,740 per 100,000 AI/AN population)<br>- White 169 (95% CI 137–209) per 100,000 white population<br><br>- AI/AN had significantly higher relative risk of getting COVID-19 RR 3.5, 95%CI 1.2–10.1 compared to Whites. |

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| (McCarty, 2020) new | USA, retrospective cohort analysis of 9 Massachusetts hospitals including 379 COVID-19 patients. Association of race/ethnicity of patients and hospitalization outcomes (i.e. in-hospital mortality, ICU admission, or mechanical ventilation). | - On multivariable analysis controlling for age, gender, obesity, cardiopulmonary comorbidities, hypertension, and diabetes, no significant differences in in-hospital mortality, ICU admission, or mechanical ventilation by race/ethnicity were found. |
| (Karaca-Mandic, 2020) new | USA, retrospective cohort examined the racial/ethnic prevalence of cumulative COVID-19 hospitalizations in 12 states between April 30 and June 24, 2020.<br><br>The proportion of hospitalizations by ethnicity was compared to the proportion of each ethnicity in the population.<br><br>Ethnicities reported on: Hispanic, White, Black, Asian, American Indian/ Alaskan Native.<br><br>Data are descriptive and not adjusted. | Hospitalizations: Whites had a substantially smaller proportion hospitalized compared to their share of state population in all 12 states.<br>- The percentage of hospitalizations among Black patients exceeded the percentage of their representative proportion of the state population in all 12 states.<br>- Hispanic hospitalizations exceeded their representative proportion in 10 states, this was very pronounced in Virginia, Utah, and Rhode Island.<br>- Asians hospitalized for COVID-19 were approximately equivalent or lower than their proportion in the population.<br>- American Indians and Alaskan Native populations were reported in 8 states with large disparities in Arizona and Utah. |
| (Gottlieb, 2020) new | USA, retrospective case-control study conducted at Rush University Medical Center in Chicago, Illinois between March 4 and June 21, 2020, explored risk factors associated with hospitalization. | - Hispanic ethnicity was a risk factor for hospital admission (OR = 1.52, 95% CI = 1.18 to 1.92). |
| (Rozenfeld, 2020) new | USA, retrospective cohort study conducted between February 28 and April 27, 2020, to characterize risk factors in 34,503 patients in the Providence Health System. | Risk of SARS-CoV-2 infection compared to White patients:<br>- Asian (OR 1.43; 95% CI 1.18–1.72, p = 0.0002)<br>- Black (OR 1.51; 95% CI 1.25–1.83, p < 0.0001)<br>- Hispanic (OR 2.07; 95% CI 1.77–2.41, p < 0.0001) |

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| (McPadden, 2020) preprint new | USA, retrospective cohort study conducted at the Yale New Haven Health (YNHH) on 7,995 patients with SARS-CoV-2 between March 1 and April 30, 2020. The study assessed hospitalization and in-hospital mortality. | Race/ ethnicity with increased risk of hospitalization:<br>- Asian (OR 1.58, 95%CI=1.02-2.41)<br>- Black (OR 1.43, 95%CI 1.14-1.78)<br>- Hispanic (OR 1.81, 95%CI 1.50-2.18)<br>In the discharged population, age-adjusted, in-hospital mortality was similar among all racial and ethnic groups.<br>In-hospital, age adjusted mortality rates:<br>- White = 4.3%<br>- Black = 3.3%<br>- Hispanic = 3.4%<br>- Asian = 4.6%<br>- Hawaiian = 4.0%<br>- Pacific Islander = 3.1% |
| (Emeruwa, 2020) new | USA, New York retrospective cohort study of women (n=100) delivering at two New York-Presbyterian–affiliated hospitals in Manhattan from March 13 through April 23, 2020. The SARS-CoV-2 infection rate per racial–ethnic group of women delivering was analyzed. | - There was a significantly higher SARS-CoV-2 infection rate among Hispanic women compared with non-Hispanic White women (18.1% vs 9.4%, P< 0.01).<br>- The rate of positive SARS-CoV-2 infection results in non-Hispanic Black women (12.7%) was not significantly different. |
| (Mendy, 2020) preprint new | Retrospective cohort of hospitalized cases at the University of Cincinnati health system (4 hospitals) March 13 to May 31, 2020.<br><br>N=689 cases (RT-PCR positive)<br><br>Logistic regression modeling adjusted for covariates: age, sex, ethnicity, smoking, comorbidities. | - Hospitalizations (31.3% total): Adjusted analyses Black OR 2.23 (95%CI 1.41-3.53) and Hispanic OR 1.91 (95%CI 1.11-3.29) compared to Whites<br>- Severe COVID-19: Adjusted analyses Black OR 3.15 (95%CI 1.71-5.79) and Hispanic OR 2.78 (95%CI 1.29-5.96) compared to Whites<br>- ICU (13.2% total): Adjusted analyses Black OR 3.32 (95%CI 1.56-7.07) and Hispanic OR 3.44 (95CI 1.42-8.34) compared to Whites |

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| | | - Deaths: adjusted analysis Blacks OR 3.44 (95%CI 1.32-9.00) |
| (Kalyanaraman Marcello, 2020)* preprint new | Retrospective cohort, New York's public hospital system data, New York City, March 5- April 9 with follow-up to April 16, 2020.<br><br>22254 patients tested in the hospital catchment area, 13442 positive SARS-CoV-2.<br><br>Black and Hispanics comprised approximately a third of the COVID-19 cases, which is an over-representation of these ethnicities compared to the NYC population.<br><br>Descriptive analysis, Chi-square test used.<br>No multivariable analysis was conducted. | - Positive Test 13442/22254 (61%). 26% Black, and 34% Hispanic. Both had significantly higher proportion of positive tests than Whites P<0.001. The higher proportion may be due to Blacks and Hispanics were more likely to present for testing at the ER rather than outpatient clinics.<br>- Hospitalization 6248/13442 (46%). 31% Black, and 34% Hispanic. A significantly higher proportion of Blacks were hospitalized P<0.001, no association for Hispanic.<br>- Deaths 1724/6248 (28%). 29% Black, and 31% Hispanic. |
| (Price-Haywood, 2020) | Retrospective cohort, Louisiana, USA, Ochsner Health system, March 1- April 11.<br><br>N=3481 positive COVID-19 tests in the catchment area<br>The population serviced by this hospital are 31% Black and 65% White.<br><br>Analysis:<br>- Multivariable logistic regression (hospitalization) adjusted by age, sex, comorbidity index score, low-income residence, public health insurance.<br>-Survival analysis (mortality), adjusted by age, sex and comorbidity index score. | - The racial profile of positive COVID-19 tests 70.4% Black, 29.6% White.<br>- Hospitalization (N=1382) 76.9% Black. Blacks had a higher odds OR 1.96 (95%CI 1.62-2.37) of being hospitalized.<br>- ICU (N=474) 80.2% Black.<br>- Mechanical Ventilation (N=364) 81.6% Black.<br>- Death (N=326) 70.6% Black. In the survival analysis, Black race was not independently associated with mortality (HR= 1.14, 95%CI 0.88-1.49). |
| (Azar, 2020)* | Multihospital, retrospective cohort. San Francisco USA, patients Jan 1- Apr 8, 2020 | - Hospitalization of Black 52.5% (n = 32) vs. 25.7% (n = 110) of White patients. |

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| | Overall data:<br>n=14036 tested for COVID-19<br>n=1025 COVID-19<br>n= 256 hospitalized<br>n= 110 ICU | - Black case hospitalization odds was 2.7 (OR) times higher compared to White cases, multivariable model adjusted for age, gender, and sociodemographic variables. Note: Black cases were more likely to be captured at the ER in severe condition rather than in a non-ambulatory setting, which may explain this association.<br>- ICU admittance was higher for Black cases 24.6% vs. the White cases 10.7%.<br>- Black cases with COVID-19 lived in ZIP codes with lower income compared to all other racial and ethnic groups ($p<0.001$).<br>- There was no significant difference in mortality across ethnic groups. |
| (Rentsch, 2020)* preprint | USA, 6 million US veterans, Feb 8- May 4. Retrospective cohort.<br><br>N= 5630 COVID-19 cases from 62098 tested.<br><br>Ethnicity: Whites 74%, Black 19%, Hispanic 7%.<br><br>Estimates were adjusted by demographic, medical and high risk behaviours, socio economic variables. | - Tests per 1000 were higher for Blacks 16.4 (95%CI 16.2 - 16.7) and Hispanic 12.2 (95%CI 11.9 - 12.5) vs. White 9.0 (95%CI 8.9 - 9.1)<br>- Compared to Whites, Blacks were more likely to test positive aOR 1.96 (95%CI 1.81-2.12) as were Hispanics aOR 1.73 (95%CI 1.53 – 1.96).<br>- There was no significant difference in 30 day mortality by ethnic group among the COVID-19 cases. |
| (Gu, 2020)* preprint new | Retrospective cohort, Michigan USA, March 10- April 22, 2020.<br>N= 5698 tested patients (randomly selected unmatched controls n=7211 and frequency matched controls by race, age and sex n=13351)<br>logistic regression, adjusted for age, sex and socioeconomic characteristics. | - Risk factors for testing positive: Black test positive rate (42.6%) was significantly higher than Whites (13.7%, $P<0.001$)<br>- Hospitalized Blacks 52.2% vs. Whites 39%, $p<0.001$ and OR 1.66 (95% CI, 1.09-2.52)<br>- ICU Black 27% vs. Whites 14.8% $p<0.001$ and OR 1.52 (95%CI 0.92-2.52) |

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| | | - Mortality Blacks 5.3% vs. Whites 3.0%, p<0.12 and OR 1.17 (95%CI 0.4-3.45) |
| (Joseph, 2020) new | USA, single institution retrospective cohort study to study whether non-White COVID-19 patients present with increased severity on admission chest X-ray than White patients, between March 27-April 10 2020, total n=326 (210 non-White; 116 White) | - Non-White patients hospitalized with COVID-19 infection were more likely to present with higher severity of disease on admission chest X-ray than White/Non-Hispanic patients (adjusted average difference 1.6, 95% CI 0.5–2.7, p<0.01). |
| (Antwi-Amoabeng, 2020)<br>preprint | Single Center, retrospective cohort study<br>Nevada USA, n=172 COVID-19 patients Mar 12- May 8<br>Hispanic vs. non-Hispanic<br>Overall outcomes:<br>- 121 hospitalized<br>- 28 ICU<br>18 died | - Significantly more Hispanics were COVID-19 cases (50.6%) than would be expected, they represent 25.7% of the population.<br>- Mortality significantly higher in non-Hispanic group (15.3% vs. 5.8%), p=0.048.<br>*Analysis accounting for the Hispanic group being significantly younger, fewer comorbidities, more likely to be uninsured and live in low income communities compared to the non-Hispanic group was not conducted. |
| (Kim, 2020)* | US COVID-NET (surveillance across 14 states): 2491 hospitalized cases March 1- May2.<br>N=16318 COVID-19 cases<br>n= 2491 COVID-19 cases with complete records that were discharged as of May 3, 2020 were analysed. Of these 47% White, 30% Black and 12% Hispanic.<br>n= 798 ICU<br>n= 420 died<br>n=246/462 died of those receiving mechanical ventilation<br><br>Multivariable logistic regression controlling for age, sex, and underlying conditions, smoking, treatment with ACE inhibitors. | Among hospitalized cases of COVID-19, ethnicity was not associated with admission to the ICU or mortality. |

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| (Bui, 2020) new | USA, Utah outbreak investigations March 6 and June 5, 2020. Racial and ethnic composition of workplace outbreak-associated cases were compared with the overall racial and ethnic composition in each sector in Utah. | Although 24% of Utah's workforce in all 15 affected sectors identified as Hispanic or a race other than White (non-White), 73% (970 of 1,335) of workplace outbreak-associated COVID-19 cases were in persons who identified as Hispanic or non-White. |
| (Chamie, 2020) new | A cross-sectional study was conducted in a 16 square block area of San Francisco's Mission District April 25-28. Serology and RT-PCR testing was conducted on residents that volunteered.<br>N=3953 tested, 40% Hispanic, 41% White, 9% Asian/Pacific Islander, 2% Black, and 7% other/mixed | - 83/3953 were RT-PCR positive, 95% of the positive individuals were Hispanic.<br>- Prevalence among residents/workers for Hispanics: 3.9% (2.0-6.4)/10.4% (7.0-14.8) compared to other ethnicities: 0.2% (0.0-0.4) / 0.0% (0.0-2.0).<br>- Recent infection was most likely to be identified in a Hispanic 10.1 (2.81-64.6) compared to others.<br>- Positive Hispanics in this study were more likely to be male, work in a frontline service job, have a low income (50k) and report a COVID-19 contact. |
| (Ko, 2020) new | USA, cross-sectional study examined factors associated with COVID-19 hospitalizations by assessing data from 70 counties participating in the Coronavirus Disease 2019-Associated Hospitalized Surveillance Network (COVID-NET) and a population-based sample of non-hospitalized adults residing in the COVID-NET catchment area. | Risk of hospitalization by ethnicity compared to Whites:<br>- Blacks (aRR: 4.7; 95%CI: 3.8, 5.9)<br>- Other ethnicities (aRR: 3.5; 95%: 2.8, 4.3) |
| (A. Pan, 2020) preprint new | USA, Houston cross-sectional analysis conducted between March 3 and July 18, 2020, evaluated hospitalization and mortality outcomes for Blacks vs. Whites and Hispanics vs. Whites in the Greater Houston Metropolitan Area. | In a fully adjusted model, statistically significant higher likelihood of hospitalization<br>- Blacks aOR 1·42 (95%CI 1·24–1·63)<br>- Hispanics aOR 1·61 (95%CI 1·46–1·78)<br>There was no association with mortality. |
| (Vahidy, 2020) new | USA, cross-sectional study on data being contemporaneously collected since March 5, 2020 by the Houston Methodist Hospital system on association of ethnicity and susceptibility of SARS-CoV-2 infection. | In the fully adjusted model compared to Whites, there was a higher likelihood of infection among:<br>- Black; aOR, CI: 1.84, 1.49-2.27)<br>- Hispanic; aOR, CI: 1.70, 1.35-2.14) |

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| | | - Asians; aOR, CI: 1.46, 1.09-1.95) |
| (Goyal, 2020) new | USA, cross-sectional study of 1000 children tested between March 21 and April 28, 2020 to assess association between patient ethnicity and SARS-CoV-2 infection rates. | In comparison to Whites (7.3%), minority children had higher rates of SARS-CoV-2 infection (Black: (30.0%; adjusted OR 2.3 [95% CI 1.2, 4.4]; Hispanic: 46.4%; adjusted OR 6.3 [95% CI 3.3, 11.9]). |
| (Alvarez Retamales, 2020) preprint new | USA, observational cross-sectional, nationwide hospital admission data taken from CDC COVID-NET on June 11, 2020 to investigate the discrepancy in hospitalization rate by race/ethnicity, 21,221 hospitalized COVID-19 patients compared to population of 328,239,523. | Significant differences in the ethnic proportion of COVID-19 cohort vs the population respectively:<br>- White: 38% vs 60.4%<br>- Hispanic: 19% vs 18.3%<br>- Black: 36% vs 13.4%<br>- Asian/Pacific Islander: 5% vs 6%<br>- American Indian/Alaska Native: 1.6% vs 1.3%<br>The discrepancy is greatest for Whites and Blacks: with Whites being disproportionately underrepresented and Blacks being disproportionately overrepresented in the COVID-19 cohort compared to total population. |
| (Gross, 2020) | USA, 28 states: Cross-sectional study up to April 21, 2020.<br><br>Data from CDC was extracted by state, 28 states and NYC have racial data.<br><br>Analysis adjusted for age (standardised mortality by age across race groups in each state) and meta-regression analysis was conducted to assess the association of state-level racial disparities. | - Risk of death in Black compared to the White population was aRR 3.57 (95%CI 2.84-4.48). Pennsylvania was the only state where Black risk of COVID-19 death was lower than White.<br>- Hispanic aRR 1.88 (95%CI 1.61-2.19) times higher risk of death than white population. 12 states reported a significantly higher risk of COVID-19 deaths among Hispanic populations. |
| **United Kingdom (UK)** | | |
| (Leeds, 2020) new | UK, NHS Trust hospital healthcare workers prospective cohort study. A staff testing programme was conducted in | - Age, sex, occupation and ethnicity are not associated with increased risk of contracting SARS-CoV-2. |

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| | April and examined the characteristics of 991 affected healthcare workers. | |
| (Harrison, 2020) preprint new | Prospective cohort, England Scotland and Wales. 260 hospitals, February 6th - May 8th.<br><br>N=30693 suspected and confirmed COVID-19 cases<br><br>Analysis: hierarchical regression models / Cox Proportional Hazards regression, adjusted for age, sex, location | - Compared to Whites, critical care admission was more common in South Asian OR 1.28 (95%CI 1.09 - 1.52), Black OR 1.36 (95%CI 1.14 - 1.62) and other ethnic minority OR 1.29 (95%CI 1.13-1.47).<br>- Mortality compared to Whites:<br>South Asian HR 1.19 (95%CI 1.05 - 1.36), East Asian HR 1.00 (95%CI 0.74 - 1.35), Black HR 1.05 (95%CI 0.91 - 1.26), Other Ethnic Minority HR 0.99 (95%CI 0.89 - 1.10).<br>- Diabetes had a significant mediation effect (17.8%, 8.9-65.7) of South Asian ethnicity on mortality. |
| (Williamson, 2020) new | UK NHS patient notification system, OPENSafely, for 24 million registered adults (40% population), prospective cohort.<br><br>N= 12 718 279 people with ethnicity data from the general population in this cohort.<br><br>Data Feb 1- May 6 was analysed (multivariable Cox proportional hazards model) for the outcome death of confirmed COVID-19 cases (n= 10 926). Adjusted by age, sex, BMI, smoking status, comorbidities, asthma, cancer, socio-economic indices, ethnicity. | - Mortality due to COVID-19: Compared to Whites, hazard ratio for black ethnicity aHR 1.48 (95%CI 1.29-1.69), South Asian ethnicity aHR 1.45 (95%CI 1.32-1.58), mixed ethnicity aHR 1.43 (95%CI 1.11-1.84) in the population.<br>- Higher risk of death was associated with male, older age, deprivation, uncontrolled diabetes, severe asthma and other medical conditions.<br>- Controlled for socio-economic and medical factors, ethnicity remained a strong predictor of mortality within the population. |
| (Razieh, 2020) new | Prospective cohort, UK Biobank Study (N= 502 543).<br>COVID data March 16 - June 14.<br>N=5623 tested, 1087 positive<br>Logistic regression looking at BMI and ethnicity. Analysis adjusted for: age at test, sex, social deprivation (Townsend score), smoking status, cancer illnesses (number) and non- | - Greater risk of COVID-19 in Blacks relative to Whites was only apparent at higher BMI values (Figure 1). For example, at a BMI value of 25 kg/m2, there was no difference in risk (OR = 0.96; 95% CI: 0.61, 1.52), whereas at a BMI of 30 or 35 kg/m2, the odds of |

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| | cancer illnesses (number), systolic blood pressure, HDL-cholesterol, total cholesterol and HbA1c | COVID-19 were 1.75 (1.24, 2.48) and 2.56 (1.63, 4.03) higher in Blacks, respectively. |
| (McQueenie, 2020) new | UK Biobank, prospective cohort of 502,503 participants<br>COVID-19 Data: March 16 and May 18. | - Non-White ethnicities with multi-morbidity had nearly three times the risk [RR 2.81 (2.09-3.78)] of having COVID-19 infection compared to those of White ethnicity. |
| (Woolford, 2020) new | UK Biobank, prospective cohort analysis of adults admitted (n=470) with COVID-19 to Royal Oldham Hospital, UK to explore factors predicting death.<br>COVID-19 Data: March 16- June 1<br>logistic regression model | Association of mortality by ethnicity compared to White<br>- Asian [OR = 0.37, (95%CI: 0.18-0.76), p<0.01)]<br>- Other ethnicity [OR=0.29, (95%CI: 0.10-0.88), p=0.03]<br>- Black had no significant association with death from COVID-19 [OR = 1.18, {95%CI: 0.31-4.45), p=0.81] |
| (Chadeau-Hyam, 2020) new | Prospective cohort, UK, Biobank study.<br>Test-negative case-control design modelling the risk of testing positive conditional on being tested.<br>Data up to May 18<br>N=4509 tests (1325 positive COVID-19 cases)<br>Statistics: multivariable and penalized logistic regression models<br>Adjusted for age, sex, education, home ownership, number in household, income, healthcare worker, unemployed, smoker, obesity, comorbidities. | Risk factors for testing positive or negative: Black vs White ethnicity (OR 1.05 [1.02–1.08]) |
| (Lassale, 2020) new | Prospective cohort, UK, Biobank study.<br>N=340966 (640 COVID-19 cases March 16- April 26)<br>Logistic regression to estimate risk of COVID-19 hospitalization. Adjusted for age, sex, neighbourhood deprivation, household crowding, smoking BMI, inflammation, glycated haemoglobin and mental illness. | Hospitalization compared to White:<br>- Black OR 2.66 (95%CI 1.82, 3.91)<br>- Asian OR 1.43 (95%CI 0.91, 2.26)<br>- Other non-white group OR 1.41 (95%CI 0.87, 2.31)<br>After controlling for measured factors, clear ethnic differences in risk of COVID-19 hospitalization remained. The largest attenuating factors were for socioeconomic factors. |

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| (Raisi-Estabragh, 2020) | UK biobank (prospective cohort of >500 000 participants, recruited in 2006-2010 at age 40-69)<br>Data Mar 16 – May 18, 2020<br>N= 4510 tested for COVID, 1326 positive.<br>Analysis is restricted to within the tested cohort, the tested people in the UK are considered those with severe disease at this time. | - Multivariate logistic regression for COVID-19 positivity, non-Whites had a higher odds OR 1.59 (95%CI 1.26-1.99) compared to Whites. Adjusted for sex, ethnicity, BMI, Townsend score, and household size. |
| (Niedzwiedz, 2020) | UK biobank (prospective cohort of 392116 participants in England, recruited in 2006-2010 at age 40-69) Mar 16-May 3.<br>Logistic regression model adjusted for: Initial adjustment= age, sex and assessment centre<br>Full adjustment= Above adjustments + healthcare worker status, socioeconomic variables, lifestyle variables, medical conditions | - Compared to Whites a positive test was more likely for Blacks aRR 2.05 (95%CI 1.39–3.03, full adjustment) and south Asians aRR 2.42 (95%CI 1.75–3.36, initial adjustment).<br>- In defined ethnic groups for risk of testing positive (initial adjustment):<br>  - Pakistani RR 3.24 (95%CI 1.73–6.07)> other south Asians RR 3.00 (95%CI 1.64-5.49)> Indian RR 1.98 (95%CI 1.26-3.09) for testing positive compared to Whites.<br>- Black Caribbean RR 3.51 (95%CI 2.39-5.15) and Black Africans RR 3.11 (95%CI 1.97-4.91) were similar. |
| (Kolin, 2020) preprint | UK Biobank, (prospective cohort of >500 000 participants, recruited in 2006-2010 at age 40-69) review of the first 669 cases of COVID-19, Mar 16-data pull date not provided.<br>Adjusted for age, sex, body-mass index, Townsend deprivation score, and history of diabetes, angina, or myocardial infarction, | Compared to White participants<br>- Blacks aRR 3.14 (95%CI 2.28-4.31) were at a higher risk of COVID-19.<br>- Asians s were also at higher risk of COVID-19 aRR 2.03 (95%CI 1.40-2.95).<br>*Denominator is the Biobank cohort/population. |
| (Patel, 2020) | UK Biobank, (prospective cohort of 418,794 participants, recruited in 2006-2010 at age 40-69)<br>Dates are not specified. | Both Blacks aOR 3.1 (95%CI 2.0–4.8) and Asianss2.0 (95%CI 1.2-3.1) were at increased risk of hospitalisation due to COVID-19 positive test as compared to White participants. |

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| | Regression adjusted for age, sex and socioeconomic factors. | *Denominator is the Biobank cohort/population. |
| (Harman, 2020)* | Small single center cohort of children admitted with COVID-19.<br>Prospectively identified from King's College Hospital, London, UK, between Feb 25, and April 28, 2020. | - Hospitalization: 9/12 (75%) were from Black, Asian, and minority ethnic background vs. the 39% that these ethnic backgrounds represent in the inner London area. |
| (Sapey, 2020) new | UK, University Hospitals Birmingham NHS Foundation Trust (UHB) retrospective cohort study on SARS-CoV-2 patients (n=2217) admitted between March 10 and April 17, 2020.<br>South Asian ethnicity defined as Pakistani, Bangladeshi and Indian.<br>Cox regression analysis adjusted for age, sex, deprivation and comorbidities. | - Severe disease on presentation among South Asian patients 34/137 (24.8%) vs White patients 54/483 (11.2%) p <0.0001.<br>- ICU admissions of South Asian patients 86/410 (21.0%) vs White patients 133/1540 (8.6%), p <0.001.<br>- Mortality comparted to Whites was aHR 1.4 (95%CI: 1.2-1.8) for South Asians.<br>- There was no significant difference noted in survival for Blacks compared to Whites. |
| (Russell, 2020)* new | UK, London's Guy's Cancer Center conducted a retrospective cohort study to assess 156 cancer patients with COVID-19 diagnosis between February 29 and May 12, 2020 and their clinical characteristics associated with COVID-19 death. | - Among cancer patients with a COVID-19 diagnosis, Asians as compared to White (OR 3.73 (95%CI 1.28-10.91) had a positive statistically significant association with COVID-19 death. |
| (Martin, 2020) new | UK, Leicester retrospective study on COVID-19 patients at University Hospitals of Leicester NHS Trust between March 1 and April 28, 2020, and assessed factors associated with SARS-CoV-2 PCR positivity before/after lockdown. | After adjustment, compared to Whites, the odds of testing positive for other ethnicities was:<br>- South Asian (aOR 2.44 95%CI 2.01, 2.97)<br>- Black (aOR 2.56 95%CI 1.71, 3.84)<br>- Other (aOR 2.53 95%CI 1.74, 3.70) |
| (Perez-Guzman, 2020)* new | UK, London NHS Trust retrospective cohort study assessing factors associated with mortality in 614 patients admitted between February 25 and April 5 in three large London hospitals.<br>Patient population ethnicities: | - When adjusting for age, sex and comorbidities Black patients were at higher odds of death compared to Whites (aOR 1.69, 95%CI 1.00-2.86).<br>- This association was stronger when further adjusting for admission severity (aOR 1.85 95% CI 1.06-3.24). |

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| | - BAME = 40% (244)<br>- White = 38% (235)<br>- Unknown ethnicity = 22% (135)<br>Analysis: logistic regression | |
| (Ayoubkhani, 2020) preprint new | UK, England and Wales retrospective cohort study assessing deaths occurring between March 2 and May 15, 2020, and association of deaths with ethnic minority groups.<br><br>Analysis: Cox proportional hazards model. | - The fully adjusted model for females, only Black females were associated with mortality (aHR 1.29 [95% CI: 1.18 to 1.42]).<br>- For males, COVID-19 mortality risk remained elevated for the Black (1.76 [1.29 [95% CI: 1.63 to 1.90]), Bangladeshi/Pakistani (1.35 [1.29 [95% CI: 1.21 to 1.49]) and Indian (1.30 [1.29 [95% CI: 1.19 to 1.43]) groups. |
| (Zakeri, 2020) preprint new | UK, South London (King's College Hospital Trust), case-control + retrospective cohort study to examine relationship between ethnicity and hospital admission and in-hospital mortality for severe COVID-19 between March 1-June 2, 2020, 872 cases, 3488 controls. Of the cases,<br>- 48.1% were Black<br>- 33.7% were White<br>- 12.6% were Mixed/other<br>- 5.6% were Asian | - Compared to Whites, admission risk was higher in Black (OR 2.28 [95%CI: 1.87-2.79]) and mixed/other patients (OR 2.66 [95%CI: 2.01-3.52]) Asians were not at higher risk of admission (OR 1.04 [95%CI: 0.72-1.48]).<br>- In hospital mortality was not associated with Black (HR 0.84 [95%CI: 0.63-1.11]) and mixed/other ethnicities (HR 0.69 [95%CI: 0.43-1.10]). Asians had higher risk of in-hospital mortality (HR 1.54 [95%CI: 0.98-2.41]). |
| (Swann, 2020) preprint new | UK, multi-hospital retrospective cohort (260) in England, Wales, and Scotland from January 17-July 3, 2020, to investigate admission to ICU, mortality and multisystem inflammatory syndrome in children and adolescents (MIS-C) admitted with SARS-CoV-2 infection, n=651 | - Critical care admission was associated with age younger than 1 month, age 10-14 years, and Black ethnicity. Blacks were significantly associated with admission to critical care aOR 2.82 (95% CI 1.41 to 5.57) as was other ethnicities aOR 1.91 (95%CI 1.07-3.34), and no association was identified for South Asians compared to Whites.<br>- 11% cases were classified as MIS-C more likely to be of non-White ethnicity (64% (29/45) vs. 42% (148/355); P=0.004). |

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| (Kakkar, 2020)* new | Retrospective cohort of adults tested (n=3018) for COVID-19 at Sheffield Teaching Hospitals, UK, January 3 - April 25, 2020.<br><br>BAME 19% of Sheffield population<br><br>Descriptive analysis, chi-square. | BAME vs. Whites<br>- Test positive 95/296 vs 631/2424, p=0.026<br>- Hospitalized 86/95 vs. 599/631, p0.083 (not significant)<br>- ICU 20/86 vs. 43/599 p<0.00001<br>- Significantly fewer tests were done on BAME population compared to their proportion in society and BAME people tested were significantly younger than Whites. |
| (Galloway, 2020)* new | Retrospective cohort, London UK, 2 hospitals March 1-April 17, 2020.<br>N=1157 COVID-19 hospital admissions with positive RT-PCR for SARS-CoV-2.<br>Analysis: Competing risks regression models, adjusted for age and sex. | - Admission to Critical Care compared to Whites: BAME ethnicity HR 1.53 (95%CI 1.12, 2.09)<br>- Mortality compared to Whites: BAME ethnicity HR 1.19 (95%CI 0.89, 1.58)<br>There was an association with ethnicity and more severe disease, but not mortality among hospitalized cases. |
| (Apea, 2020)* preprint new | Retrospective cohort, 5 hospitals, London UK, January 1-May 13.<br>N=1996 SARS-CoV-2 cases<br>Analysis: Logistic regression modelling of ethnicity on ICU treatment using mechanical ventilation was carried out adjusted for age and sex.<br>Cox proportional hazards model adjusted for age and sex | Racial profile of cases 35.2% White, 27.0% Asian, 17.0% Black.<br>- ICU admission was significant p<0.001 where 11% White, 20.1% Asian and 18.5% Black group were admitted to ICU.<br>- Mechanical ventilation, age/sex adjusted odds compared to Whites across hospitalized cases: Asian OR 1.54 (95%CI 1.06-2.23), Black OR 1.80 (95%CI 1.20-2.71)<br>- Mortality (30 day) Asian HR 1.49 (95%CI 1.19-1.86), Black HR 1.30 (95%CI 1.02-1.63) compared to Whites, controlling for comorbidities widened the confidence interval for ethnicity, Black p=0.09.<br>- Mortality (90 day) Asian HR 1.46 (95%CI 1.18-1.81) compared to Whites |

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| (Fletcher, 2020) preprint | UK, Single center retrospective cohort study.<br>2756 patients admitted to the Chelsea and Westminster Hospital NHS Foundation Trust, Jan 1- Apr 23.<br>multivariable logistic regression model<br>Note: self-reported ethnicity, many observations were unspecified leading to underpowered estimates. | - Presentation at a clinic with symptomatic COVID-19 was higher in Asians aOR 1.63 (95%CI 1.00-2.69) and other 1.70 (95%CI 1.21-2.39) compared to Whites (adjusted by age, sex and some blood biomarkers). The adjusted comparison for Black was similar, but not significant.<br>- No association with admission to ICU and ethnicity was observed in this study.<br>- Mortality was associated with Asians aOR 2.24 (95%CI 1.23-4.50), and similar among Blacks, but not significant. |
| (S. de Lusignan, 2020a) preprint | UK, Retrospective medical chart review – cross sectional study, Oxford RCGP research and surveillance centre network, Jan 28-Apr 4, 2020.<br>COVID-19 positive cases n=587, negative test n=3215.<br>Ethnic distribution:<br>White n=2497 (65·7%)<br>Asian n=152 (4·0%)<br>Black n=58 (1·5%)<br>Mixed, other n=81 (2·1%)<br>Missing n=1014 (26·7%)<br>Multivariate logistic regression. | - Compared with Whites (15.5%), the adjusted odds of a positive test were greater in Blacks (62.1%) aOR 4.75 (95%CI 2.65–8.51), adjusted by age, sex, socioeconomic deprivation, household size, urban/rural, smoking, BMI, hypertension, chronic kidney disease, diabetes, chronic heart disease. |
| (Wright, 2020) new | Cross-sectional data of hospital patients tested for COVID-19 March 18- April 27 in Bradford, UK.<br>Chi-square tests. | - Mortality rates in COVID-19 cases compared to negative patients. No significant difference in mortality among White (25.4%) compared to South Asian (18.1%) in hospitalized COVID-19 cases (P=0.122). However, South Asians were significantly younger than Whites. |

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| (Hull, 2020) preprint | UK, east London general practice dataset. Cross-sectional study of 1.2 million people in 157 practices that included n=8985 COVID-19 cases Feb 14- Apr 30, 2020.<br>Adjusted model: age, sex, social deprivation, clinical predictors. | - The odds of SARS-COV-2 infection, fully adjusted for other variables were: South Asian aOR 1.93 (95%CI 1.83-2.04) and Black aOR 1.47 (95%CI 1.38-1.57). |
| (Cook, 2020) | UK, NHS staff: Cross-sectional data on health care worker deaths up to April 22, 2020 was analysed.<br>106 cases, 98 had patient facing roles. HCW deaths were 0.51-0.58% of deaths.<br>No statistical analysis. | - The proportion of BAME deaths (verses their proportion in a profession)<br>- Nurse 71% (20%)<br>- Healthcare support worker 56% (17%)<br>- Doctor / Dentist 94% (44%)<br>- Other staff 29% (-) |
| (Riphagen, 2020) | London, UK: A small case series of children with a multisystem inflammatory syndrome that is now well recognised. 8 children were identified over 10 days mid-April 2020 in a single pediatric hospital. | - 6/8 children with this inflammatory condition were of Black ethnicity. No analysis or investigation on this potential association was undertaken in this small study. |
| **Other countries** | | |
| (Toubiana, 2020) | Paris, France, prospective observational study of multisystem inflammatory syndrome in Children Apr 27-May 11 (follow up to May 15).<br>21 children median age 7.9 years (3.7-16.6) | - 57% (12/21) were Black, 3/21 were Asian. There was insufficient data in this study to explore the association, however the proportions were higher than would generally be expected based on the population demographics and what is known about Kawasaki disease in children. |
| (Elias, 2020) new | Paris, France, prospective cohort study of kidney transplant patients (n=1216) under active follow-up in two referral transplant centers between March 1 and April 30, 2020. | - Non-White ethnicity was independently associated with higher risk of developing COVID-19 disease: aOR= 2.17; [95% CI], 1.23 to 3.78; p=0.007) |
| (Baqui, 2020)* | Brazil, cross-sectional study of hospital mortality (country wide).<br>Data from Feb 27 – May 4, 2020.<br>N= 6882 cases with known outcomes. | - Hospital mortality was higher in mixed ethnicity aHR 1.47 (95%CI 1.33-1.58) and Blacks aHR 1.32 (95%CI 1.15-1.52) compared to Whites. Mixed ethnicity was the most influential risk factor on mortality after age. |

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| | Racially classifies the Brazilian population in five categories (percentages as of 2010 of Brazilian population): branco (white) (47.5%), pardo (mixed ethnic) (43.4%), preto (black) (7.5%), amarelo (yellow) (1.1%) and indígena (0.4%).<br>Cox regression analysis adjusted by age, sex, ethnic group, and comorbidities (fixed effects), with state (random effect) | |

*= study is also included in (Raharja, 2020). New= Study has been published since June 1, 2020 when the first version of this review was completed. Preprint = refers to papers that have not undergone the peer-review process. BAME = Black, Asian and minority ethnic, OR= odds ratio, HR= Hazard Ratio, RR= risk ratio, 95%CI = confidence interval, $I^2$= measure of heterogeneity in a meta-analysis, k= number of studies.

## ETHNICITY AND EXPOSURE TO COVID-19 (SEROLOGY STUDIES)

Seroprevalence and other serological investigations and associations with ethnicity were reported in five studies. Four seroprevalence studies conducted in USA on the general population, healthcare workers and pregnant women reported that there were significantly higher proportion of people seropositive among certain ethnicities: Blacks (n=3/4 studies), Hispanic (n=3), Asian (n=1/2) (Table 2). One UK study examined the dynamics of IgG antibodies to SARS-CoV-2 during acute and convalescent phases of SARS-CoV-2 infection and found that there was a difference in the magnitude of the ELISA results that may indicate during infection COVID-19 cases of non-White ethnicity may have higher viral loads (Staines, 2020). This finding requires further research to understand the significance of the difference noted in this study. Registered trials described in the systematic review included seroprevalence studies that will add to the body of information (D. Pan, 2020).

**Table 2: Serology based studies on cumulative incidence and the dynamics of antibodies against SARS-COV-2 (n=5)**

| Reference | Study Description | Key Outcome |
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| (Ebinger, 2020)* preprint new | USA, seroprevalence survey in a large diverse healthcare employee cohort of 6,062 adults employed in Los Angeles County.<br>Date: May-June 2020 | - The main factors significantly associated with greater odds of seropositive status were Hispanic (OR 1.80 [95% CI 1.31, 2.46], P<0.001), and Black (1.72[1.03, 2.89], P=0.04), compared to Whites. |

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| | Analysis: multivariable-adjusted analyses of pre-existing characteristics e.g. ethnicity, age, sex, asthma, hypertension | |
| (Flannery, 2020) new | USA, Pennsylvania prospective cohort study conducted serological testing of 1293 parturient women at two centers in Philadelphia between April 4 and June 3, 2020, and assessed for differences among race/ethnicities among the women. | Seroprevalence rates by race/ethnicity:<br>- Black (9.7%; 95% CI, 7.3-12.5%)<br>- Hispanic (10.4%; 95% CI, 5.7-17.1%)<br>- White (2.0%; 95% CI, 0.9 to 3.8%)<br>- Asian (0.9%; 95% CI, 0.0 to 5.1%) |
| (Biggs, 2020) new | USA, cross-sectional study in 2 Atlanta counties between April 28 and May 3, 2020 assessing SARS-CoV-2 seroprevalence in 696 persons. | Total weighted seroprevalence rate = 2.5% (95% CI: 1.4-4.5)<br>- Black 5.2% (95% CI: 2.9-9.1), p<0.01 compared to other ethnicities. |
| (Rosenberg, 2020) | New York State seroprevalence survey n=15101 adults, Apr 19-28, 2020.<br>Estimated cumulative incidence using a post-stratification weighting to standardize to the New York population and adjustments by the antibody test characteristics. | Cumulative incidence varied significantly by ethnicity:<br>- Hispanic 29.2% (95%CI 27.2-31.2%)<br>- Black 20.2% (95%CI 18.1-22.3%)<br>- Asian 12.4% (95%CI 9.4-15.4%)<br>- Compared to Whites 8.1% (95%CI 7.4-8.7%), p<0.0001) |
| (Staines, 2020) preprint | Single center prospective cohort Mar 29 – May 22, London UK. 177/1785 COVID-19 cases are included.<br>Test: COVID-19 IgG ELISA assay developed by Mologic (Bedford, UK) and manufactured by Omega (Omega Diagnostics, Cambridge UK)<br>- 2-8% of the cases did not seroconvert. | - Non-White ethnicity was associated with a higher normalized optical density value from the ELISA than White ethnicity, mean value 1.06 vs. 0.85, p 0.035 (unpaired t-test)<br>- Author suggests this finding may be associated with higher viral loads |

*= study is also included in (Raharja, 2020). New= Study has been published since June 1, 2020 when the first version of this review was completed. Preprint = refers to papers that have not undergone the peer-review process. OR= odds ratio, 95%CI = confidence interval.

# ETHNICITY AND COVID-19 IN CANADA

Limited Canadian research was identified despite a grey literature search; a preprint ecological study, two unpublished reports of surveys conducted in Canada, Indigenous Service Canada surveillance reports and Toronto Public Health's COVID-19 dashboard had relevant results addressing ethnicity and COVID-19 in Canada (Table 3). The search also identified provinces (Ontario / British Columbia) and/or health units (Toronto) collecting or planning to start collecting ethnicity data on COVID-19 cases. As of September 2020, only Toronto Public Health had an available report.

The available Canadian data suggests non-White ethnicities, with the exception of East Asians, are disproportionately infected with COVID-19 which is in agreement with other studies on risk of COVID-19 infection from other countries in this review. These studies also highlight inequalities in the social determinants of health that may be related to increased risk of COVID-19 such as housing, education, income, occupation and access to healthcare.

- A cross-sectional survey designed to compare COVID-19 impacts on Black Canadians to a representative "national" sample reported a higher likelihood of COVID-19 among Black Canadians individually and in their social circle. Canadian Blacks had a higher frequency of risk factors such as taking public transportation and having a job that requires face-to-face interactions with people. Higher frequency of severe financial impacts associated with the pandemic. These data are consistent with similar studies published in the USA (Table 1).
- Toronto Public Health dashboard shows that a higher proportion of COVID-19 cases than the representation in the community was seen for Black, Hispanic, Southeast Asian, South Asian/ Indo-Caribbean and Middle Eastern ethnic groups.
- The ecological study analysed population data on number of COVID-19 cases and deaths in Canada by population level demographic information including proportion Black, proportion foreign-born, proportion over 65 years, population density and median income. Findings from their multivariable negative binomial model include:
    - Double the case count was associated with a 1% increase in proportion Black and 3% increase in case count was associated with 1% increase in foreign born population.
    - 2.1 increase in the rate of COIVD-19 deaths was associated with a 1% increase in proportion Black in the population.

COVID-19 data focusing on Canada's indigenous population was only identified on the Indigenous Services Canada webpage and provincial webpages for Alberta, British Columbia, and Manitoba {{85811;}}. Analysis conducted at the end of July indicated that indigenous populations in Canada has reported on-reserve COVID-19 rates that were a quarter of the rate in the general population and a case fatality rate approximately one fifth that in the general population {{85811;}}. To date commentaries and news articles in CMAJ have reported successful public health

mitigation efforts by indigenous communities across Canada {{65290;}}. Indigenous populations are also more likely to live in remote communities which may protect a closed community from COVID-19, however if these communities are affected by COVID-19, they have more limited access to healthcare and are more likely be in poor socioeconomic condition (Statistics Canada, 2020). No Canadian data on ethnicity and hospitalizations, severity or mortality was identified. However publications on the relationship between ethnicity and medical conditions or socioeconomic factors identified as risk factors for severe COVID-19 disease may be useful indicators of what could be expected until COVID-19 data is available. The search identified two publications that suggested compared to Whites; Black immigrants, Indigenous people and South Asian immigrants were significantly more likely to have one or more medical conditions that have been associated with a higher risk of severe COVID-19 (Lin, 2020).

**Table 3: Details of observational studies and reports conducted in Canada on the association of ethnicity and risk of COVID-19 infection (n=5)**

| Reference | Study information | Key Outcomes |
|---|---|---|
| **Susceptibility, Clinical Severity and Mortality associated with COVID-19** | | |
| **Canada** | | |
| (Nur, 2020) new unpublished report | An online survey (cross-sectional) was conducted June 17-30, 2020. The sample strategy was weighted by age, gender, region, ethnicity and place of birth to target a representative sample of 1500 Canadians and 400 Black Canadians (Black).<br>N=2322 adult Canadians | COVID-19 outcomes:<br>- Blacks were more likely to report COVID-19 symptoms and treatment (10% vs. 7% national).<br>- Blacks were more likely have had (10% vs. 7% national) or to know someone who has had COVID-19 symptoms (28% vs. 17% national).<br>  - Commuters had higher results: they were more likely to have had (16% Black vs 12% national) and to know someone who has had COVID-19 symptoms (34% vs. 18%).<br>- Blacks were 3x more likely to know someone who died of COVID-19 (21% vs. 8% national).<br>Risk Factors for COVID-19<br>- Blacks were more likely to commute to work using public transit (25% vs. 12% national), (This has been |

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| | | shown to be an indicator for higher COVID-19 risk in other studies.).<br>- Blacks were more likely to report frequent face-to-face requirements of their job (61% vs. 50% national).<br>Impacts of COVID-19<br>- Minimal financial impact was reported in 45% of both Black and national respondents.<br>- Black men age 45+ were more likely to report significant negative financial impact 38% vs. 22% national.<br>- Financial confidence was lower among Black households (67% vs. 72% national). |
| Requested a copy of the report, not available on line.<br>new | BC COVID-19 population survey (N=394000).<br>(Information from news articles, Aug 14, 2020) | - Data indicate that Hispanics, West and South Asians, and Blacks were disproportionately affected by the pandemic and financially having difficulty due to lost work.<br>- Ethnicity and access to health care was identified, where Japanese, Korean, multi-ethnic and South Asians reported difficulties. |
| (Toronto Public Health, 2020)<br>new | Toronto COVID-19 by Ethno-Racial Identity and Income by Proportions surveillance dashboard.<br>Data May 20 to August 16, 2020<br>24% of the ethnicity data is missing.<br>Excludes cases in long-term care facilities.<br><br>Results are descriptive and only include observations with ethnicity data. | 83% of COVID-19 cases identified with an ethnic minority group compared to 52% of Toronto's population. The list below is % COVID-19 vs. % of population.<br>- White 17% vs. 48%<br>- Black 22% vs. 9%<br>- Hispanic 10% vs. 3%<br>- Southeast Asian 16% vs. 7%<br>- South Asian or Indo-Caribbean 20% vs. 13%<br>- Middle Eastern 11% vs. 4%<br>- East Asian 4% vs. 13% |

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| (Choi, 2020) preprint | Canada wide, ecological study with data up to May 5, 2020.<br>Data sources included PHAC data, STATsCan data and crowd sourced data to compare COVID-19 cases and deaths by health unit data analysing proportion black, proportion foreign born, percent over 65 years, population density and median income as predictors. Analysis for cases and deaths respectively were conducted in a negative binomial multivariable (for over dispersed count data) model with the above predictors. | - COVID-19 infection multivariate model estimated that a 1% increase in the proportion of Black residents in a health region was associated with the doubling of COVID-19 infection rates. And a 1% increase in share of foreign-born residents was association with a 3% rise in COVID-19 infection rates.<br>- A 1% increase in the proportion of Black residents in the health region was associated with 2.1x increase in COVID-19 death rates. An increase of 1% in the proportion of residents 65 and older were associated with a 26% increase in deaths. |
| {{85811;}}<br>Surveillance report<br>new | Surveillance Data: as of September 20, 2020 there had been 408 cases of COVID-19 in Indigenous communities' on-reserve. | As of July 31, 2020:<br>- The percentage of Indigenous individuals living on reserve reported positive for COVID-19 is currently one-quarter the rate of the general Canadian population<br>- The COVID-19 case fatality rate for Indigenous Peoples living on reserve is about one-fifth that of the fatality rate in the general Canadian population |

New= Study has been published since June 1, 2020 when the first version of this review was completed. Preprint = refers to papers that have not undergone the peer-review process.

## Methods:

A daily scan of the literature (published and pre-published) is conducted by the Emerging Science Group, PHAC. The scan has compiled COVID-19 literature since the beginning of the outbreak and is updated daily. Searches to retrieve relevant COVID-19 literature are conducted in Pubmed, Scopus, BioRxiv, MedRxiv, ArXiv, SSRN, Research Square and cross-referenced with the literature on the WHO COVID literature list, and COVID-19 information centers run by Lancet, BMJ, Elsevier and Wiley. The daily summary and full scan results are maintained in a Refworks database and an excel list that can be searched. Targeted keyword searching is conducted within these databases to identify relevant citations on COVID-19 and SARS-CoV-2. Search terms used included: racial, ethnic, ethnicity. This review contains research published up to September 7, 2020. An augmented search for Canadian literature on ethnicity was also conducted using the indicated search terms with COVID-19 AND Canada or provinces as key terms in google and on official websites. 464 citations were captured by the search, studies were screened out for not being relevant, not primary research or systematic reviews, and not an included study design. Seventy-three studies that analyzed an association with ethnicity are included in this review. Each potentially relevant reference was examined to confirm it had relevant data and relevant data is extracted into the review.

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# APPENDIX:

Within the studies captured in this review ethnicity is self reported based upon a person's self-identification with one or more social groups within a list of predefined options. There were variations in the lists between countries and between studies. The table below captures the main categories of ethnicity or ethno-racial classifications and definitions used by the US and UK. In some studies there was additional granularity or classification options, those are also noted below.

**Definitions:**

**Ethnicity:** The social group a person belongs to, and either identifies with or is identified with by others, as a result of a mix of cultural and other factors including language, diet, religion, ancestry, and physical features traditionally associated with race (see race). Increasingly, the concept is being used synonymously with race but the trend is pragmatic rather than scientific.

**Ethno-racial** classifications refers to the administrative categorization of people along ethnic and racial lines for the purposes of statistics. This term was used by Toronto Public Health.

| Ethnic Category used in the Review | Acronyms and definitions of the category. |
|---|---|
| White | Non-Hispanic White, USA definition: people with origins in Europe, the Middle East or North Africa. UK definition: British, Irish or other white background |
| Black | Non- Hispanic Black, African American, Black British, Black Caribbean, African, Afro-Caribbean, Haitian. USA definitions: person that have origins in any of the black racial groups of Africa. UK definition: Caribbean, African, Any other black background |
| Hispanic | Latino, Latinx, Latin American. Note: the US census bureau uses "Hispanic" for both Hispanic and Latinx referring to anyone born in or with ancestors from Latin America. USA definition: person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin, regardless of race. |
| Indigenous | First Nations, Inuit and Metis (Canada), American Indian and Alaska Native (USA). By definition Indigenous people refers to the original populations of North and South America. |
| Pacific Islander | Native Hawaiian. Refers to a person having origins Hawaii, Guam, Samoa, or other Pacific Islands. |
| Asian | A person having origins in any of the original peoples of the Far East, Southeast Asia, or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, and Vietnam. UK definition: Indian, Pakistani, Bangladeshi, any other Asian background |
| Chinese | UK definition: Chinese or any other |
| Mixed | UK definition: white and black Caribbean, White and Black African, White and Asian, or any other mixed background |
| BAME | Black Asian and minority ethnic group is a term used in many UK-based studies to denote non-White ethnicity. |
| Racialized communities | Refers to visible minorities and usually encompasses all people that are non-Caucasian in race or non-white in color. In Canada this may or may not include indigenous people depending on the individual report/study. |
| East Asians | A racialized classification for people descended from east Asian countries: China, Taiwan, Japan, Mongolia, North Korea and South Korea. |

| | |
|---|---|
| South Asian | A person whose ancestry is in the countries of the Indian subcontinent, including India, Pakistan, Bangladesh, and Sri Lanka. Indo-Caribbean was also grouped with South Asian, these are people of Indian descent that live in the Caribbean. |
| Southeast Asian | This is a group of mixed cultures from 11 countries Brunei, Burma (Myanmar), Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, the Philippines, Singapore, Thailand and Vietnam. |
| Middle Eastern | Arab, Western Asian people of Middle Eastern and North African descent |

Notes: Capitalization is in line with the ASA style guide for sociology research papers. United States Census Bureau definitions of ethnicity or race indicate that these are a social construct of race/ethnicity rather than a biologically based segregation. United Kingdom Census Bureau ethnicity categories.