Socioeconomic status and cardiovascular health in the COVID-19 pandemic

Jeremy Naylor-Wardle,[1] Ben Rowland,[1] Vijay Kunadian [1,2]

[1]Translation and Clinical Research Institute, Faculty of Medical Sciences, Newcastle University, Newcastle upon Tyne, UK
[2]Cardiothoracic Centre, Freeman Hospital, Newcastle upon Tyne Hospitals NHS Foundations Trust, Newcastle Upon Tyne, UK

Correspondence to
Dr Vijay Kunadian, Translation and Clinical Research Institute, Faculty of Medical Sciences, Newcastle University, Newcastle Upon Tyne NE7 7DN, UK; vijay.kunadian@newcastle.ac.uk

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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.[1] The contribution of an individual's socioeconomic (SE) status has been evaluated and deemed similar to some of these factors, for example, smoking.[2] 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 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.[3] 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.[4] A lower SE status also has implications of increased cardiovascular disease (CVD) mortality[5] and poorer CVD risk factor profiles.[6] Lifestyle and CVD risk factors can only partially explain this disparity, illustrating the multifactorial relationship between SE status and health inequity.[7]

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.[8] Cardiovascular (CV) comorbidity is also associated with a higher case severity and mortality rate.[9] Black, Asian and minority ethnic (BAME) populations are over-represented as a proportion of patients with COVID-19,[10] and age standardised mortality rates of Black British individuals measure more than twice that of White British individuals.[11] With SE status thought to be an underlying factor,[11] 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,[12] COVID-19 can also precipitate acute COVID-19 CV syndrome involving direct viral myocarditis, stress cardiomyopathy or cytokine storm.[13] 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

Table 1 Socioeconomic status and general health

Authors	Year of publication	Findings
Socioeconomic status and excess risk factors		
Dam *et al*[w65]	2008	▶ 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: – 4.31 for all-cause mortality. – 3.36 (95% CI 2.45 to 4.34) for cancer mortality. – 8.17 (95% CI 4.96 to 13.47) for CV mortality.
Meader *et al*[w66]	2016	▶ There is a fivefold and fourfold increase in clustering of risk-associated behaviour. ▶ Socioeconomic status is the strongest predictor of this. ▶ A common cluster in adult populations was that of excessive drinking and smoking. ▶ Younger populations demonstrated sexual risk behaviour with smoking, illicit drug use and alcohol misuse.
Hall[w67]	2017	▶ Relative risk of harm from excess drinking was higher in lower socioeconomic groups (HR 10.22, 95% CI 7.73 to 13.53).
Iacobucci[w68]	2019	▶ Low socioeconomic status is an independent risk factor for premature death and ill health. ▶ Increased prevalence in risk-associated behaviour.
Socioeconomic status and excess morbidity		
Marmot *et al*[w69]	2020	▶ The difference in UK DFLE is 17 years between areas of low and high socioeconomic status.
Kivimäki *et al*[w70]	2020	▶ 109 246 Finnish adults aged 17–77 years were measured against 56 physical and mental health conditions. ▶ 18 of these had higher prevalence in lower socioeconomic status individuals. ▶ A cascade of inter-related health issues with an HR >5 was identified: psychiatric disorders and self-harm, which precipitated liver and renal disease, ischaemic heart disease, cerebral infarction, chronic obstructive bronchitis, lung cancer and dementia.
Dugravot *et al*[w71]	2020	▶ Socioeconomic status measured by occupation demonstrated inequalities from health to: – Multimorbidity (HR 1.54, 95% CI 1.37 to 1.73). – Frailty (HR 2.08, 95% CI 1.85 to 2.33). – Disability (HR 1.44, 95% CI 1.18 to 1.74).
Socioeconomic status and excess mortality		
Marmot *et al*[w72]	1978	▶ A steep inverse association between socioeconomic status, assessed by grade of employment, and mortality from a range of pathology.
Stringhini *et al*[w73]	2017	▶ 1.7 million individuals in 48 cohorts demonstrated that low SE status is associated with a 2.1-year reduction in life expectancy. ▶ Other risk factors accounted for the following years of life lost: – 0.5 years in excess alcohol consumption. – 0.7 years in obesity. – 1.6 years in hypertension. – 2.4 years in physical inactivity. – 3.9 years in diabetes. ▶ 4.8 years in current smokers.
Marmot *et al*[w72]	2020	▶ Life expectancy among women in the most deprived 10% of areas fell between 2010–2012 and 2016–2018.
Lewer *et al*[w74]	2020	▶ One in three premature deaths can be attributed to low socioeconomic status.

References w65–74 can be found in online supplemental file 1.
CV, cardiovascular; DFLE, disability-free life expectancy; SE, socioeconomic.

and mortality rate.[9] 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%).[14]

Following national lockdown measures, there has been a decline in rates of primary percutaneous coronary intervention procedures and increases in symptom-to-hospital and door-to-balloon time among patients with ST-elevation myocardial infarction (STEMI).[15] While this has not compromised the outcomes of treatment, it does indicate that more STEMIs could be occurring in the community. It is unlikely that these changes are due to fewer STEMIs occurring, but are more likely due to multiple factors in avoiding medical care. Be this the fear of COVID-19, misdiagnosis or the pharmacological management of symptoms.[16] Nevertheless, the incidence of out-of-hospital cardiac arrest has been strongly associated with the cumulative incidence of COVID-19.[17] During the pandemic, the greatest cause of excess CV death in care homes and hospices 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.[18] 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.[19]

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.[8] 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.[20] 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/m^2) and comorbid hypertension, chronic obstructive pulmonary disease, asthma and specific renal diseases were also associated with increased risk of COVID-19.[21] Particularly, obesity has been highlighted as a leading risk factor for worse prognosis in COVID-19.[22]

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.[23 24] Added to the additional

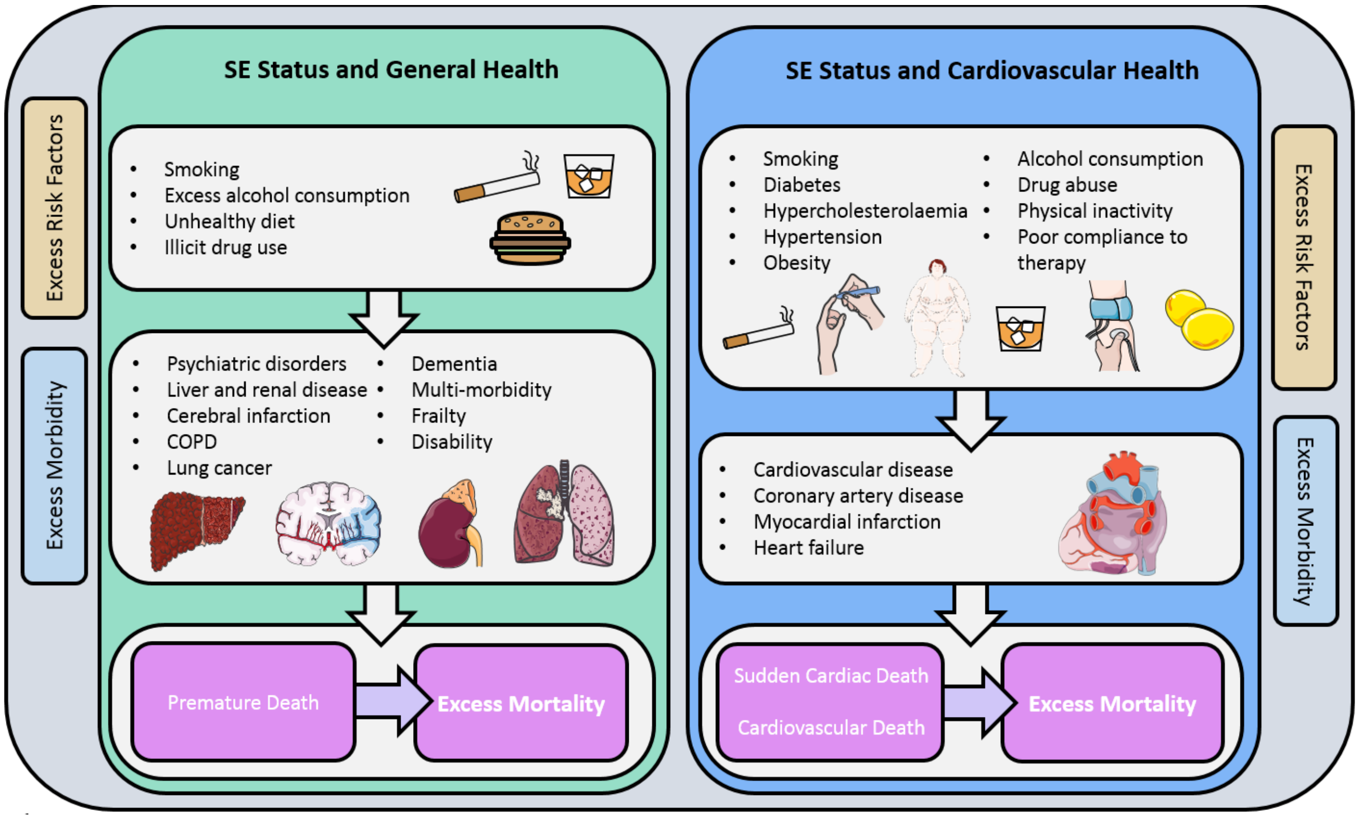

Figure 1 Effects of socioeconomic (SE) status on general and cardiovascular (CV) health. COPD, chronic obstructive pulmonary disease.

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%.[25] 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).[26]

Although acute stressors may increase CV complications, attendances to emergency departments have fallen by half since the beginning of March.[27] 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.[28]

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).[11] 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).[21] An evaluation of 48 788 individuals admitted to hospital with COVD-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%.[29]

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.[30] Crowded or poor-quality housing and occupational exposure have both been linked to COVID-19 susceptibility,[31] yet these parameters are not included in the IMD. Bangladeshi households are more likely to be multigenerational and overcrowded, with more working in front-line occupations which may increase their risk.[31] In South Asian countries, for example, populations may already be genetically at risk due to higher incidence of comorbidities such as diabetes,[32] only adding to the SE concerns. This may be further exacerbated with overcrowding and limited supplies of hand washing equipment in low and middle-income settings.[33]

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.[34] However, these factors seem inadequate to explain the total disparity observed in susceptibility to COVID-19.[35]

Table 2 Socioeconomic status and cardiovascular health

Authors	Year of publication	Findings
SE status and excess cardiovascular risk factors		
Marmot *et al*[w75]	1991	► Common cardiovascular risk factors account for no more than 40% of the difference in mortality between socioeconomic grades of employment.
Steptoe *et al*[w76]	2007	► Lower socioeconomic status is associated with: – Larger hip/waist ratio (p=0.04). – Lower high-density lipoprotein cholesterol (p<0.001). – Elevated fasting glucose (p=0.006). – Elevated HbA1c (p<0.001). – Elevated smoking rates (OR 4.41, 95% CI 1.45 to 13.5). – Elevated diabetes incidence (OR 5.93, 95% CI 1.52 to 23.2).
Palomo *et al*[w77]	2014	► Lower socioeconomic status is associated with: – Female obesity (OR 2.5, 95% CI 1.5 to 4.2). – Male obesity (OR 1.5, 95% CI 1.0 to 2.3). – Male arterial hypertension (OR 1.5, 95% CI 1.0 to 2.4). – Male hypercholesterolaemia (OR 1.5, 95% CI 1.0 to 2.2).
Floud *et al*[w78]	2016	► A cohort of 1.6 million UK women with endpoints of a first coronary event and coronary heart disease mortality yielded a social gradient for coronary heart disease risk and incidence. ► This was related to four main health factors: – Smoking. – Alcohol consumption. – Physical inactivity. – High BMI. ► Adjustment for these factors together reduced the likelihood ratio of the statistics for education and deprivation by 76% and 71%, respectively, for the first coronary heart disease event, and by 87% and 89% for coronary heart disease mortality.
SE status and excess cardiovascular morbidity		
McCartney *et al*[w79]	2015	► Only 25% of the disparity in cardiovascular disease burden between Scotland and the rest of the UK could be explained by socioeconomic factors. ► These were more likely due to differences in hospital access, ambulance services or higher case fatality rates.
Veronesi *et al*[w80]	2016	► Educational inequalities accounted for 343 and 170 additional coronary heart disease events per 100 000 person-years in the least educated males and females over a 12-year period.
Bhatnagar *et al*[w81]	2016	► Scotland has a higher cardiovascular disease burden than the rest of the UK.
Socioeconomic status and excess cardiovascular mortality		
Peters *et al*[w82]	2001	► Excess mortality from acute myocardial infarction has been observed in areas with increased concentrations of air pollutants (OR 1.48, 95% CI 1.09 to 2.20).
Huisman *et al*[w83]	2005	► From 1 million deaths between 1990 and 1997, cardiovascular disease accounted for 39% of the total mortality disparity between low and high educational groups. ► In females, this disparity reached 60%.
Stirbu *et al*[w84]	2012	► Low socioeconomic status patients in the Netherlands were less likely to receive intervention, such as percutaneous coronary intervention, when presenting with acute myocardial infarction.
Lemstra *et al*[w85]	2013	► Cardiac rehabilitation is less likely to be attended by low socioeconomic status individuals (OR 1.58, 95% CI 1.39 to 1.71).
Shah *et al*[w86]	2013	► Excess mortality from heart failure has been observed in areas with increased concentrations of air pollutants (2.12% increase, 95% CI 1.42 to 2.82).
Hajat *et al*[w87]	2013	► Levels of air pollutants tend to be higher in areas of lower socioeconomic status and could be contributing to some of the excess mortality observed.
Doll *et al*[w88]	2015	► Cardiac rehabilitation demonstrates reduced mortality after acute MI (HR 0.87, 95% CI 0.83 to 0.92).
Doerschuk *et al*[w89]	2016	► In low and middle-income countries, educational status is a better indicator to cardiovascular health than wealth.
Schultz *et al*[w90]	2018	► The cause for substandard care in low socioeconomic status individuals is unclear, but may be attributed to poor availability of quality healthcare.
Foster *et al*[w91]	2018	► The interaction between lifestyle and deprivation for all-cause and cardiovascular disease mortality was significant ($p_{interaction}$<0.0001). ► The interaction with cardiovascular disease incidence was not significant ($p_{interaction}$=0.11).
Rosengren *et al*[w92]	2019	► Low and middle-income countries possess a higher incidence and mortality from cardiovascular disease, but have less detrimental risk factor profiles.
Di Girolamo *et al*[w93]	2020	► Cardiovascular mortality is decreasing across socioeconomic boundaries. ► It is reducing at a slower rate in those of a lower socioeconomic status.

References w75–93 can be found in online supplemental file 1.
BMI, body mass index; MI, myocardial infarction; SE, socioeconomic.

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.[36] 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.[37] 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.[11] 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.[38]

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.[10] 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.[20] 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.[39]

Importantly, a recent report identified significant under-representation of BAME groups in three large-scale UK ageing studies.[40] 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.[41 42] 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).[43] 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.[44]

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.[45] 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.

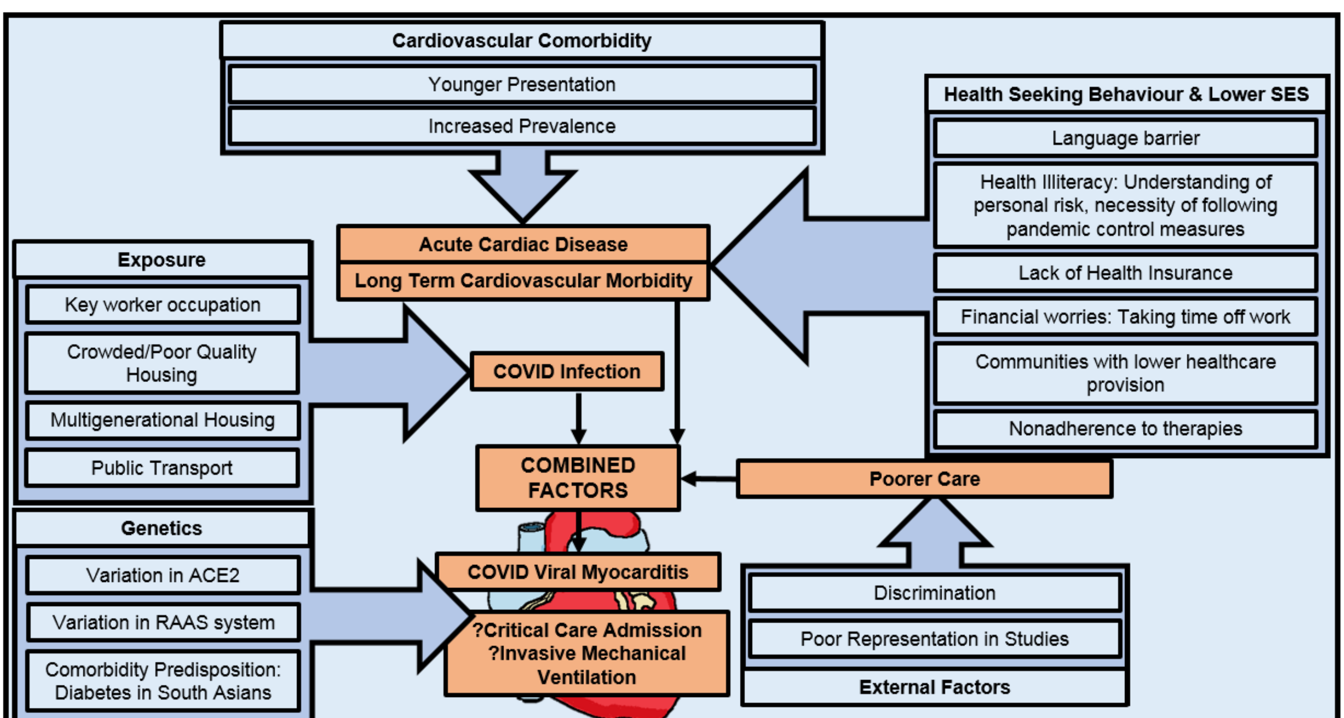

Figure 2 Predisposing factors to poor outcomes in Black, Asian and minority ethnic (BAME) group. RAAS, renin–angiotensin–aldosterone system; SES, socioeconomic status.

Table 3 A summary of interventions

Targeting jobs and socioeconomic status

1. Pay the living wage.
2. Provide financial support to businesses to ensure good working conditions.
3. Enforce thorough risk assessment on return to work.
4. Tax and benefit reforms to favour low socioeconomic status communities.

Risk factor intervention at a population level

	Policies to protect	Policies to empower
1. Tobacco usage	▶ Increases in taxation. ▶ Implementing annual increases in price. ▶ Raise legal buying age from 18 to 21.	▶ Public engagement campaigns focusing on the benefits of quitting. ▶ Signposting to smoking cessation services.
2. Poor diet	▶ Widen the taxation on sugary food and drink. ▶ Restrict price promotions on unhealthy food. ▶ Increase low-salt content food availability, restricting that of high-salt content. ▶ Implementing warning messages on foods that are high in salt. ▶ Restricting advertisement of unhealthy food.	▶ Improve availability of healthy food to less affluent families. ▶ Public engagement campaigns to raise awareness of obesity and methods to combat it.
3. Physical inactivity	▶ Shift taxation on the use of private road vehicles to favour safe public transport.	▶ Investment in attractive and safe infrastructure to encourage active commuting and outdoor activity. ▶ Safe public events and public engagement campaigns to encourage activity.
4. Alcohol usage	▶ Legislate a minimum unit price, implementing annual increases in price. ▶ Restrict maximum units per transaction. ▶ Restrict advertisement from public places and to postwatershed times.	▶ Public engagement campaigns to encourage periods of reduced alcohol consumption.
5. Air pollutants	▶ Increase zones of congestion charge. ▶ Increase carbon emission taxation.	▶ Increase availability of cleaner, more efficient fuel.

The Prospective Urban Rural Epidemiology study reported differing rates of decline in mortality from CVD between the most and the least deprived.[46] It has been proposed that on this basis, CVD could become purely a disease of the lower SE groups by the mid 2020s.[47] The most effective method could involve the ‘upstream’ approach to targeting disease prevention.[48] 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.[49] In fact, more individualised strategies could actually act to widen to 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 the detriment of low SE status.[50] Similarly, the use of polypill approaches to primary prevention of CVD in low-income populations has demonstrated promising results.[w51] However, this has recently been criticised due to not addressing the fundamental SE issues contributing to excess CVD, which, if unaddressed, may continue to adversely affect health outcomes.[w52] This is apparent in the consistent decline in US life expectancy despite an 80% increase in statin use.[w53]

Previous research has outlined interventions to target risk-associated behaviour.[w54] 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,[w55] 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.[w56] 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.[w57] 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).[w58]

Health literacy has also been considered a potential contributor to CVD risk.[w59] Individuals with poor health literacy are more likely to be non-compliant with their medications.[w60] In turn, public engagement campaigns to empower individuals to understand their health needs may improve health literacy and the concurrent CVD risk.[w61] The American Heart Association guidelines justified the use of overarching policy to reduce SE disparity in CVD.[w61] 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 behaviour.[w61]

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.[4] Guaranteeing employers are paying the living wage will reduce this poverty, improve wealth inequalities and combat food insecurity.[4] Activities such as walking, running and cycling may also be suitable in maintaining social distancing while encouraging physical activity. Underlying policy intervention and greater BAME representation in research will further enable treatment and further intervention to follow the best evidence. Alongside individualised care, community outreach, as well as strong social and economic policy in support of these communities, may reduce the disparity further in outcomes.[4]

It is important care providers are aware of SE disparities faced by patients to support best practice. As screening for disparity is not currently common practice, tools have been proposed to integrate it into patient assessment.[w62] Identifying this risk can allow appropriate interventions to be introduced, for example, community health workers have been successful in negotiating

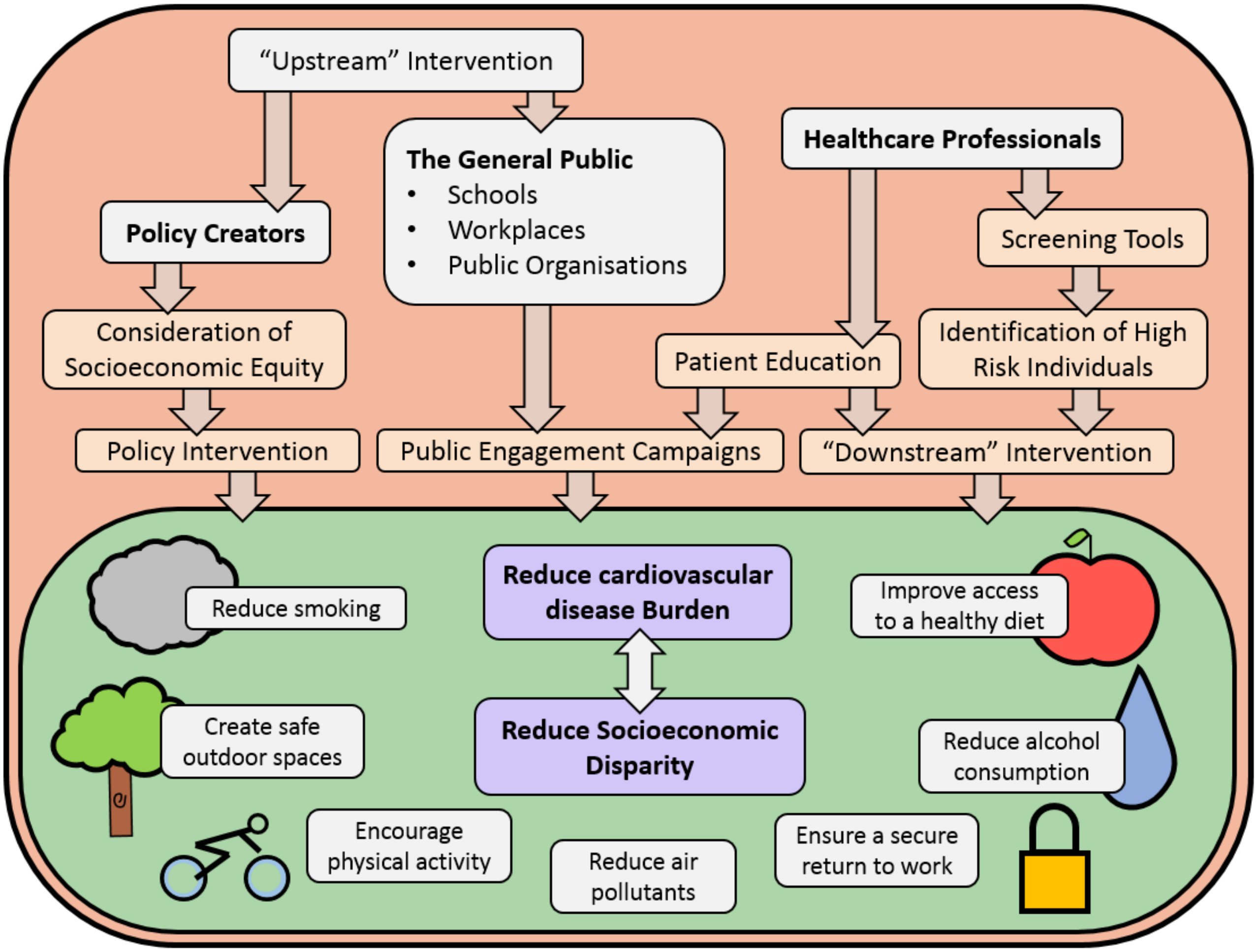

Figure 3 Potential interventions to improve well-being.

housing issues with patients, improving patient-reported quality of care and reducing hospital admission in heart failure.[w63] Between high and low SE status groups, smoking cessation services demonstrated the greatest improvement to absolute and RR in CHD.[w64] 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.

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ORCID iD
Vijay Kunadian http://orcid.org/0000-0003-2975-6971

REFERENCES

1 Naghavi M, Abajobir AA, Abbafati C, *et al*. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the global burden of disease study 2016. *Lancet* 2017;390:1151–210.
2 Stringhini S, Carmeli C, Jokela M, *et al*. Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1·7 million men and women. *Lancet* 2017;389:1229–37.
3 Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. *Health Aff* 2002;21:60–76.
4 Marmot M. Health equity in England: the Marmot review 10 years on. *BMJ* 2020;368:m693.
5 Foster HME, Celis-Morales CA, Nicholl BI, *et al*. The effect of socioeconomic deprivation on the association between an extended measurement of unhealthy lifestyle factors and health outcomes: a prospective analysis of the UK Biobank cohort. *Lancet Public Health* 2018;3:e576–85.
6 Floud S, Balkwill A, Moser K, *et al*. The role of health-related behavioural factors in accounting for inequalities in coronary heart disease risk by education and area deprivation: prospective study of 1.2 million UK women. *BMC Med* 2016;14:145.
7 Bihan H, Backholer K, Peeters A, *et al*. Socioeconomic position and premature mortality in the AusDiab cohort of Australian adults. *Am J Public Health* 2016;106:470–7.
8 Office for National Statistics. *Deaths involving COVID-19 by local area and socioeconomic deprivation: deaths occurring between 1 March and 31 may 2020*. Office for National Statistics, 2020.
9 Kang Y, Chen T, Mui D, *et al*. Cardiovascular manifestations and treatment considerations in COVID-19. *Heart*2020;106:1132–41.
10 Abuelgasim E, Saw LJ, Shirke M, *et al*. COVID-19: unique public health issues facing black, Asian and minority ethnic communities. *Curr Probl Cardiol* 2020;45:100621.
11 England PH. *Disparities in the risk and outcomes of COVID-19*. Public Health England, ed: In, 2020.
12 Kwong JC, Schwartz KL, Campitelli MA, *et al*. Acute myocardial infarction after laboratory-confirmed influenza infection. *New England Journal of Medicine* 2018;378:345–53.
13 Rowland B, Kunadian V. Challenges in the management of older patients with acute coronary syndromes in the COVID-19 pandemic. *Heart* 2020;106:1296–301.
14 Zhou F, Yu T, Du R, *et al*. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 2020;395:1054–62.
15 Kwok CS, Gale CP, Kinnaird T, *et al*. Impact of COVID-19 on percutaneous coronary intervention for ST-elevation myocardial infarction. *Heart*2020;106:1805–11.
16 Garcia S, Albaghdadi MS, Meraj PM, *et al*. Reduction in ST-segment elevation cardiac catheterization laboratory activations in the United States during COVID-19 pandemic. *J Am Coll Cardiol* 2020;75:2871–2.
17 Baldi E, Sechi GM, Mare C, *et al*. Out-of-hospital cardiac arrest during the COVID-19 outbreak in Italy. *N Engl J Med* 2020;383:496–8.
18 Wu J, Mamas MA, Mohamed MO, *et al*. Place and causes of acute cardiovascular mortality during the COVID-19 pandemic. *Heart* 2021;107:113–9.
19 Brant LCC, Nascimento BR, Teixeira RA, *et al*. Excess of cardiovascular deaths during the COVID-19 pandemic in Brazilian capital cities. *Heart* 2020;106:1898–905.
20 Rosengren A, Smyth A, Rangarajan S, *et al*. Socioeconomic status and risk of cardiovascular disease in 20 low-income, middle-income, and high-income countries: the prospective urban rural epidemiologic (pure) study. *Lancet Glob Health* 2019;7:e748–60.
21 Prats-Uribe A, Paredes R, Prieto-Alhambra D. Ethnicity, comorbidity, socioeconomic status, and their associations with COVID-19 infection in England: a cohort analysis of UK Biobank data. *medRxiv* 2020;2020.05.06.20092676.
22 Sanchis-Gomar F, Lavie CJ, Mehra MR, *et al*. Obesity and outcomes in COVID-19: when an epidemic and pandemic collide. *Mayo Clin Proc* 2020;95:1445–53.
23 Best PJM, Skelding KA, Mehran R, *et al*. SCAI consensus document on occupational radiation exposure to the pregnant cardiologist and technical personnel. *EuroIntervention* 2011;6:866–74.
24 Patel VLC, Hatheril S, Plagerson S, *et al*. *Mental disorders: equity and social determinants*. Geneva: World Health Organisation, 2010: 115–34.
25 Brooks SK, Webster RK, Smith LE, *et al*. The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *The Lancet* 2020;395:912–20.
26 Song H, Fang F, Arnberg FK, *et al*. Stress related disorders and risk of cardiovascular disease: population based, sibling controlled cohort study. *BMJ* 2019;365:l1255.
27 Public Health England. *Emergency department syndromic surveillance system*, 2020.
28 Mafham MM, Spata E, Goldacre R. COVID-19 pandemic and admission rates for and management of acute coronary syndromes in England. *The Lancet*.
29 Karaca-Mandic P, Georgiou A, Sen S. Assessment of COVID-19 hospitalizations by Race/Ethnicity in 12 states. *JAMA Intern Med* 2020. doi:10.1001/jamainternmed.2020.3857
30 GOV.UK. *People living in deprived neighbourhoods*. Ministry of Housing CaLG, 2020.
31 Platt LWR. *Are some ethnic groups more vulnerable to COVID-19 than others?* Institute for Fiscal Studies, 2020.
32 Hall LML, Moran CN, Milne GR, *et al*. Fat oxidation, fitness and skeletal muscle expression of oxidative/lipid metabolism genes in South Asians: implications for insulin resistance? *PLoS One* 2010;5:e14197.
33 Lee KK, Stelzle D, Bing R, *et al*. Global burden of atherosclerotic cardiovascular disease in people with hepatitis C virus infection: a systematic review, meta-analysis, and modelling study. *Lancet Gastroenterol Hepatol* 2019;4:794–804.
34 Carnethon MR, Pu J, Howard G, *et al*. Cardiovascular health in African Americans: a scientific statement from the American heart association. *Circulation* 2017;136:e393–423.
35 Raisi-Estabragh Z, McCracken C, Bethell MS, *et al*. Greater risk of severe COVID-19 in Black, Asian and Minority Ethnic populations is not explained by cardiometabolic, socioeconomic or behavioural factors, or by 25(OH)-vitamin D status: study of 1326 cases from the UK Biobank. *J Public Health* 2020;42:451–60.
36 Ethnicity and outcomes from COVID-19: the ISARIC CCP-UK prospective observational cohort study of hospitalised patients 2020.
37 Harrison EDA. Ethnicity and outcomes from COVID-19: the ISARIC CCP-UK prospective observational cohort study of hospitalised patients. *SSRN The Lancet Preprints* 2020.
38 Price-Haywood EG, Burton J, Fort D, *et al*. Hospitalization and mortality among black patients and white patients with Covid-19. *N Engl J Med Overseas Ed* 2020;382:2534–43.
39 Ferdinand DP, Nedunchezhian S, Ferdinand KC. Hypertension in African Americans: advances in community outreach and public health approaches. *Prog Cardiovasc Dis* 2020;63:40–5.
40 Bécares L, Kapadia D, Nazroo J. Neglect of older ethnic minority people in UK research and policy. *BMJ* 2020;368:m212.
41 Koo JR, Cook AR, Park M, *et al*. Interventions to mitigate early spread of SARS-CoV-2 in Singapore: a modelling study. *Lancet Infect Dis* 2020;20:678–88.
42 Mossong J, Hens N, Jit M, *et al*. Social contacts and mixing patterns relevant to the spread of infectious diseases. *PLoS Med* 2008;5:e74.
43 Islam N, Sharp SJ, Chowell G, *et al*. Physical distancing interventions and incidence of coronavirus disease 2019: natural experiment in 149 countries. *BMJ* 2020;370:m2743.
44 Webster RK, Brooks SK, Smith LE, *et al*. How to improve adherence with quarantine: rapid review of the evidence. *Public Health* 2020;182:163–9 https://doi.org/
45 Marmot M, Friel S, Bell R, *et al*. Closing the gap in a generation: health equity through action on the social determinants of health. *Lancet* 2008;372:1661–9.
46 Di Girolamo C, Nusselder WJ, Bopp M, *et al*. Progress in reducing inequalities in cardiovascular disease mortality in Europe. *Heart* 2020;106:40–9.
47 Leyland AH, Dundas R. Declining cardiovascular mortality masks unpalatable inequalities. *Heart* 2020;106:6–7.
48 Capewell S, Capewell A. An effectiveness hierarchy of preventive interventions: neglected paradigm or self-evident truth? *J Public Health* 2018;40:350–8.
49 de Korte-de Boer D, Kotz D, Viechtbauer W, *et al*. Effect of smoke-free legislation on the incidence of sudden circulatory arrest in the Netherlands. *Heart* 2012;98:995–9.
50 Capewell S. *Cardiovascular disease prevention in populations and effects on health inequalities*. National Institute for Clinical Excellence, 2010.

Additional references for main document

51. Wang TJ, Muñoz D, Blot WJ. Polypill for Cardiovascular Disease Prevention in an Underserved Population. Reply. N Engl J Med 2020;382(1):95. Doi: 10.1056/NEJMc1914047 [published Online First: 2019/12/26]
52. Bilal U, Cainzos-Achirica M. Polypill for Cardiovascular Disease Prevention in an Underserved Population. N Engl J Med 2020;382(1):94-95. Doi: 10.1056/NEJMc1914047 [published Online First: 2019/12/26]
53. Salami JA, Warraich H, Valero-Elizondo J, et al. National Trends in Statin Use and Expenditures in the US Adult Population From 2002 to 2013: Insights From the Medical Expenditure Panel Survey. JAMA Cardiology 2017;2(1):56-65. Doi: 10.1001/jamacardio.2016.4700
54. Marteau TM, White M, Rutter H, et al. Increasing healthy life expectancy equitably in England by 5 years by 2035: could it be achieved? The Lancet 2019;393(10191):2571-73. doi: 10.1016/S0140-6736(19)31510-7
55. Bertram M, Banatvala N, Kulikov A, et al. Using economic evidence to support policy decisions to fund interventions for non-communicable diseases. BMJ 2019;365:l1648. doi: 10.1136/bmj.l1648
56. Wakefield MA, Loken B, Hornik RC. Use of mass media campaigns to change health behaviour. Lancet 2010;376(9748):1261-71. doi: 10.1016/S0140-6736(10)60809-4
57. Matson-Koffman DM, Brownstein JN, Neiner JA, et al. A site-specific literature review of policy and environmental interventions that promote physical activity and nutrition for cardiovascular health: what works? Am J Health Promot 2005;19(3):167-93. Doi: 10.4278/0890-1171-19.3.167 [published Online First: 2005/02/08]
58. Pearson-Stuttard J, Bandosz P, Rehm CD, et al. Comparing effectiveness of mass media campaigns with price reductions targeting fruit and vegetable intake on US cardiovascular disease mortality and race disparities. Am J Clin Nutr 2017;106(1):199-206. doi: 10.3945/ajcn.116.143925 [published Online First: 2017/06/02]
59. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic Status and Cardiovascular Outcomes. Circulation 2018;137(20):2166-78. Doi: doi:10.1161/CIRCULATIONAHA.117.029652
60. Zhang NJ, Terry A, McHorney CA. Impact of health literacy on medication adherence: a systematic review and meta-analysis. Ann Pharmacother 2014;48(6):741-51. Doi: 10.1177/1060028014526562 [published Online First: 2014/03/13]
61. Pearson TA, Palaniappan LP, Artinian NT, et al. American Heart Association Guide for Improving Cardiovascular Health at the Community Level, 2013 Update. Circulation 2013;127(16):1730-53. doi: doi:10.1161/CIR.0b013e31828f8a94
62. White-Williams C, Rossi LP, Bittner VA, et al. Addressing Social Determinants of Health in the Care of Patients With Heart Failure: A Scientific Statement From the American Heart Association. Circulation 2020;141(22):e841-e63. doi:10.1161/CIR.0000000000000767
63. Kangovi S, Mitra N, Norton L, et al. Effect of Community Health Worker Support on Clinical Outcomes of Low-Income Patients Across Primary Care Facilities: A Randomized Clinical Trial. JAMA Internal Medicine 2018;178(12):1635-43. Doi: 10.1001/jamainternmed.2018.4630
64. Kivimäki M, Shipley MJ, Ferrie JE, et al. Best-practice interventions to reduce socioeconomic inequalities of coronary heart disease mortality in UK: a prospective

occupational cohort study. The Lancet 2008;372(9650):1648-54. doi: 10.1016/S0140-6736(08)61688-8

Table References

65. Dam RMv, Li T, Spiegelman D, et al. Combined impact of lifestyle factors on mortality: prospective cohort study in US women. BMJ 2008;337:a1440.
66. Meader N, King K, Moe-Byrne T, et al. A systematic review on the clustering and cooccurrence of multiple risk behaviours. BMC Public Health 2016;16:657.
67. Hall W. Socioeconomic status and susceptibility to alcohol-related harm. The Lancet Public Health 2017;2:e250-e1.
68. Iacobucci G. Socioeconomic status should be seen alongside smoking as mortality risk, say experts. BMJ 2019;364:l1450.
69. Michael Marmot JA, Tammy Boyce, Peter Goldblatt, Joana Morrison. Health Equity in England: The Marmot Review 10 Years On. The Health Foundation 2020.
70. Kivimäki M, Batty GD, Pentti J, et al. Association between socioeconomic status and the development of mental and physical health conditions in adulthood: a multi-cohort study. The Lancet Public Health 2020;5:e140-e9.
71. Dugravot A, Fayosse A, Dumurgier J, et al. Social inequalities in multimorbidity, frailty, disability, and transitions to mortality: a 24-year follow-up of the Whitehall II Cohort study. The Lancet Public Health 2020;5:e42-e50.
72. Marmot MG, Rose G, Shipley M, et al. Employment grade and coronary heart disease in British civil servants. Journal of epidemiology and community health 1978;32:244-9.
73. Stringhini S, Carmeli C, Jokela M, et al. Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1·7 million men and women. Lancet 2017;389:1229-37.
74. Lewer D, Jayatunga W, Aldridge RW, et al. Premature mortality attributable to socioeconomic inequality in England between 2003 and 2018: an observational study. Lancet Public Health 2020;5:e33-e41.
75. Marmot MG, Smith GD, Stansfeld S, et al. Health inequalities among British civil servants: the Whitehall II study. Lancet 1991;337:1387-93.
76. Steptoe A, Shamaei-Tousi A, Gylfe Å, et al. Socioeconomic status, pathogen burden and cardiovascular disease risk. Heart 2007;93:1567.
77. Palomo L, Félix-Redondo F-J, Lozano-Mera L, et al. Cardiovascular risk factors, lifestyle, and social determinants: a cross-sectional population study. British Journal of General Practice 2014;64:e627.
78. Floud S, Balkwill A, Moser K, et al. The role of health-related behavioural factors in accounting for inequalities in coronary heart disease risk by education and area deprivation: prospective study of 1.2 million UK women. BMC Med 2016;14:145-.
79. McCartney G, Russ TC, Walsh D, et al. Explaining the excess mortality in Scotland compared with England: pooling of 18 cohort studies. Journal of epidemiology and community health 2015;69:20-7.
80. Veronesi G, Ferrario MM, Kuulasmaa K, et al. Educational class inequalities in the incidence of coronary heart disease in Europe. Heart 2016;102:958.
81. Bhatnagar P, Wickramasinghe K, Wilkins E, et al. Trends in the epidemiology of cardiovascular disease in the UK. Heart 2016;102:1945.
82. Peters A, Dockery DW, Muller JE, et al. Increased Particulate Air Pollution and the

Triggering of Myocardial Infarction. Circulation 2001;103:2810-5.
83. Huisman M, Kunst AE, Bopp M, et al. Educational inequalities in cause-specific mortality in middle-aged and older men and women in eight western European# populations. The Lancet 2005;365:493-500.
84. Stirbu I, Looman C, Nijhof GJ, et al. Income inequalities in case death of ischaemic heart disease in the Netherlands: a national record-linked study. Journal of Epidemiology and Community Health 2012;66:1159.
85. Lemstra ME, Alsabbagh W, Rajakumar RJ, et al. Neighbourhood income and cardiac rehabilitation access as determinants of nonattendance and noncompletion. Can J Cardiol 2013;29:1599-603.
86. Shah ASV, Langrish JP, Nair H, et al. Global association of air pollution and heart failure: a systematic review and meta-analysis. The Lancet 2013;382:1039-48.
87. Hajat A, Diez-Roux AV, Adar SD, et al. Air pollution and individual and neighborhood socioeconomic status: evidence from the Multi-Ethnic Study of Atherosclerosis (MESA). Environ Health Perspect 2013;121:1325-33.
88. Doll JA, Hellkamp A, Thomas L, et al. Effectiveness of cardiac rehabilitation among older patients after acute myocardial infarction. Am Heart J 2015;170:855-64.
89. Doerschuk P, Bahrim C, Daniel J, et al. Closing the Gaps and Filling the STEM Pipeline: A Multidisciplinary Approach. Journal of Science Education and Technology 2016;25.
90. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic Status and Cardiovascular Outcomes. Circulation 2018;137:2166-78.
91. Foster HME, Celis-Morales CA, Nicholl BI, et al. The effect of socioeconomic deprivation on the association between an extended measurement of unhealthy lifestyle factors and health outcomes: a prospective analysis of the UK Biobank cohort. The Lancet Public Health 2018;3:e576-e85.
92. Rosengren A, Smyth A, Rangarajan S, et al. Socioeconomic status and risk of cardiovascular disease in 20 low-income, middle-income, and high-income countries: the Prospective Urban Rural Epidemiologic (PURE) study. The Lancet Global Health 2019;7:e748-e60.
93. Di Girolamo C, Nusselder WJ, Bopp M, et al. Progress in reducing inequalities in cardiovascular disease mortality in Europe. Heart 2020;106:40.