Socioeconomic status and cardiovascular health in the COVID-19 pandemic

Jeremy Naylor-Wardle, Ben Rowland, Vijay Kunadian

ABSTRACT
The goals of this review are to evaluate the impact of socioeconomic (SE) status on the general health and cardiovascular health of individuals during the COVID-19 pandemic and also discuss the measures to address disparity. SE status is a strong predictor of premature morbidity and mortality within general health. A lower SE status also has implications of increased cardiovascular disease (CVD) mortality and poorer CVD risk factor profiles. CVD comorbidity is associated with a higher case severity and mortality rate from COVID-19, with both CVD and COVID-19 sharing important risk factors. The COVID-19 pandemic has adversely affected people of a lower SE status and of ethnic minority group, who in the most deprived regions are suffering double the mortality rate of the least deprived. The acute stress, economic recession and quarantine restrictions in the wake of COVID-19 are also predicted to cause a decline in mental health. This could pose substantial increase to CVD incidence, particularly with acute pathologies such as stroke, acute coronary syndrome and cardiogenic shock among lower SE status individuals and vulnerable elderly populations. Efforts to tackle SE status and CVD may aid in reducing avoidable deaths. The implementation of ‘upstream’ interventions and policies demonstrates promise in achieving the greatest population impact, aiming to protect and empower individuals. Specific measures may involve risk factor targeting restrictions on the availability and advertisement of tobacco, alcohol and high-fat and salt content food, and targeting SE disparity with healthy and secure workplaces.

INTRODUCTION
Non-communicable diseases are the most common cause of global mortality and are largely attributed to unhealthy lifestyle factors. The contribution of an individual’s socioeconomic (SE) status has been evaluated and deemed similar to some of these factors, for example, smoking. In this review, we define SE status as the combination of economic and social factors that determine disparity between individuals. Education level, occupation, household income, health, disability and living conditions all contribute to SE status. Literature often uses a combination of these factors, with tools such as the Index for Multiple Deprivation (IMD) frequently included as a standardised measure. An individual’s well-being is multifaceted; it cannot be solely based on a single determinant. As such, multidimensional tools such as the IMD can provide insight into the overall well-being of geographical areas relative to one another. Particularly, SE status is traditionally defined by education, income and occupation, with each component baring separate relationships to health. Therefore, each is addressed by different policies. When targeting a specific area, one must assess every determinant of SE status to discover potential interventions to promote it.

Excluding the 5% most and least deprived communities, the disparity in life expectancy and disability-free life expectancy is 6 and 13 years, respectively, favouring the more affluent. A lower SE status also has implications of increased cardiovascular disease (CVD) mortality and poorer CVD risk factor profiles. Lifestyle and CVD risk factors can only partially explain this disparity, illustrating the multifactorial relationship between SE status and health inequity.

The COVID-19 pandemic has adversely affected populations of a lower SE status, who in the most deprived regions are suffering double the mortality rate of the least deprived. Cardiovascular (CV) comorbidity is also associated with a higher case severity and mortality rate. Black, Asian and minority ethnic (BAME) populations are over-represented as a proportion of patients with COVID-19, and age standardised mortality rates of Black British individuals measure more than twice that of White British individuals. With SE status thought to be an underlying factor, the pandemic has perpetuated its significance in modern medicine. The goals of this review are to evaluate the impact of SE status on the general health and CV health of individuals during the COVID-19 pandemic and also discuss the measures to address disparity.

SE STATUS AND GENERAL HEALTH
SE status has been associated with excess risk factors, excess morbidity and mortality as shown in table 1 and figure 1.

SE STATUS AND CV HEALTH
SE status has been associated with excess CV risk factors, excess CV morbidity and CV mortality as shown in table 2 and figure 1.

THE CONTEXT OF COVID-19

COVID-19 and CVD
As the unfolding pandemic continues to humble the globe, it has shed new light on the risk posed to CVD. Aside from the increased risk of myocardial infarction (MI) observed in pneumonia, COVID-19 can also precipitate acute COVID-19 CV syndrome involving direct viral myocarditis, stress cardiomyopathy or cytokine storm. This has further implications of multiorgan dysfunction and disseminated intravascular coagulopathy in critically ill patients partially manifesting as microvascular thrombosis in coronary circulation. CV comorbidity is associated with a higher case severity.
and mortality rate. A previous study identified that 48% of patients had a comorbidity, the most prominent of which were hypertension (30% of patients), diabetes (19%) and coronary heart disease (CHD) (8%).

Following national lockdown measures, there has been a decline in rates of primary percutaneous coronary intervention and mortality rate. A previous study identified that 48% of symptoms. Nevertheless, the incidence of out-of-hospital cardiac arrest has been strongly associated with the cumulative incidence of COVID-19. During the pandemic, the greatest cause of excess CV death in care homes and hospiotals was stroke (+39%), compared with acute coronary syndrome (+41%) at home and cardiogenic shock (+15%) in hospital suggesting there were delays to seeking help or likely the result of undiagnosed COVID-19. The substantial increase in community mortality within care homes highlights the vulnerability of the elderly to the CV repercussions of COVID-19. In Brazil, excess community CV mortality was also noted to be greater in less developed cities, suggesting a SE aspect to the disparity.

**SE status and COVID-19 infection**

People living in the most deprived areas of the UK are twice as likely to die from COVID-19 as those from the least deprived. The rate of deaths involving COVID-19 in the most deprived areas was 128.3 deaths per 100,000 persons compared with 58.8 deaths per 100,000 in the least deprived. Within developed countries, risk factors for CVD, and subsequently COVID-19, are more common in deprived areas. In a recent study from the UK Biobank, SE status (adjusted relative risk (RR) 1.93 (1.51–2.46) for the most deprived), obesity (adjusted RR 1.04 (1.02–1.05) per kg/m²) and comorbid hypertension, chronic obstructive pulmonary disease, asthma and specific renal diseases are more common in deprived areas. Particularity, obesity has been highlighted as a leading risk factor for worse prognosis in COVID-19.

**COVID-19 infection and mental health**

The detrimental impact of a low SE status and economic recession on mental health and mortality from suicide is clearly documented across a number of studies. Added to the additional community CV mortality was also noted to be greater in less developed cities, suggesting a SE aspect to the disparity.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year of publication</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam et al</td>
<td>2008</td>
<td>In a cohort of 77,782 US women, relative risk of five compared with zero lifestyle risk factors prevalent in low socioeconomic status areas was:</td>
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<tr>
<td>Meader et al</td>
<td>2016</td>
<td>There is a fivefold and fourfold increase in clustering of risk-associated behaviour.</td>
</tr>
<tr>
<td>Hall</td>
<td>2017</td>
<td>Relative risk of harm from excess drinking was higher in lower socioeconomic groups (HR 10.22, 95% CI 7.73 to 13.53).</td>
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**Table 1 Socioeconomic status and general health**

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year of publication</th>
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</thead>
<tbody>
<tr>
<td>Marmot et al</td>
<td>2020</td>
<td>The difference in UK DFLE is 17 years between areas of low and high socioeconomic status.</td>
</tr>
<tr>
<td>Kivimäki et al</td>
<td>2020</td>
<td>109,246 Finnish adults aged 17–77 years were measured against 56 physical and mental health conditions.</td>
</tr>
<tr>
<td>Dugravot et al</td>
<td>2019</td>
<td>Socioeconomic status measured by occupation demonstrated inequalities from health to:</td>
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<tr>
<td>Marmot et al</td>
<td>1978</td>
<td>A steep inverse association between socioeconomic status, assessed by grade of employment, and mortality from a range of pathology.</td>
</tr>
<tr>
<td>Stringhini et al</td>
<td>2017</td>
<td>1.7 million individuals in 48 cohorts demonstrated that low SE status is associated with a 2.1-year reduction in life expectancy.</td>
</tr>
<tr>
<td>Lever et al</td>
<td>2019</td>
<td>One in three premature deaths can be attributed to low socioeconomic status.</td>
</tr>
</tbody>
</table>

References w65–74 can be found in online supplemental file 1.

CV, cardiovascular; DFLE, disability-free life expectancy; SE, socioeconomic.
stressor of quarantine restrictions, the mental health of global populations is in a fragile state. A previous study evaluated 24 studies to observe the impact of quarantine on individuals. The rate of post-traumatic stress symptoms ranged from 28% to 34%, with one study demonstrating rates of low mood reaching 73% and irritability reaching 57%. A 27-year CVD follow-up of 136,637 Swedish participants with stress-related disorders, including post-traumatic stress disorder and acute stress response, yielded an increased risk of CVD in sibling-based comparisons (HR 1.64, 95% CI 1.45 to 1.84). Particularly, it demonstrated an association between stress-related disorders and early-onset CVD (HR 1.40, 95% CI 1.32 to 1.49 for age <50 years) when compared with later onset (HR 1.24, 95% CI 1.18 to 1.30) (p=0.002).

Although acute stressors may increase CV complications, attendances to emergency departments have fallen by half since the beginning of March. Some studies suggest that people may not be attending or delaying attending hospital for MI due to fear of transmission from COVID-19 or reluctance to be a burden on the healthcare system.

Susceptibility of minority ethnic groups to COVID-19

A recent analysis indicates that a social gradient exists with mortality from COVID-19, with age-standardised mortality rates in confirmed cases per 100,000 in Black British people being higher (119 in females and 257 in males) than White ethnic groups (36 in females and 70 in males). In a recent analysis from the UK Biobank, the incidence of COVID-19 was 0.61% (95% CI 0.46% to 0.82%) in Black/Black British participants, 0.32% (95% CI 0.19% to 0.56%) in ‘other’ ethnicities, 0.32% (95% CI 0.23% to 0.47%) in Asian/Asian British, 0.30% (95% CI 0.11% to 0.80%) in Chinese, 0.16% (95% CI 0.06% to 0.41%) in mixed and 0.14% (95% CI 0.13% to 0.15%) in White. Compared with White participants, Black/Black British participants had an adjusted RR of 3.30 (95% CI 2.39 to 4.55), Chinese participants 3.00 (95% CI 1.11 to 8.06), Asian/Asian British participants 2.04 (95% CI 1.36 to 3.07), ‘other’ ethnicities 1.93 (95% CI 1.08 to 3.45) and mixed ethnicities 1.07 (95% CI 0.40 to 2.86).

An evaluation of 48,788 individuals admitted to hospital with COVID-19 across 12 US states demonstrated an increase in the cumulative percentage of hospital admissions of Black individuals (ranging from 1.4% to 18.8%) compared with White ethnic groups ranging from −11.1% to −35.6%.

Pakistani and Bangladeshi groups are over three times more likely than White British individuals to live in the most income-deprived 10% of neighbourhoods, respectively representing 31.1%, 19.3% and 9.0% of ethnicities in such areas. Individuals of a Black ethnicity represent 15.2% of this population. Comorbidities have also been connected to the disparity observed. African-American individuals experience an earlier onset of peripheral vascular disease (OR 1.9, 95% CI 0.7 to 4.7), stroke (RR 2.77, 95% CI 1.37 to 5.62) and heart failure (HR 1.81, 95% CI 1.07 to 3.07) compared with white populations. However, these factors seem inadequate to explain the total disparity observed in susceptibility to COVID-19.
Severity of COVID-19 in minority ethnic groups

One recent cohort study in the UK found that ethnic minorities presenting with COVID-19 were more likely to have diabetes, but less likely to have other comorbidities than white patients.30 Despite there being no difference between races in illness severity on admission, South Asian individuals (OR 1.28, 95% CI 1.09 to 1.52) and other ethnic minorities were more likely to be subsequently admitted to critical care and to receive invasive mechanical ventilation. This discrepancy remained even after adjusting for deprivation and comorbidities. In South Asians in particular, higher mortality was observed compared with white patients (HR 1.19, 95% CI 1.05 to 1.36) but not in other ethnicities.
determined to be in part due to the higher prevalence of diabetes in South Asians. People of Bangladeshi ethnicity were identified as having twice the mortality of White British populations, even when deprivation was accounted for, among other ethnicities the adjusted death rate was also between a 10% and 50% increase. Interestingly, after adjustment for sociodemographic differences and presentation characteristics, there was no association with a higher in-hospital mortality rate among African-American individuals than in white individuals.

Quality of care received by minority ethnic groups
The health disparity also extends to the quality of care received. Patients of African ethnicity have been displayed to receive delayed and lower quality care. Additionally, ethnic minorities experience barriers which prevent health-seeking behaviour despite their desire to do so. For example, first-generation immigrants may experience language barriers that prevent them from accessing rapid care. In the UK, however, it does appear that for those infected with COVID-19, there is no difference along ethnic lines between presentation time and severity on admission. The absence of universal healthcare and lack of insurance coverage in the USA is thought to be contributing to the disparities seen. Twenty-three per cent of African-American individuals were less likely to be insured compared with white individuals at 17% and the consequent challenges in receiving the same quality of care.

Importantly, a recent report identified significant under-representation of BAME groups in three large-scale UK ageing studies. The English Longitudinal Study of Ageing had only 300 BAME individuals out of 7265 participants in its most recent data wave (2016/2017), and the UK household longitudinal study included 570 out of 6470 (2017/2018), with only 32 Bangladeshi participants (figure 2).

MEASURES TO ADDRESSING SE DISPARITY
Addressing disparity in the context of COVID-19
Measures of social distancing, school closures, workplace closures and public transport closures were globally introduced in an attempt to reduce disease burden on healthcare systems. In a meta-analysis, it was observed that implementation of any physical distancing intervention (including closure of workplaces, schools and public transport, restrictions of mass gatherings and restriction of movement) reduced COVID-19 incidence by 13% (incidence risk ratio (IRR) 0.87, 95% CI 0.85 to 0.89). Earlier implementation of movement restriction (lockdown) was associated with a larger reduction in incidence (IRR 0.86, 95% CI 0.84 to 0.89) compared with implementation after other physical distancing measures (IRR 0.90, 95% CI 0.87 to 0.94). A review of 14 studies evaluated the adherence of different populations to quarantine restrictions. Adherence ranged from 0% to 92.8%, with the main affecting factors including poor understanding of the disease, quarantine procedure and risk of disease, social norms and the financial consequences of not being able to work.

Potential measures to address the disparity
The Whitehall study results prompted the WHO to commission a global collaboration to refine the social determinants of health in order to promote and achieve SE equity. It highlighted the SE disparities observed within a country and between countries, proposing three principles of action: (1) improve the conditions of daily life; (2) tackle the inequitable distribution of power, money and resources; and (3) measure and understand the problem and assess the impact of action. A summary of interventions is shown in table 3.

Figure 2 Predisposing factors to poor outcomes in Black, Asian and minority ethnic (BAME) group. RAAS, renin–angiotensin–aldosterone system; SES, socioeconomic status.
The Prospective Urban Rural Epidemiology study reported differing rates of decline in mortality from CVD between the most and the least deprived. It has been proposed that on this basis, CVD could become purely a disease of the lower SE groups by the mid 2020s. The most effective method could involve the ‘upstream’ approach to targeting disease prevention. The 2004 smoke-free legislation introduced in the Netherlands resulted in 6.8% reduction in sudden cardiac events being observed in the year following a workplace ban on smoking. In fact, more individualised strategies could actually act to widen the SE gap due to often a small population impact and a higher cost. Such strategies may involve individual CV screening, breast cancer screening and smoking cessation services, all of which have demonstrated high uptake among more affluent individuals, to screen for and smoking cessation services, all of which have strategies may involve individual CV screening, breast cancer screening and smoking cessation services, all of which have strategies may involve individual CV screening, breast cancer screening and smoking cessation services, all of which have demonstrated moderate to strong evidence to influence behaviour. The introduction of high-fat content or ‘unhealthy food’ signs on products at the point of purchase is an example that has demonstrated promise in improving nutritional intake. Comparisons between public engagement campaigns and financial incentives to improve fruit and vegetable intake in the USA reported that a 1-year campaign would improve the national fruit and vegetable intake by 7%, preventing approximately 18 600 CVD deaths (95% CI 17 600 to 19 500). A 10% decrease in fruit and vegetable prices would also increase their consumption by ~14% and prevent ~153 300 deaths (95% CI 14 600 to 159 200).

Health literacy has also been considered a potential contributor to CVD risk. Individuals with poor health literacy are more likely to be non-compliant with their medications. In turn, public engagement campaigns to empower individuals to understand their health needs may improve health literacy and the concurrent CVD risk. The American Heart Association guidelines justified the use of overarching policy to reduce SE disparity in CVD. Intervention at different levels of community has been proposed, encompassing schools, workplaces, healthcare facilities and religious organisations. Targeting such populations provides a platform to promote and improve health behaviours. In addition, the social media presence of some organisations may be useful in widening messages to improve health behaviours.

Increased poverty has the collateral effect of increasing food insecurity. With a poor diet being attributed to a lack of money, rather than personal choice, it is imperative to ensure that healthy food is available to those of a lower income. Guaranteeing employers are paying the living wage will reduce this poverty, improve wealth inequalities and combat food insecurity. Activities such as walking, running and cycling may also be suitable in maintaining activity. Enforcing thorough risk assessment on return to work. Providing financial support to businesses to ensure good working conditions. GuaranTEEING employers are paying the living wage will reduce this poverty, improve wealth inequalities and combat food insecurity.

Table 3 A summary of interventions

<table>
<thead>
<tr>
<th>Risk factor intervention at a population level</th>
<th>Policies to protect</th>
<th>Policies to empower</th>
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<tr>
<td><strong>Targeting jobs and socioeconomic status</strong></td>
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<tr>
<td>1. Tobacco usage</td>
<td>Increases in taxation.</td>
<td>Public engagement campaigns focusing on the benefits of quitting.</td>
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<td></td>
<td>Implementing annual increases in price.</td>
<td>Signposting to smoking cessation services.</td>
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<td></td>
<td>Raise legal buying age from 18 to 21.</td>
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<tr>
<td>2. Poor diet</td>
<td>Widen the taxation on sugary food and drink.</td>
<td>Improve availability of healthy food to less affluent families.</td>
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<td></td>
<td>Restrict price promotions on unhealthy food.</td>
<td>Public engagement campaigns to raise awareness of obesity and methods to combat it.</td>
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<td></td>
<td>Increase low-salt content food availability, restricting that of high-salt content.</td>
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<tr>
<td></td>
<td>Implementing warning messages on foods that are high in salt.</td>
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<tr>
<td></td>
<td>Restricting advertisement of unhealthy food.</td>
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<tr>
<td>3. Physical inactivity</td>
<td>Shift taxation on the use of private road vehicles to favour safe public transport.</td>
<td>Investment in attractive and safe infrastructure to encourage active commuting and outdoor activity.</td>
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<td></td>
<td>Safe public events and public engagement campaigns to encourage activity.</td>
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<tr>
<td>4. Alcohol usage</td>
<td>Legislate a minimum unit price, implementing annual increases in price.</td>
<td>Public engagement campaigns to encourage periods of reduced alcohol consumption.</td>
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<td></td>
<td>Restrict maximum units per transaction.</td>
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<td></td>
<td>Restrict advertisement from public places and to postwatershed times.</td>
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<tr>
<td>5. Air pollutants</td>
<td>Increase zones of congestion charge.</td>
<td>Increase availability of cleaner, more efficient fuel.</td>
</tr>
<tr>
<td></td>
<td>Increase carbon emission taxation.</td>
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The Prospective Urban Rural Epidemiology study reported apparent in the consistent decline in US life expectancy despite an 80% increase in statin use. Previous research has outlined interventions to target risk-associated behaviour. Informed by the WHO, it highlights the leading causes of years of life lost as: tobacco use, an unhealthy diet, alcohol consumption and physical inactivity. The interventions are divided into three regions: fiscal and economic, marketing and availability. Fiscal and economic interventions are regarded as the most effective, with many tax reforms proposed to ensure consistent and increasing unit prices of both alcohol and tobacco, alongside public engagement campaigns and measures to reduce their availability. To target poor diet, tax similar to the 2018 Soft Drinks Industry Levy has been suggested to be extended to other drinks and food high in sugar, aiming to make fruits and vegetables more affordable for those in a lower SE position (figure 3).

Public engagement often involves interaction with health messages positioned in frequently used locations. They have demonstrated moderate to strong evidence to influence behaviour on smoking, poor nutrition and physical inactivity, but must be carefully constructed and tested with the target audience to observe the desired outcomes. The introduction of high-fat content or ‘unhealthy food’ signs on products at the point of purchase is an example that has demonstrated promise in improving nutritional intake. Comparisons between public engagement campaigns and financial incentives to improve fruit and vegetable intake in the USA reported that a 1-year campaign would improve the national fruit and vegetable intake by 7%, preventing approximately 18 600 CVD deaths (95% CI 17 600 to 19 500). A 10% decrease in fruit and vegetable prices would also increase their consumption by ~14% and prevent ~153 300 deaths (95% CI 14 600 to 159 200).

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Between high and low SE status groups, smoking cessation services demonstrated the greatest improvement to absolute and RR in CHD. It is essential that while these effective ‘downstream’ measures continue, they must be supported by ‘upstream’ intervention and adequate access for those from a lower SE status. This could be improved through the use of such screening tools which have the potential to be extended to the risk assessment of future vaccination programmes.

CONCLUSION
The global battle against COVID-19 has highlighted the adverse health conditions experienced by individuals of a lower SE status. With substantial links to poorer general health and CVD mortality, a lower SE status should be understood as a risk factor for poorer COVID-19 outcomes, particularly among BAME populations. To combat this inequity, there must be policy intervention to both protect and empower these communities from an SE and risk-associated behaviour standpoint. Greater research representation of BAME populations must also be actioned in order to better understand the over-representation observed in adverse outcomes from COVID-19.

Contributors
VK conceived the idea and made critical review and multiple revisions. JNW wrote the draft and multiple revisions. BR contributed to sections and critical review.

Funding
VK is supported by the British Heart Foundation Clinical Study Grant (CS/15/7/316), Newcastle NIHR Biomedical Research Centre, and Institutional Research Grant from AstraZeneca (ISSBRIL0303).

Competing interests
None declared.

Patient consent for publication
Not required.

Provenance and peer review
Not commissioned; externally peer reviewed.

Author note
Additional references w51–93 can be found in online supplemental file 1.

Supplemental material
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