Summary

- PHSKC developed the Social and Economic Risk Index (SERI) to identify census tracts where King County residents are placed at greater risk of COVID-19 because of socioeconomic factors.
- The SERI provides a metric to describe socioeconomic inequities and can be utilized to support resource allocation such as testing, contact tracing, care coordination, and vaccinations to communities with higher burden of COVID-19 morbidity and mortality.
- Higher SERI scores indicate greater COVID-19 risk because of socioeconomic factors than lower SERI scores.
- COVID-19 testing rates were significantly higher in King County census tracts with the lowest SERI scores, whereas COVID-19 cases, hospitalizations, and deaths were disproportionately higher in census tracts with higher SERI scores.
- While the SERI scores map closely with previous measures of socioeconomic risk across King County, such as the Determinants of Equity report and the COVID-19 Vulnerable Communities Data Tool, this analysis demonstrates that these social and economic factors correlated with COVID-19 risk and outcomes which can be used to inform planning, response, recovery, and policy changes to address inequities.
# Table of Contents

**Introduction** ................................................................................................................................. 3  
What is the Social & Economic Risk Index (SERI)? ............................................................. 3  
Why were these social and economic factors included in the index? ........................................... 3  
How does the SERI differ from other indices of social vulnerability? ........................................... 4  
How is PHSKC using the SERI to inform policy and program decisions? .................................... 4  

**Methods** ........................................................................................................................................... 5  
Results: COVID-19 and Social & Economic Risk ......................................................................... 5  
How does the Social and Economic Risk Index vary across King County? ................................. 5  
How do social and economic factors relate to COVID-19 testing and rate of positive test results? 6  
How is the relationship between SERI, testing, and COVID-19 cases changing over time? .......... 8  
How do social and economic factors relate to COVID-19 hospitalizations and deaths? ............... 9  
How is the relationship between SERI, COVID-19 hospitalizations and deaths changing over time? 10  
Which social and economic factors were most strongly related to COVID-19 outcomes? ............. 10  
How are the factors in the SERI related to each other? ............................................................... 11  

**Conclusion** ........................................................................................................................................ 13  
**Limitations** ..................................................................................................................................... 13  
**Next Steps** ...................................................................................................................................... 14  
**Suggested Citation** ....................................................................................................................... 14  

**Appendix – Technical Notes & Methodology** ............................................................................. 15  
SERI score construction....................................................................................................................... 15  
Essential worker categories ............................................................................................................... 15  
Spatial and space-time modeling ...................................................................................................... 16
Introduction
Locally and across the United States, social and economic inequities have placed certain communities at higher risk of COVID-19 morbidity and mortality. Public Health - Seattle & King County (PHSKC) developed the Social and Economic Risk Index to examine social and economic disparities in COVID-19 testing, infections, hospitalizations, and deaths at the census tract-level in King County, WA, to facilitate and prioritize resource allocation to communities at greatest risk of COVID-19 morbidity and mortality.

What is the Social & Economic Risk Index (SERI)?
PHSKC developed a Social and Economic Risk Index (SERI) to identify census tracts in King County where residents are at greater risk of COVID-19 morbidity and mortality because of social and economic factors.

The SERI score combines the following six factors from the 2015-2019 American Community Survey:
- Race/ethnicity, language, and place of birth:
  - Percent of population who identify as people of color
  - Percent of limited English-speaking households
  - Percent of population born outside the United States
- Median number of occupants per household
- Percent of adults in essential healthcare-related occupations
- Percent of adults in essential non-healthcare occupations
- Percent of adults age 25+ with less than a college degree
- Percent of households with income less than 200% of the federal poverty level

These factors are combined and standardized into the SERI score. Scores range from 0 to 1, with 0 representing the lowest level of socioeconomic risk and 1 representing the highest level of risk. The census tracts are then grouped into three groups representing high, moderate, and low risk levels based on the SERI scores.

Why were these social and economic factors included in the index?
- Residents who were born outside the United States or who speak limited English may face challenges accessing healthcare and essential information needed to reduce exposure to or severe illness from COVID-19.
- Because of historic and ongoing systemic racism and discrimination, people identifying with certain racial and ethnic groups experience worse social, economic, and health outcomes, which may place these groups at higher risk of COVID-19. In particular, communities that have been subject to systemic racism may experience:
  - Higher risk for exposure to COVID-19 from being disproportionately employed in essential settings (such as healthcare facilities, farms, factories, grocery stores, and transportation), where it may be more difficult to practice social distancing, access personal protective equipment, or have sick leave benefits.

---

2 200% of the federal poverty level was $52,400 for a family of four in 2020 [https://www.cdc.gov/healthequity/racism-disparities/index.html](https://www.cdc.gov/healthequity/racism-disparities/index.html)
3 [https://www.communitiescount.org/blog/2020/12/8/racism-has-always-been-a-public-health-issue](https://www.communitiescount.org/blog/2020/12/8/racism-has-always-been-a-public-health-issue)
5 [https://www.nature.com/articles/s41562-020-00998-2](https://www.nature.com/articles/s41562-020-00998-2)
Higher risk for exposure to COVID-19 from being disproportionately more likely to live in crowded housing, where it is more difficult to separate from others who are sick;7, 8
Higher risk for severe COVID-19 illness due to higher prevalence of preexisting health conditions9;
Higher risk for economic and social consequences due to lower average wealth and access to resources such as health insurance and broadband internet.4,10

- People in households with lower income may have less flexibility to leave jobs that put them at risk of COVID-19 or to miss work if they are exposed or become sick, because they do not have enough money saved up to cover essential needs such as food, housing, and medical care.6
- As education levels are also correlated with income and occupation type, people with lower levels of education may have less access to jobs, income, or resources that allow them to reduce COVID-19 risk.

How does the SERI differ from other indices of social vulnerability?
Other organizations and government agencies have developed similar indices of social vulnerability and COVID-19 risk:

- The Social Vulnerability Index (SVI) was developed by the Centers for Disease Control and Prevention (CDC) to identify census tracts that are most likely to need support before, during, and after a disaster. Similar to the SERI, the SVI uses census data on 15 social factors including poverty, vehicle access, and crowded housing to rank census tracts by vulnerability. However, this index was developed prior to the COVID-19 pandemic; while it includes factors that might increase risk of negative social and economic consequences from the pandemic, it does not include factors, such as healthcare and non-healthcare essential workers and household size, that may specifically increase risk of illness, hospitalization, or death from COVID-19.
- The COVID-19 Community Vulnerability Index (CCVI) was created by the private organization Surgo Ventures and builds on the SVI to include COVID-specific epidemiological risk factors, health and public health system capacity, and factors related to increased risk of viral transmission. The CCVI is complex, comprising 40 variables across 7 themes; we aimed to create a simpler model, focusing on identifying a parsimonious set of social and economic risk factors related to COVID-19 outcomes rather than epidemiological factors such as age or underlying health conditions.

How is PHSKC using the SERI to inform policy and program decisions?

- PHSKC is using the SERI to support COVID-19 planning and decision-making, including to inform testing and vaccination site locations and to prioritize confirmed COVID-19 cases for contact tracing and case investigation.
- PHSKC and other government and community partners could use the SERI to inform other efforts such as:
  - Policymaking, planning and decision-making regarding resource allocation (e.g. vaccination site locations and vaccine dose allocation);

---

7 https://www.census.gov/content/dam/Census/programs-surveys/ahs/publications/Measuring_Overcrowding_in_Hsg.pdf
9 https://www.communitiescount.org/health-disparities-dashboard
10 https://kingcounty.gov/depts/it/services/cable-communications/broadband-access-study.aspx
Quantifying the relationship between specific social or economic factors and COVID-19 disparities to provide evidence for qualitative observations and rationale for prioritizing allocation of resources to specific communities;

Informing emergency preparedness planning and policies to mitigate the impact of social and economic risks in the case of future disease outbreaks and emergencies;

Advocating for social and economic policies to reduce and eliminate inequities and promote recovery.

Methods

- We used data from the Washington Disease Reporting System (the State’s electronic surveillance system, which gathers data from sources including healthcare provider, laboratory reports, and investigations) to estimate age-adjusted COVID-19 testing, positive cases, hospitalization, and death rates for King County census tracts during March 1, 2020-March 31, 2021.

- We modeled the relationship between SERI scores and COVID-19 outcomes to estimate rates and relative risks to compare tracts with high and moderate SERI scores to tracts with low SERI scores.

- See the Technical Appendix for a more detailed description of analysis and methodology.

Results: COVID-19 and Social & Economic Risk

How does the Social and Economic Risk Index vary across King County?

- Figure 1 shows which King County census tracts have high, moderate, and low Social & Economic Risk Index (SERI) scores. The SERI scores map closely with previous measures of socioeconomic risk across King County, such as the Determinants of Equity report and the COVID-19 Vulnerable Communities Data Tool. High-SERI census tracts are disproportionately located in south and southeast King County; census tracts in Central and North Seattle, Vashon Island, and the eastern shores of Lake Washington have disproportionately low SERI scores, and census tracts with moderate SERI scores are primarily located in North and East King County and rural areas of South King County.

- (Note: maps of each individual social and economic factor included in the SERI are available on the SERI dashboard.)

---

12 https://www.communitiesscount.org/covid19vulnerable
How do social and economic factors relate to COVID-19 testing and rate of positive test results?

- Figure 2 shows the SERI score, rate of COVID-19 testing, and rate of positive test results in King County census tracts.
- Communities with low SERI scores (i.e., lower social and economic risk) had higher rates of testing (1,107 tests per 1,000 individuals) than communities with higher SERI scores (772 tests per 1,000 individuals).
- However, the opposite trend is observed for COVID-19 morbidity: King County residents in census tracts with the highest SERI scores had higher rates of COVID-19 (53.4 cases per 1,000 individuals) relative to areas with low SERI scores (21.1 cases per 1,000 individuals).
- While the rate of testing in high-SERI census tracts was 0.7 times the rate in low-SERI tracts (i.e. 30% lower), the rate of COVID-19 was 2.6 times higher in high-SERI tracts than low-SERI tracts.
Figure 2. Map of SERI scores, rate of COVID-19 testing, and rate of positive cases in King County census tracts from 3/5/2020 to 3/31/2021
How is the relationship between SERI, testing, and COVID-19 cases changing over time?

- We modeled rates of COVID-19 testing and positive test results over time during March 2020-March 2021 in relation to SERI score using a space-time model which controls for correlation in rates between neighboring areas and over time.
- Over the course of the past year, the rate of COVID-19 testing was consistently highest in census tracts with low SERI scores. Rates of COVID-19 testing peaked in July 2020 in low-SERI tracts and have remained higher than testing rates in moderate- and high-SERI areas at all time periods. In contrast, census tracts with high and moderate SERI scores had two peaks in testing – one in July 2020 and one in December 2020, corresponding to the summer and winter peaks in case counts in King County, corresponding with periods of higher case counts.
- Testing rates in low-SERI areas have consistently been higher than testing rates in high- and moderate-SERI areas from March 2020 to March 2021. As overall testing rates declined after November 2020, the disparity in testing rates between high- and low-SERI areas also declined. As of March 2021, the testing rate in high- and low-SERI areas is about the same.
- Over the course of the year, the rate of positive test results was consistently highest in census tracts with high SERI scores and lowest in tracts with low SERI scores.
- However, the size of the disparity in positive tests was not constant over time; looking at rate ratios, the disparity in the rate of positive cases across the three categories of SERI scores increased during the first and second surge. The rate of positive cases in high-SERI tracts was 4.4 times higher in May 2020 and 3.5 times higher in August 2020 relative to low-SERI tracts, compared to about 2.4 times higher in mid-summer 2020 and from fall 2020 onwards.

![Figure 3. Rate and ratio of COVID-19 testing and positive cases over time, by SERI score](image)
How do social and economic factors relate to COVID-19 hospitalizations and deaths?

- Figure 4 shows the social and economic risk level, rate of COVID-19 hospitalizations and rate of COVID-19 deaths in King County census tracts, excluding COVID-19 patients linked to long-term care facilities (LTCFs). King County residents in census tracts with the highest SERI scores had 4.2 times higher COVID-19 hospitalization rates and 3.71 times higher death rates than residents in areas with low SERI scores.
- The COVID-19 hospitalization rate in high-SERI census tracts was 3.2 per 1,000 residents compared to 0.8 per 1,000 in low-SERI tracts; the COVID-19 death rate in high-SERI census tracts was 0.4 per 1,000 residents compared to 0.1 per 1,000 in low-SERI tracts.

Figure 4. Map of SERI scores, COVID-19 hospitalization rate, and COVID-19 death rate in King County census tracts from 3/5/2020 to 3/31/2021

---

13 While a large proportion of COVID-19 hospitalizations and deaths in King County are linked to long-term care facilities (LTCFs), the socioeconomic and demographic characteristics of LTCF residents are markedly different than that of their surrounding communities. Therefore we have excluded COVID-19 hospitalizations and deaths linked to LTCF from these analyses. See more information about COVID-19 and LTCFs here: https://kingcounty.gov/depts/health/covid-19/data/LTCF.aspx
How is the relationship between SERI, COVID-19 hospitalizations and deaths changing over time?

- We used a space-time model to examine how rates of COVID-19 hospitalization or death changed over time in relation to SERI score.
- Over the course of the year, COVID-19 hospitalizations and deaths were consistently highest (between 2 to 7 times higher) in census tracts with high SERI scores and lowest in tracts with low SERI scores.
- For hospitalization rates, the disparity between high- and low-SERI census tracts was greatest during May-June and August-September 2020.
- The largest disparity in death rates occurred in early summer 2020; death rates in high-SERI census tracts were 4 to 6.5 times higher than low-SERI census tracts in May-June 2020.

**Figure 5. Rate and ratio of COVID-19 hospitalizations and deaths over time, by SERI score**

Which social and economic factors were most strongly related to COVID-19 outcomes?

- Testing rates were lower in tracts with larger household size, more essential workers, more adults with less than a college education, more foreign-born residents, or more limited-English speaking households.
- In contrast, the following factors in the SERI had the strongest association with a higher rate of positive COVID-19 tests, hospitalizations, and deaths:
  - Concentration of essential non-healthcare workers
  - Proportion of adults with less than a college education
  - Proportion of low-income households
  - Percent of population identifying as people of color
- In census tracts with high vs. low proportion of essential workers, adults with less than a college degree, low income households, or people of color:
  - The rate of positive test results was 2 to 3 times higher
  - The hospitalization rate was 3 to 5 times higher
  - The death rate was 2.5 to 4 times higher
In census tracts with high vs. low average household size, foreign born population, or English-speaking population:
  - The rate of positive test results was 1.5 to 2 times higher
  - The hospitalization rate was about 2 times higher
  - The death rate was about 1.6 to 1.9 times higher

Census tracts with a high proportion of healthcare workers had higher rates of COVID-19 testing; however, the rate of positive test results was similar across census tracts regardless of the number of healthcare workers in the tract.

Figure 6. Rate of positive COVID-19 cases in census tracts with high, moderate, low SERI scores and risk factors

How are the factors in the SERI related to each other?

- While the factors described above have the strongest association with COVID-19 outcomes, we cannot determine causality from this analysis.
- Furthermore, many of the factors included in the SERI are correlated with one another, and some of these factors may work in tandem with each other to place some groups at greater risk of COVID-19 outcomes.
- For example, the number of essential non-healthcare workers is positively correlated with the average household size, education level, poverty rates, and the proportion of the population who are people of color, limited English-speaking, or born outside of the US (Figure 7). Additionally, the proportion of the population who identify as people of color is highly correlated with the proportion who are limited English-speaking and who are born outside the U.S. (Figure 8). In contrast, the number of healthcare workers in a census tract is not correlated with these factors.
These correlations suggest that opportunities to intervene and reduce risk of COVID-19 among essential non-healthcare workers – such as by improving working conditions, increasing ability to engage in prevention measures like staying home when ill (by providing paid sick leave), and increasing access to resources such as testing and PPE – could in turn reduce the observed disparities in COVID-19 related to race, language, place of birth, education, and income.

Figure 7. Correlation between factors included in the SERI in King County census tracts

Figure 8. Correlation between proportion of population who identify as people of color, who are limited English-speaking, and who are born outside the United States in King County census tracts
**Conclusion**

- COVID-19 cases, hospitalizations, and deaths have disproportionately impacted King County census tracts with higher SERI scores, whereas testing rates were significantly higher in census tracts with the lowest SERI scores.
- The SERI provides a metric to describe socioeconomic inequities and can be utilized to support planning, response. PHSKC is using the SERI to inform allocation and prioritization of resources such as testing, contact tracing, care coordination and vaccinations to communities with the highest exposure, morbidity and mortality from COVID-19 in order to reduce inequities and promote recovery from the pandemic.

**Limitations**

- This analysis focuses on how community-level social and economic factors relate to community-level COVID-19 outcomes. Therefore, we cannot draw conclusions about how an individual’s characteristics or socioeconomic status relates to their risk of becoming ill or dying from COVID-19. In addition, the associations we observed between the community-level factors and COVID-19 outcomes do not necessarily reflect individual-level causal relationships.
- The SERI identifies a set of social and economic factors that can help inform pandemic planning and recovery efforts. Other factors that were considered but ultimately not included in the index include rental crowding, unemployment, lack of health insurance coverage, median home prices, median household income, and metrics of inequity and segregation (e.g. GINI coefficient). As this list suggests, there are multiple dimensions to structural socioeconomic inequities that collectively have placed certain communities at greater risk of COVID-19 exposure, morbidity, and mortality. While the SERI highlights several of these factors and how they relate to one another, there are more complex dynamics at play than what is presented in this report.
- There are important differences in identity, culture, geography, health status, and socioeconomic status between and within racial and ethnic communities in King County. Because of ongoing and historic systemic racism and discrimination and other factors that impact COVID-19 risk and care seeking behavior, people who identify with certain racial and ethnic groups have experienced widely disparate rates of COVID-19 illness\(^\text{14}\) deaths, as well as social and economic impacts\(^\text{15}\) of the pandemic. We recognize that using a single measure to denote the proportion of people of color in each census tracts masks these important differences. Because this analysis focuses on census-tract level characteristics and COVID-19 outcomes rather than individual-level risk, we included this summary measure in lieu of separate measures for each racial/ethnic group in order to ensure that the risk index would be straightforward to interpret and – importantly – more difficult to misinterpret. To learn more, please refer to the [COVID-19 race/ethnicity dashboard](https://kingcounty.gov/depts/health/covid-19/data/race-ethnicity.aspx) for COVID-19 case, hospitalization, and death rates by race/ethnicity; and the [King County Population Dashboard](https://kingcounty.gov/depts/health/covid-19/data/impacts.aspx) or the [COVID-19 Vulnerable Communities Data Tool](https://kingcounty.gov/depts/health/covid-19/data/impacts.aspx) to view population distribution by race/ethnicity across King County geographies.

---


\(^{15}\) [https://kingcounty.gov/depts/health/covid-19/data/impacts.aspx](https://kingcounty.gov/depts/health/covid-19/data/impacts.aspx)
Next Steps

- We plan to update this analysis to incorporate vaccination rates by SERI. While tiered vaccine prioritization meant that not everyone was eligible to receive the COVID-19 vaccine initially, new research examining vaccination rates across the United States suggests that early vaccination rates were lower in counties with high Social Vulnerability Index (SVI) scores despite having higher rates of COVID-19.\(^\text{16}\)

- As of May 13, 2021, everyone ages 12 and older is eligible for vaccination in Washington State. Therefore, it is critically important to continue monitoring vaccine distribution and uptake to ensure equitable prioritization of immunization services to communities that have experienced the greatest burden of illness and death from COVID-19. In addition, we will continue to monitor trends in testing and disease transmission as new cases and hospitalizations are primarily occurring among unvaccinated residents and given the rise of new, more transmissible viral variants. PHSKC currently monitors trends in vaccination and COVID-19 by race/ethnicity and neighborhood. The SERI builds upon this by highlighting the structural, community-level factors that relate to increased risk of exposure, illness, and death from COVID-19. This approach and index can be used or adapted to support preparedness planning and emergency response, as well as to inform policy change to address the structural factors that increase risk of adverse outcomes within King County communities.

Suggested Citation

Social & Economic Inequities in COVID-19 Testing and Outcomes in King County Census Tracts. July 16, 2021. Tigran Avoundjian, Abigail Schachter, Kathryn M. Lau, Sargis Pogosjans, Atar Baer, Meagan Kay, Matt Hanson, Jeffrey Duchin. Public Health Seattle & King County; Communicable Disease Epidemiology Section, Analytics & Informatics Unit. Available from: https://kingcounty.gov/depts/health/covid-19/data/inequities.aspx

\(^\text{16}\) https://www.cdc.gov/mmwr/volumes/70/wr/mm7012e1.htm?s_cid=mm7012e1_w
Appendix – Technical Notes & Methodology

SERI score construction
- We used a confirmatory factor analysis (CFA) approach to develop the SERI. We grouped variables from the 2015-2019 American Community Survey into the following sub-factors:
  - **Race/ethnicity, language, and place of birth**: percent of population identifying as people of color (i.e., American Indian/Alaska Native, Asian, Black/African American, Hispanic/Latinx, Native Hawaiian/Pacific Islander, other non-White limited English-speaking households, and percent of population born outside the U.S.
  - **Household size**: median number of occupants per household
  - **Essential healthcare workers**: percent of population in essential healthcare occupations
  - **Essential non-healthcare workers**: percent of population in essential non-healthcare occupations
  - **Educational attainment**: percent of adults ages 25+ with less than a college degree
  - **Poverty**: percent of households with income < 200% of the federal poverty level.
- We allowed for correlation between individual variables within each sub-factor, and correlation across each sub-factor.
- To create the final SERI score, the scores for each sub-factor were added together, and standardized to range between 0 and 1.

Essential worker categories
- Essential occupations were identified based on definitions from ACLU of Massachusetts. Using data from the U.S. Census 2015-2019 American Community Survey (ACS), we estimated the proportion of workers in each King County census tract who are employed in one of the following “COVID-essential” occupations:
  - **Essential non-healthcare workers**:
    - Construction and extraction occupation
    - Farming, fishing, and forestry occupation
    - Installation, maintenance, and repair occupation
    - Material moving occupation
    - Production occupation
    - Transportation occupation
    - Office and administrative support occupation
    - Sales and related occupation
    - Building and grounds cleaning and maintenance occupation
    - Food preparation and serving related occupation
    - Personal care and service occupation
    - Protective service occupations
Spatial and space-time modeling

- We conducted a spatial regression using spatial intrinsic conditional autoregressive (ICAR) models to examine the relationship between the SERI and each COVID-19 outcome. These models were used to estimate standardized incidence rates (SIR) within each census tract, after adjusting for age and spatial autocorrelation, which is the spatial dependence in COVID-19 rates among neighboring census tracts.
- Separate models for each COVID-19 outcome were constructed. Each model included the SERI score (as a continuous variable) as an independent variable and was adjusted for age. To adjust for spatial autocorrelation, census tract was included as an i.i.d. random variable and as a spatial intrinsic conditional autoregressive (ICAR) random effect. Integrated Nested Laplace Approximations (INLA) was used to fit the models and construct a posterior distribution for each model parameter.
- To estimate rates at each tertile of SERI (i.e., high, moderate, and low SERI), we took a random draw of the predicted count of each COVID-19 outcome for each census tract from the posterior distribution of the model. We grouped census tracts into tertiles, aggregated the counts, and divided by the total population of the census tracts in each SERI tertile to calculate rates. We divided the rate in the high and moderate SERI tertiles with the low SERI tertile to calculate rate ratios. This process was repeated 1000 times to obtain the median rate and rate ratio and 95% credible intervals.
- To examine whether rates and rate ratios changed over time, we fit a space-time regression model. Similar to the spatial regression above, we fit separate models for each COVID outcome. SERI (as a continuous variable) was included as the independent variable, and estimates were adjusted for age. To adjust for spatial autocorrelation, census tract was included as an i.i.d. random variable and as a spatial ICAR random effect. To adjust for temporal autocorrelation, indicator variables for each month of the study period were included, along with a random walk (rw2) term for time. An interaction term between the spatial ICAR and rw2 term was added to account for any dependence between spatial and temporal autocorrelation.
- All models were fit using the R-INLA package.