Examining Disparities and Excess Cardiovascular Mortality Before and During the COVID-19 Pandemic

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**Title:** Examining Disparities and Excess Cardiovascular Mortality Before and During the COVID-19 Pandemic

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Abstract:


Methods: In this cross-sectional study, we utilized the US multiple cause of death files 2018-2021 to examine trend of excess cause-specific deaths due to CVD (International Classification Disease, version 10 [ICD10]: I00-I99), MI (ICD10: I21-I22), stroke (ICD10: I60-I69) and HF (ICD10: I42, I50). Our primary outcome was excess mortality from CVD and its 3 subtypes (MI, stroke, and HF) between pre-pandemic (2018-2019) and pandemic years (2020-21). We performed a subgroup analysis on race and month to month and year to year variation, using chi-squared analysis to test statistical significance.

Results: Overall, 3,598,352 CVD deaths were analyzed during the study period. There was a 6.7% excess CVD mortality, 2.5% MI mortality, and 8.5% stroke mortality during COVID-19 pandemic (2020-2021) compared to pre-pandemic era (2018-2019). Black individuals had higher excess CVD mortality (13.8%) compared with white individuals (5.1%), P<.001. This remained consistent across subtypes of CVD, including MI (9.6% vs 1.0%, P<.001), stroke (14.5% vs 6.9%, P<.001), and HF (5.1% vs -1.2%, P<.001).

Conclusion: There has been a significant rise in CVD and subtype-specific mortality during the COVID-19 pandemic which has been persistent despite two years since the onset of the pandemic. Excess CVD mortality has disproportionately affected Black compared with white individuals. Further studies targeting and eliminating health care disparities are necessary.
**Abbreviations:**
CVD, cardiovascular disease
COVID-19, severe acute respiratory syndrome coronavirus 2 2019
MI, myocardial infarction
HF, heart failure
Introduction:
Although the direct toll of COVID-19 in the United States has been devastating, concerns have risen regarding the indirect effects of the pandemic\(^1\). Despite hospitalizations for acute cardiovascular conditions declining, cardiovascular (CVD) mortality has risen substantially during the COVID-19 pandemic in the United States\(^2\). Whether this is attributed to avoidance of medical care, overwhelmed medical personnel, a combination or another underlying factor remains unknown\(^3\). Early reports (2019-2020) indicate a dramatic shift in cardiovascular mortality whether directly or indirectly related to COVID-19\(^2\).

While underlying disparities are known to exist in society including structural racism and the US healthcare system\(^4\), the COVID-19 pandemic seems to have exacerbated these inequalities\(^5\) not just in healthcare but in all facets of society\(^6\). Recent publications have highlighted growing disparities in CVD death in the early (March- December 2020) COVID-19 pandemic\(^7\). We sought to investigate the patterns and demographics of CVD, myocardial infarction (MI), stroke, and heart failure mortality from pre-pandemic (2018-2019) and during the COVID-19 pandemic (2020-2021).

Methods:
This was a retrospective study utilizing the multiple cause of death files maintained by the National Center for Health Statistics through the Centers for Disease Control and Prevention (CDC) Wide-Ranging Online Data for Epidemiologic Research (WONDER). The CDC Wonder dataset is publicly available\(^8\) and easily replicated as described. The dataset contains the death certificates for US residents, where the underlying cause of death is ascertained by the treating physician on the section of death on the certificate. Each certificate identifies a single cause of death and baseline demographic information\(^9\). The underlying and contributing causes of death are entered according to the provision of the International Classification of Disease 10\(^{th}\) Revision (ICD-10) and associated selection rules and modifications. Race is reported by funeral directors as provided by an informant (surviving next of kin) or based on observation in the absence of an informant\(^8\). Population estimates were obtained via the 2020 Census Bureau of the US national and state resident population\(^10\).

We investigated the change in CVD, myocardial infarction, stroke, heart failure between January 1, 2018 and December 31, 2021\(^11\). Our primary outcome was excess mortality from CVD and its 3 subtypes comparing three consecutive years (2019-2021) to 2018. The year 2018 was established as our referent year, thus allowing us to evaluate the pre-existing trends in mortality in the year 2019 (pre-pandemic era) for comparative purposes. We then compared total mortality from 2018-2019 (pre-pandemic) with mortality during the COVID-19 pandemic years (2020 and 2021). We obtained the monthly cause of death using the
provisional *International Classification of Diseases, Tenth Revision* codes for CVD (I00-I99 Diseases of the Circulatory System), MI (I21 Acute myocardial infarction and I22 Subsequent myocardial infarction), stroke (I60-I69 Cerebrovascular disease), and HF (I42 Cardiomyopathy and I50 Heart Failure). We divided the population by race and compared Black to white individuals. Our subgroup exploratory analysis was investigating mortality of CVD, Myocardial infarction, cerebrovascular and heart failure to state level demographics. Additionally, we examined the month-to-month mortality to view the temporal changes throughout each year and compared each month the same month in the referent year (2018). Further, we sought to explore the changes in location of death in the two eras given the disruptions of healthcare delivery. Given that the population size did not change significantly between 2019 and 2021 and because we wanted to evaluate month-month variation, the use of age-adjusted mortality rates was not performed as it is available only for annual estimates. This study did not require institutional review board approval due to the fact the analysis solely used government issued public data without any individually identifiable information.

**Statistical Analysis**

We used the total number of deaths per month and per year in our final analysis. We stratified our analysis by subgroup of state and race. We used chi-squared analysis to test statistical significance of the years 2019, 2020 and 2021 compared to the historical baseline (2018), p values <0.05 were considered significant. We utilized IBM SPSS Statistics for analysis.

**Results**

Overall, 3,598,352 CVD deaths were analyzed during the study period (Table 1). Baseline demographics demonstrated a higher percentage of older, female, and Black individuals in certain CVD subtypes like stroke and heart failure.

We first compared the two years prior to the pandemic (2018 and 2019) compared with the years during the pandemic (2020 and 2021). Overall, in the pandemic CVD mortality rose by 6.7% with varying degrees by subtype: MI (2.5%), stroke (8.5%), and interestingly remained relatively steadfast in heart failure (-0.1%) (Figure 1) when comparing the corresponding 2-year periods. In order to better understand temporal fluctuations, we compared year-to-year to our standard pre-COVID-19 pandemic year of 2018. For total CVD, 2019 saw a rise of 0.7% in mortality, while 2020 (6.9%) and 2021 (7.1%) demonstrated a substantially higher CVD mortality (Figure 2). In the overall population, and compared with 2018, MI mortality decreased by 4.0% in 2019 and increased by 0.5% in 2020, followed by an increase by 0.4% (Figure 3). Regarding stroke mortality, there was a rise in 2019 by 1.5%, followed by a dramatic increase.
during the pandemic: 8.4% in 2020 and 10.1% in 2021 (Figure 4). HF mortality showed a rise of 1.7% in 2019, 1.3% in 2020, and a 0.1% rise in 2021 (Figure 5). Southern states had the highest increase in excess CVD mortality (Figure 6).

When examining trends in location of death (Table 2), there was a shift in the location of death during the pandemic in the overall population, with more deaths occurring at home in CVD (26%), MI (16.5%), stroke (38.8%), and HF (17.9%). Compared to CVD mortality 2018, there was a rise in Black individuals dying 35.7% in 2020, 32.8% in 2021 while whites demonstrated only a rise by 23.6% in 2020, and 26.3% in 2021 ($P<.001$) (Supplemental table 1).

On subgroup analysis, there are striking differences in mortality in Black compared to white individuals. In 2020-2021, Black individuals had an excess CVD mortality by 13.8%, however white individuals had an excess CVD mortality of 5.1% $P<.001$. This remained consistent across subtype of CVD, including myocardial infarction (9.6% compared to 1.0% $P<.001$), stroke (14.5% compared to 6.9% $P<.001$), and heart failure (5.1% compared to -1.2% $P<.001$). On a year-to-year analysis by comparing to baseline year of 2018, Black individuals had a rise of CVD mortality by 1.5% compared to white individuals 0.5% (figure 2) in 2019 (pre-pandemic). However, when examining the COVID-19 pandemic years we see a rise of 15.8% in 2020 in Black individuals while only a 5.1% rise in white individuals. This continued into 2021 where Black individuals had a rise of 13.5% and white individuals had a rise of 5.7% (figure 2). This excess mortality remained consistent across myocardial infarction in 2020 (Black individuals 9.5% compared to 1.2% white individuals) and 2021 (6.7% compared to -1.0% respectively) (figure 3). Cerebrovascular disease demonstrated the most striking difference where in 2021 Black individuals had a rise of 14.9% mortality compared to 6.7% in white individuals, and 2021 Black individuals had a rise of 17.5% compared to 8.1% in white individuals (figure 4). These disparities remained consistent in heart failure mortality where 2020 showed Black individuals with a rise 9.1% mortality compared to white individuals 0%, and in 2021 with black individuals having a 4.1% increase in mortality compared to -0.8% in white individuals (figure 5).

Finally, we examined the month-to-month mortality of CVD and each subtype to examine temporal changes (Supplemental Figures 1-4). The results of the month-to-month variation of excess mortality visually demonstrate that the majority of the study time, Black individuals demonstrate excess mortality for CVD and subtypes over white individuals. There are temporal spikes corresponding to waves of the COVID-19 pandemic (April 2020 “First wave”, July 2020 “Second wave”, Dec 2020 “Third wave”, September 2021 “Delta Variant”)12. At these critical timepoints Black individuals’ excess CVD mortality remained
substantially elevated compared to white individuals. For instance, during the first wave (May 2020) Black individuals’ excess CVD mortality was 44.3% compared to 8.6% excess CVD mortality seen in white. During the second wave (July 2020) Black individuals’ excess CVD mortality was 19.1% compared to 10.1% excess CVD mortality in white individuals, which continued in the third wave (December 2020) 19.8% excess CVD mortality in Black individuals compared to 11.0% excess CVD mortality in white individuals, and in the Delta variant (fourth wave, Sept 2021) 20.3% excess CVD mortality in Black individuals compared to 14.6% excess CVD mortality in white individuals.

**Discussion:**
In this analysis, we demonstrated a significant rise in excess CVD mortality in COVID-19 pandemic (6.7% in 2020-2021 compared to 2018-2020). However, this excess mortality appears to be unevenly distributed with Black individuals having an almost 3-fold higher rates of excess CVD mortality (13.8%) compared with white individuals (5.1%). These results remained relatively consistent across CVD subtypes of MI, stroke, and HF mortality. Our results support and extend prior findings through 2021."13.

The racial disparities in CVD mortality that have grown during the COVID-19 pandemic are disparaging."14 While early data indicate the direct toll of COVID-19 on Black individuals, the continuing (two years and counting) and growing health care disparities and outcomes show the disproportionate indirect effects of the pandemic."15 Explanations for health care inequity remain not well understood,"16 however, they are likely multifactorial. Biologic explanations include a higher prevalence of CVD comorbidities including hypertension, obesity, and chronic kidney disease among Black individuals may play a small role. More likely, structural and systematic racism play a large, multigenerational role in healthcare outcomes."17

Our results demonstrated a significant trend of Black individuals to die at home compared to white individuals. Particularly in the early pandemic, avoidance of healthcare systems,"18 likely lead to reductions in individuals seeking hospital care for acute non-COVID-19 related CVD illnesses. Regardless of the underlying cause, our data highlight the critical need to address and improve access and distribution of health resources and care.

Additionally, when plotted on a month-to-month comparison to the referent month of the year 2018, we visually demonstrate this temporal trend extends throughout the study period. Spikes related to waves of COVID and variant subtypes seem to affect Black individuals to a higher degree. Reasons behind this are likely multifactorial, however there is a known contribution from discrimination in housing and access to care during these surges likely played a critical role."19 However, the overall trendline demonstrates an
almost continuously higher excess mortality in Black individuals. This further shows a continuous and systemic problem that plaques Black individuals and communities and has a continual and longitudinal impact.

Policy level changes must occur at a patient, provider, and system level\textsuperscript{20}. Health care providers must understand the nuances in disease prevention and treatment differences in racial and ethnic groups. Cultural competency requires “tailoring delivery of care to meet patients’ social, cultural, and linguistic needs”\textsuperscript{21}. Cultural competency training has preliminarily shown some ability to decrease bias\textsuperscript{22}, however this must be balanced with lifelong cultural humility\textsuperscript{23}. On a community level, community based participatory research projects, and intervention strategies are needed to provide sustaining and generational effects\textsuperscript{20}. Lastly, elected officials must change policy to produce population level efforts to improve lifestyles through primary and secondary prevention strategies.

Decades prior to the COVID-19 pandemic, studies have demonstrated Black individuals exhibit less trust in healthcare systems\textsuperscript{24}. Multivariate analysis found that perception of racism and mistrust of the medical care system led to significantly less satisfaction with the delivery of care\textsuperscript{25}. This likely has been exacerbated by the politicization of COVID-19 and the associated vaccines\textsuperscript{26}. All of which has been further compounded by the fact Black individuals are more likely to be exposed and hospitalized by COVID-19\textsuperscript{27}.

Our study does contain a few limitations. Our analysis was based on provisional diagnosis codes, which may be incomplete because of reporting delays. This study was also based on including only underlying causes of death as a result of CVD, and it may be possible that undiagnosed cases of COVID-19 partially contributed to the excess death seen. However, our results are consistent with prior literature cited previously. Lastly, because race was based upon reporting on death certification, some may have been misadjudicated.

**Conclusion:** While there has been a rise in CVD and subtype mortality during the COVID-19 pandemic, there is an unequal distribution with Black individuals suffering a larger burden of mortality. Further studies targeting and eliminating health care disparities are necessary.
References:


Figures and Tables:
Table 1 Legend: Baseline Demographics (CVD, cardiovascular disease), (MI, myocardial infarction), (HF, Heart failure)
Table 2 Legend: Location of Percent Excess Death comparing 2020-2021 vs 2018-2019 (CVD, cardiovascular disease), (MI, myocardial infarction), (HF, Heart failure)

Figure Legend
Figure 1: Overall Mortality Comparing Pandemic Mortality (2020-2021) to Pre-Pandemic Mortality (2018-2019), CVD (cardiovascular disease), MI (myocardial infarction), HF (Heart Failure)
Figure 2: Excess CVD Mortality By Year Compared to 2018 Overall and by Race
Figure 3: Excess MI Mortality By Year Compared to 2018 Overall and by Race
Figure 4: Excess Stroke Mortality By Year Compared to 2018 Overall and by Race
Figure 5: Excess Heart Failure Mortality By Year Compared to 2018 Overall and by Race
Figure 6: Heatmap of United States by Percent Excess Mortality Comparing 2020-2021 to 2018-2019
Table 1: Baseline Demographics (CVD, cardiovascular disease), (MI, myocardial infarction), (HF, Heart failure)

<table>
<thead>
<tr>
<th>Demographics</th>
<th>CVD Mortality</th>
<th>MI Mortality</th>
<th>Stroke Mortality</th>
<th>HF Mortality</th>
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<tr>
<td>n=</td>
<td>1,741,092</td>
<td>1,857,260</td>
<td>212,845</td>
<td>218,216</td>
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</table>

### Gender

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<td>Female</td>
<td>840,009</td>
<td>897,985</td>
<td>87,094</td>
<td>87,467</td>
<td>170,383</td>
<td>182,340</td>
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<td>Male</td>
<td>901,083</td>
<td>977,275</td>
<td>125,751</td>
<td>130,749</td>
<td>126,900</td>
<td>140,137</td>
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### Age at Death (Years)

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<tr>
<td>18-24</td>
<td>1,963</td>
<td>2,070</td>
<td>76</td>
<td>78</td>
<td>248</td>
<td>299</td>
</tr>
<tr>
<td>25-34</td>
<td>9,172</td>
<td>10,503</td>
<td>690</td>
<td>843</td>
<td>1,152</td>
<td>1,227</td>
</tr>
<tr>
<td>35-44</td>
<td>27,245</td>
<td>32,364</td>
<td>3,408</td>
<td>3,986</td>
<td>3,445</td>
<td>4,194</td>
</tr>
<tr>
<td>45-54</td>
<td>80,127</td>
<td>87,777</td>
<td>12,939</td>
<td>13,549</td>
<td>10,281</td>
<td>11,433</td>
</tr>
<tr>
<td>55-64</td>
<td>203,502</td>
<td>224,614</td>
<td>34,360</td>
<td>36,378</td>
<td>25,720</td>
<td>28,765</td>
</tr>
<tr>
<td>65-74</td>
<td>314,023</td>
<td>358,627</td>
<td>49,216</td>
<td>53,244</td>
<td>47,465</td>
<td>54,662</td>
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<tr>
<td>75-84</td>
<td>425,010</td>
<td>458,925</td>
<td>53,237</td>
<td>54,641</td>
<td>80,007</td>
<td>87,753</td>
</tr>
<tr>
<td>85+</td>
<td>680,050</td>
<td>682,385</td>
<td>58,919</td>
<td>55,497</td>
<td>128,965</td>
<td>134,144</td>
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### Race

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<tbody>
<tr>
<td>American Native</td>
<td>8,884</td>
<td>10,279</td>
<td>1,157</td>
<td>1,292</td>
<td>1,423</td>
<td>1,682</td>
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<td>Asian or Pacific Islander</td>
<td>45,014</td>
<td>52,369</td>
<td>5,501</td>
<td>6,401</td>
<td>10,753</td>
<td>12,718</td>
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<tr>
<td>Black or African American</td>
<td>224,703</td>
<td>255,691</td>
<td>24,152</td>
<td>26,468</td>
<td>39,730</td>
<td>45,492</td>
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<tr>
<td>Native Hawaiian</td>
<td>2,384</td>
<td>2,773</td>
<td>271</td>
<td>337</td>
<td>472</td>
<td>503</td>
</tr>
<tr>
<td>White</td>
<td>1,452,763</td>
<td>1,527,472</td>
<td>180,923</td>
<td>182,769</td>
<td>243,665</td>
<td>260,534</td>
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<tr>
<td>More than one</td>
<td>7,344</td>
<td>8,676</td>
<td>841</td>
<td>949</td>
<td>1,240</td>
<td>1,548</td>
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### Census Region

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<tbody>
<tr>
<td>Region 1</td>
<td>315,282</td>
<td>321,959</td>
<td>34,695</td>
<td>33,651</td>
<td>44,030</td>
<td>45,522</td>
</tr>
<tr>
<td>Region 2</td>
<td>395,908 (22.7%)</td>
<td>417,337 (22.7%)</td>
<td>50,416 (23.7%)</td>
<td>50,687 (23.2%)</td>
<td>65,904 (22.2%)</td>
<td>71,406 (22.1%)</td>
</tr>
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</tr>
<tr>
<td>Region 3</td>
<td>684,455 (39.3%)</td>
<td>745,276 (40.7%)</td>
<td>90,278 (42.4%)</td>
<td>94,369 (43.2%)</td>
<td>123,675 (41.6%)</td>
<td>136,082 (42.2%)</td>
</tr>
<tr>
<td>Region 4</td>
<td>345,447 (19.8%)</td>
<td>372,688 (20.7%)</td>
<td>37,456 (17.6%)</td>
<td>39,509 (18.1%)</td>
<td>63,674 (21.4%)</td>
<td>69,467 (21.5%)</td>
</tr>
</tbody>
</table>

**Place of Death**

<table>
<thead>
<tr>
<th>Inpatient Facility</th>
<th>464,977 (26.7%)</th>
<th>460,168 (24.7%)</th>
<th>68,627 (32.2%)</th>
<th>67,131 (30.8%)</th>
<th>106,585 (35.9%)</th>
<th>108,211 (33.6%)</th>
<th>58,010 (27.5%)</th>
<th>56,998 (27.0%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outpatient Facility or ER</td>
<td>169,462 (9.7%)</td>
<td>171,400 (9.7%)</td>
<td>40,130 (18.9%)</td>
<td>38,070 (17.4%)</td>
<td>8,153 (2.7%)</td>
<td>9,097 (2.8%)</td>
<td>9,664 (4.6%)</td>
<td>9,522 (4.5%)</td>
</tr>
<tr>
<td>Dead on Arrival</td>
<td>8,098 (0.5%)</td>
<td>7,302 (0.7%)</td>
<td>1,652 (0.8%)</td>
<td>237 (0.1%)</td>
<td>221 (0.1%)</td>
<td>369 (0.2%)</td>
<td>289 (0.1%)</td>
<td></td>
</tr>
<tr>
<td>Decedent’s Home</td>
<td>555,825 (31.9%)</td>
<td>698,315 (37.7%)</td>
<td>65,786 (30.9%)</td>
<td>76,631 (35.1%)</td>
<td>59,001 (19.8%)</td>
<td>81,900 (25.4%)</td>
<td>66,289 (31.4%)</td>
<td>78,153 (37.1%)</td>
</tr>
<tr>
<td>Hospice</td>
<td>106,689 (6.1%)</td>
<td>98,112 (5.7%)</td>
<td>4,137 (1.9%)</td>
<td>3,711 (1.7%)</td>
<td>36,293 (12.2%)</td>
<td>35,646 (11.1%)</td>
<td>17,481 (8.3%)</td>
<td>13,574 (6.4%)</td>
</tr>
<tr>
<td>Nursing home Long term</td>
<td>348,498 (20.0%)</td>
<td>314,983 (17.7%)</td>
<td>24,133 (11.3%)</td>
<td>21,137 (9.7%)</td>
<td>73,461 (24.7%)</td>
<td>69,617 (21.6%)</td>
<td>49,241 (23.3%)</td>
<td>40,474 (19.2%)</td>
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<tr>
<td>Other</td>
<td>87,254 (5.0%)</td>
<td>106,678 (5.7%)</td>
<td>8,348 (3.9%)</td>
<td>10,008 (4.6%)</td>
<td>13,521 (4.5%)</td>
<td>17,758 (5.5%)</td>
<td>9,896 (4.7%)</td>
<td>11,694 (5.5%)</td>
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<td>Unknown</td>
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<td>302 (0.7%)</td>
<td>32 (0.0%)</td>
<td>31 (0.0%)</td>
<td>32 (0.0%)</td>
<td>27 (0.0%)</td>
<td>35 (0.0%)</td>
<td>27 (0.0%)</td>
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Table 2- Location of Percent Excess Death comparing 2020-2021 vs 2018-2019

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Inpatient Facility</td>
<td>-1.0%</td>
<td>-2.2%</td>
<td>1.5%</td>
<td>-1.7%</td>
</tr>
<tr>
<td>Outpatient Facility or ER</td>
<td>1.1%</td>
<td>-5.1%</td>
<td>11.6%</td>
<td>-1.5%</td>
</tr>
<tr>
<td>Dead on Arrival</td>
<td>-9.8%</td>
<td>-9.4%</td>
<td>-6.8%</td>
<td>-21.7%</td>
</tr>
<tr>
<td>Decedent’s Home</td>
<td>25.6%</td>
<td>16.5%</td>
<td>38.8%</td>
<td>17.9%</td>
</tr>
<tr>
<td>Hospice</td>
<td>-8.0%</td>
<td>-10.3%</td>
<td>-1.8%</td>
<td>-22.3%</td>
</tr>
<tr>
<td>Nursing home Long term</td>
<td>-9.6%</td>
<td>-12.4%</td>
<td>-5.2%</td>
<td>-17.8%</td>
</tr>
<tr>
<td>Other</td>
<td>22.3%</td>
<td>19.9%</td>
<td>31.3%</td>
<td>18.2%</td>
</tr>
<tr>
<td>Unknown</td>
<td>4.5%</td>
<td>-3.1%</td>
<td>-15.6%</td>
<td>-22.9%</td>
</tr>
</tbody>
</table>
Figure 1

Excess Mortality 2020-2021 Compared to 2018-2019

Overall CVD: 6.7%
Overall MI: 2.5%
Stroke: 8.5%
Overall CHF: -0.1%
Figure 2

Excess CVD Mortality Compared to 2018

- **Excess Mortality 2019**
  - Overall CVD: 0.7%
  - Black CVD: 1.5%
  - White CVD: 0.5%

- **Excess Mortality 2020**
  - Overall CVD: 6.9%
  - Black CVD: 5.1%
  - White CVD: 7.1%

- **Excess Mortality 2021**
  - Overall CVD: 15.8%
  - Black CVD: 13.5%
  - White CVD: 5.7%
Figure 3

Excess MI Mortality Compared to 2018

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall MI</th>
<th>Black MI</th>
<th>White MI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excess Mortality 2019</td>
<td>-4.0%</td>
<td>-2.8%</td>
<td>-4.2%</td>
</tr>
<tr>
<td>Excess Mortality 2020</td>
<td>0.5%</td>
<td>-1.2%</td>
<td>-1.0%</td>
</tr>
<tr>
<td>Excess Mortality 2021</td>
<td>9.5%</td>
<td>6.7%</td>
<td>0.4%</td>
</tr>
</tbody>
</table>
Figure 4

Excess Stroke Mortality Compared to 2018

- Excess Mortality 2019: Stroke 1.5%, Black Stroke 3.0%, White Stroke 0.9%
- Excess Mortality 2020: Stroke 8.4%, Black Stroke 14.9%, White Stroke 6.7%
- Excess Mortality 2021: Stroke 10.1%, Black Stroke 17.5%, White Stroke 8.1%
Figure 5

Excess HF Mortality Compared to 2018

- Excess Mortality 2019:
  - Overall CHF: 1.7%
  - Black CHF: 2.9%
  - White CHF: 1.6%

- Excess Mortality 2020:
  - Overall CHF: 1.3%
  - Black CHF: -0.1%
  - White CHF: 0.1%

- Excess Mortality 2021:
  - Overall CHF: 4.1%
  - Black CHF: -0.8%
  - White CHF: -2%

*Overall CHF* | *Black CHF* | *White CHF*
Scott Janus: Conceptualization, Methodology, Writing- Original draft preparation, Editing, Writing- Subsequent draft, data collection

Mohamed Makhlouf: Conceptualization, Methodology, Writing- Original draft preparation, Editing, Writing- Subsequent draft, data collection

Sadeer Al-Kindi: Conceptualization, Methodology, Writing- Original draft preparation, Editing, Writing- Subsequent draft, data collection

Nicole Chahine: Writing- Subsequent draft, Editing, data collection

Issam Motairek: Writing- Subsequent draft, Editing, data collection