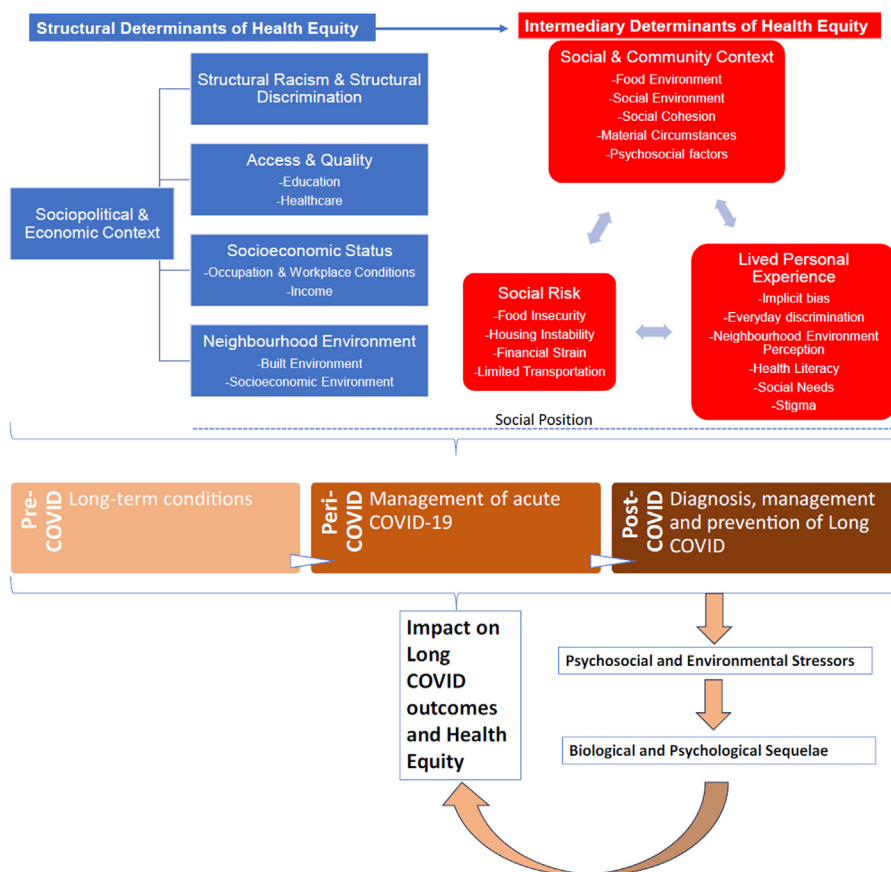


Review

Disparities by Social Determinants of Health: Links Between Long COVID and Cardiovascular Disease

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Long COVID has been defined by the World Health Organisation as “continuation or development of new symptoms 3 months after the initial SARS-CoV-2 infection, with these symptoms lasting for at least 2 months with no other explanation.” Cardiovascular disease is implicated as a risk factor, concomitant condition, and consequence of long COVID. As well as heterogeneity in definition, presentation, and likely underlying pathophysiology of long COVID, disparities by social determinants of health, extensively studied and described in cardiovas-

RÉSUMÉ

La COVID longue a été définie par l'Organisation mondiale de la Santé comme “la persistance ou l'apparition de nouveaux symptômes trois mois après l'infection initiale par le SRAS-CoV-2, ces symptômes durant au moins deux mois sans autre explication”. Les maladies cardiovasculaires sont considérées comme facteur de risque, condition concomitante et conséquence de la COVID longue. Outre l'hétérogénéité de la définition, de la présentation et de la pathophysiologie sous-jacente plausible de la COVID longue, des disparités

cular disease, have been observed in 3 ways. First, underlying long-term conditions, such as cardiovascular disease and its risk factors, are associated with incidence and severity of long COVID, and previously described socioeconomic disparities in these factors are important in exacerbating disparities in long COVID. Second, socioeconomic disparities in management of COVID-19 may themselves lead to distal disparities in long COVID. Third, there are socioeconomic disparities in the way that long COVID is diagnosed, managed, and prevented. Together, factors such as age, sex, deprivation, and ethnicity have far-reaching implications in this new postviral syndrome across its management spectrum. There are similarities and differences compared with disparities for cardiovascular disease. Some of these disparities are in fact, inequalities, that is, rather than simply observed variations, they represent injustices with costs to individuals, communities, and economies. This review of current literature considers opportunities to prevent or at least attenuate these socioeconomic disparities in long COVID and cardiovascular disease, with special challenges for research, clinical practice, public health, and policy in a new disease which is evolving.

selon les déterminants sociaux de la santé, largement étudiés et décrits dans le domaine des maladies cardiovasculaires, ont été observées de trois manières. Premièrement, les affections longue durée sous-jacentes, telles que les maladies cardiovasculaires et leurs facteurs de risque, sont associées à l'incidence et à la sévérité de la COVID longue, et les disparités socioéconomiques précédemment décrites concernant ces facteurs sont importantes dans l'exacerbation des disparités de la COVID longue. Deuxièmement, les disparités socioéconomiques dans la prise en charge de la COVID-19 peuvent elles-mêmes conduire à des disparités ultérieures dans la COVID longue. Troisièmement, il existe des disparités socioéconomiques dans la manière dont la COVID longue est diagnostiquée, prise en charge et prévenue. Ensemble, des facteurs tels que l'âge, le sexe, les privations et l'origine ethnique ont des implications considérables dans ce nouveau syndrome post-infection virale et ce, sur l'ensemble de son spectre de prise en charge. Il existe des similitudes et des différences par rapport aux disparités observées dans les maladies cardiovasculaires. Certaines de ces disparités sont en fait des inégalités, c'est-à-dire qu'au-delà de simples variations observées, elles représentent des injustices qui ont un coût pour les individus, les communautés et les milieux économiques. Cette revue de la littérature actuelle examine les possibilités de prévenir ou au moins d'atténuer ces disparités socioéconomiques dans la COVID longue et les maladies cardiovasculaires, en mettant l'accent sur les défis particuliers pour la recherche, la pratique clinique, la santé publique et les politiques face à une nouvelle maladie en évolution.

Social determinants of health have been implicated in the causal pathways for the majority of disease processes.^{1,2} Up to 45% of individuals surviving COVID-19, regardless of hospitalisation status, experience a range of unresolved post-COVID symptoms at 4 months.³ Long COVID is defined by the World Health Organisation as “continuation or development of new symptoms 3 months after the initial SARS-CoV-2 infection, with these symptoms lasting for at least 2 months with no other explanation.”⁴ Cardiovascular disease (CVD) and other long-term conditions are relevant to COVID-19 and long COVID as risk factors, comorbidities, and sequelae.⁵ Social determinants of health are the economic, social, environmental, and psychosocial factors that influence health.⁶ Disparities in social determinants of health are well documented for CVD¹ and long-term conditions.⁷ For example, a long-term longitudinal UK study investigated cardiometabolic factors, including body mass index and fasting glucose, in 8312 men and women across the life course. It found that in children and younger adults, health predicted occupational status and social mobility (the “health-related selection hypothesis”), whereas in midlife, occupational status contributed to socioeconomic differences in cardiometabolic health (the “social causation hypothesis”).⁸ Moreover, recent

analyses suggest that 35.6% of premature deaths in the UK from 2005 to 2018 (equating to 877,082 deaths) were attributable to socioeconomic inequality; 17.3% of those deaths were attributable to ischemic heart disease as the greatest contributor,⁹ and international consensus policy statements have included social determinants of health and CVD to address global inequalities.^{10,11}

There is significant heterogeneity in long COVID, including by 1) initial course of COVID-19 illness, for example, hospitalised vs nonhospitalised, 2) symptoms such as breathlessness, 3) organ impairment and resulting diseases, and 4) duration of illness. This variation has contributed to difficulties in definitions of disease, outcomes for trials and observational research, and metrics for effective care. Despite this heterogeneity and complexity, socioeconomic disparities are being increasingly recognised in long COVID,^{12,13} and links with CVD and existing knowledge of social determinants of health may inform research, public health, and policy. Although consensus recommendations are lacking, there are several ways to investigate disparities in social determinants of health, including health equity-based methodologies.¹ In the framework proposed by Powell-Wiley in relation to CVD, structural and intermediary determinants are the 2 major domains of social determinants of health. Underpinning the structural determinants is the sociopolitical and economic context (eg, legislation and economic policies), defining “access to, and the quality of, health care and education, socioeconomic status, or neighbourhood environment, as well as exposure to structural racism and discrimination.”¹ These structural, higher-level determinants affect intermediary determinants, including “social and community context

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(ie, food environment, social environment, and psychosocial factors), which ultimately defines social risk through housing instability, food insecurity, financial strain, or limited transportation”¹ (Fig. 1). These adverse social determinants of health create long-term psychosocial and environmental stresses, which in turn, influence biology and psychology of vulnerable groups, affecting risk factors, and promoting disparities in disease outcomes.

The focus of the present review is disparities and inequalities in social determinants of health for long COVID, links with CVD, and how they may be mitigated or prevented (Fig. 1). I will use the constructs from the Powell-Wiley framework to assess evidence from longitudinal studies linking to disparities for 1) CVD and underlying long-term conditions and their risk factors, 2) management of COVID-19, and 3) diagnosis, management, and prevention of long COVID, as described in the following sections and in Table 1. This framework helps to define knowledge gaps, understand biological pathways between and risk of long COVID, and design interventions targeting social determinants of health at individual, community, and policy levels.¹

CVD and Underlying Long-Term Conditions

It is clear that CVD and long-term conditions have influenced direct, indirect, and long-term effects of COVID-19 as risk factors, comorbidities, and sequelae.⁵ Since the earliest reports from Wuhan and the early first wave of the pandemic, the role of age and underlying long-term conditions led to risk stratification of individuals whether when considering acute care, social isolation policies, or vaccination strategies.⁵³ These underlying factors have themselves demonstrated disparities across social determinants of health, which may affect the pathophysiology, epidemiology, and care of long COVID. For example, the Prospective Urban and Rural Epidemiology study (PURE) study has shown wealth-related inequalities in hypertension awareness, treatment, and control across 21 countries, with wider inequalities in poorer than in richer countries, leading to recommendations for hypertension strategies tailored to national contexts.⁵⁶ Increasingly, multiple long-term conditions exist together, and there are known inequalities, eg, nonwhite ethnic groups have higher risk of having multiple long-term conditions than their white counterparts.⁷ The prevalence of multimorbidity is higher in older age, female sex, and lower socioeconomic status groups, but also varies depending on the definition of multimorbidity, eg, number of conditions or mental vs physical health long-term conditions.⁵⁷ Although there are major disparities in the volume and resource for long-term condition research in low- and middle-income countries, there is strong evidence that long-term conditions and multimorbidity are a major burden in low- and middle-income settings.⁵⁸ The evidence for CVD and cardiovascular (CV) risk factors has been reviewed by Powell-Wiley et al¹ and is adapted in Table 1.

Structural racism and discrimination

Race and ethnicity are closely related but distinct terms. Race is a social construct, grouping of people based on physical characteristics such as skin colour. Ethnicity is broader than race and is shared history and culture of people in a specific

geographic region, including language, heritage, and religion. Structural racism, “the role of the structures (laws, policies, institutional practices, and entrenched norms) that are the systems’ scaffolding” in discrimination, may contribute to health disparities associated with CVD, its risk factors, and other long-term conditions⁵⁹⁻⁶¹ and often has a long history and context which need to be considered. For example, in the United States, racial segregation of housing traces its history back to the policy of “redlining,” a racialized zoning practice that blocked fair access to home loans during the 1930s and is associated with incident CVD and long-term conditions.^{1,14,15,62} Segregation occurred in many other countries, whether occupational diseases linked to earlier policies, such as apartheid in South Africa,⁶³ megatrends in urban change with “suburbanisation of poverty,” and poverty-related diseases,⁶⁴ or a country’s history regarding slavery and colonialism.^{65,66} Structural racial inequalities have led to increasing calls for “decolonised” approaches to long-term conditions.⁶⁷ Other forms of structural discrimination, including age, sex, and socioeconomic status, have been linked with long-term conditions across countries.⁶⁸⁻⁷⁰ These disparities in CVD and long-term conditions may indirectly exacerbate inequalities for long COVID. However, data for CVD and its risk factors often lack specificity for ethnicity, making it difficult to monitor and intervene in these inequalities and highlighting a research gap also relevant to long COVID.⁷¹

Socioeconomic status

Socioeconomic status includes income level, educational attainment, employment status, and environmental factors.⁷² Associations, mostly positive, between low socioeconomic status and incidence, recurrence, progression, and severity of CVD and long-term conditions, including cancers and chronic kidney disease (CKD), have been investigated and described.⁷²⁻⁷⁴ However, these associations are likely to vary by disease, country, context, and age. Long-term impact of socioeconomic status over the life course is shown by relationships between childhood socioeconomic status and long-term conditions.^{73,75} The UK’s Whitehall Study has provided various insights to understand the complexities of these associations. As well as the “health-related selection” and “social causation” hypotheses (discussed above), suggesting bidirectionality of the relationship between socioeconomic differences and health,⁸ it highlighted that “socioeconomic status affects the risk of multimorbidity, frailty, and disability, but does not affect the risk of mortality after the onset of these adverse health conditions.” Therefore, primary prevention is crucial to reduce social inequalities in mortality, and multimorbidity had the strongest association with mortality and is also a priority target for interventions.⁷⁶ Health care access is a significant determinant of health outcomes in long-term conditions, particularly for more vulnerable or high-risk, such as homeless, populations.^{77,78} Access to education is also a major factor in long-term conditions as well as multimorbidity.^{79,80} These proximal social inequalities may lead to inequalities in long COVID and its care (Fig. 1).

Neighbourhood and food environments

Neighbourhood built environment describes the design of the area where an individual resides. It affects lifestyle through

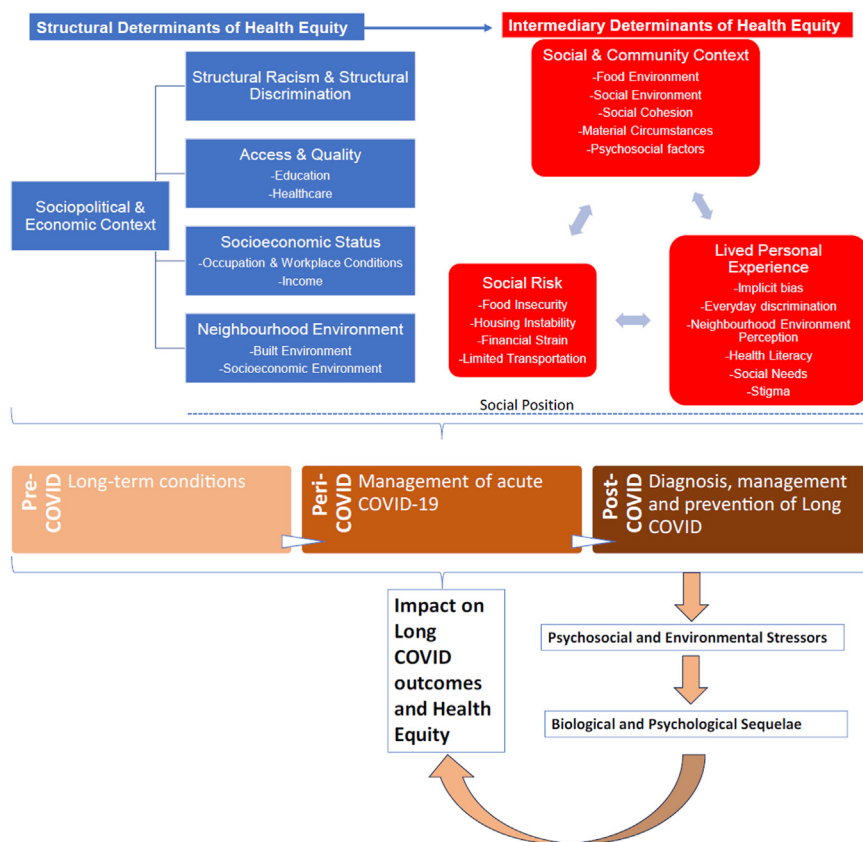


Figure 1. A critical framework for social determinants of health in long COVID. Structural and intermediary social determinants of health can act at pre-COVID, peri-COVID, and post-COVID levels to influence social inequalities in long COVID. Adapted from Powell-Wiley et al.¹ under Creative Commons Attribution 4.0 International (CC BY 4.0 DEED) license.

factors such as “walkability” that are associated with onset, progression, and outcomes of long-term conditions and risk factors, such as CVD, type 2 diabetes, hypertension, and increased body mass index.^{18,19} Neighbourhood social environment is often approximated by country-specific neighbourhood deprivation indices and has been associated with both incident heart failure and CKD.^{22,23} Perceived neighbourhood social environment, including factors such as cohesion, violence, physical disorder, and perceived safety have associations with a range of long-term conditions from hypertension to diabetes.^{25,26} The food environment includes “food access, the ability to acquire food, or food security, which is assured availability of nutritionally adequate foods acquired in socially acceptable ways,” which influences dietary behaviours and CVD risk factors.¹ Poor food availability measures have been linked with long-term conditions from obesity to colorectal cancer.^{29,30}

Psychosocial factors

There are a range of psychosocial factors associated with development and progression of long-term conditions. Chronic psychological stress is a risk factor for CV death in individuals with established coronary heart disease and for progression of CKD.^{32,33} Subjective social status has been associated with CV death and depression.^{36,37} Strain during employment (“job strain”) was associated with incident CV

death in individuals with existing CVD or diabetes,⁴⁰ and with hospitalisations or deaths from type 2 diabetes, coronary heart disease, stroke, cancer, asthma, chronic obstructive pulmonary disease (COPD), heart failure, and dementia.⁴¹ Adverse childhood experiences are linked with type 2 diabetes,⁴⁴ harmful alcohol use, smoking, illicit drug use, high body mass index, depression, cancer, CVD, stroke, and COPD.⁴⁵ Incidence of long-term conditions, including CVD, COPD, CKD, diabetes, stroke, cancer, and arthritis,⁴⁹ myocardial infarction, and death due to coronary heart disease⁴⁸ has been associated with depression. Perceived discrimination and loneliness are also risk factors for long-term conditions, including CVD, CKD, and depression.^{20,50-52} Interestingly, people with adverse childhood experiences or obesity had higher levels of psychologic stress during the first year of the pandemic in a Canadian study,⁸¹ suggesting that there are associations between both cardiometabolic factors and psychosocial factors predating the pandemic and inequalities during the pandemic.

Management of COVID-19

There are several steps from SARS-CoV-2 infection through to long COVID, and presentation and management of COVID-19 have emerged as stages with important disparities by ethnicity, age, sex, socioeconomic factors, and other social determinants of health in multiple studies in

Table 1. Environmental determinants and psychological factors of long COVID: evidence from longitudinal studies

Construct	CVD and CV risk factors ¹		Other long-term conditions		Management of COVID-19		Diagnosis, management, and prevention of long COVID	
	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome
Environmental determinants								
Neighbourhood-level racial and ethnic residential segregation	Gi* statistic	Incident CVD and CHD ¹⁴	Redlining† of neighbourhoods	Preterm births, gunshot-related injuries, cancer, asthma, self-rated health, multiple health outcomes, heat-related outcomes ¹⁵	Ethnicity, household composition (eg, multigenerational)	COVID-19 mortality ¹⁶	Ethnicity, religious affiliation, deprivation, educational attainment, geography, living conditions, country of birth, language skills, and health status	COVID-19 vaccination uptake ¹⁷
Neighbourhood built environment	Neighbourhood walkability (objective measures)	Incidence of type 2 diabetes, hypertension, and increased BMI ¹⁸	Neighbourhood walkability (objective measures)	Incident COPD ¹⁹	Neighbourhood walkability (objective measures)	COVID-19 hospitalisation ²⁰	Urban/rural settings	COVID-19 vaccine hesitancy ²¹
Neighbourhood socioeconomic status	Neighbourhood deprivation index	Incident heart failure ²²	Area of residence by postcode, ranked by corresponding British IMD score	Severity of incident CKD ²³	Ethnicity and socioeconomic deprivation	COVID-19 mortality and severity ²⁰	British IMD score	Incident long COVID ²⁴
Neighbourhood social environment	Individual-level perceived safety	Blood pressure ²⁵	Individual-level perceived safety	Prevalence of depressive symptoms ²⁶	Trust in neighbours, norm of reciprocity in the neighbourhood, neighbourhood ties, and social participation	COVID-19 mortality ²⁷	Burglary rate, aggravated assault rate	23 long COVID symptoms and conditions ²⁸
Food environment	Perceived healthy food availability scale	BMI ²⁹	Food availability and environment (objective measures)	Incidence and mortality of colorectal cancer ³⁰	NEMS-S in 62 stores	COVID-19 cases and mortality ³¹	Food access (objective measure)	23 long COVID symptoms and conditions ²⁸
Psychosocial factors								
Chronic psychologic stress	30-question version of the General Health Questionnaire	Incident CV death in patients with stable CHD ³²	History of stress-related disorder	Risk of CKD progression or acute kidney injury ³³	Perceived stress	COVID-19 incidence and hospitalisation ³⁴	Psychosomatic symptom burden (by Somatic Symptom Disorder—B Criteria Scale)	Incident long COVID ³⁵
Subjective social status	Reversed ladder score	Incident CV death ³⁶	Macarthur scale of subjective social status	Incident depression ³⁷	Social well-being scale	Risk of COVID-19 ³⁸	Subjective social status	Long COVID incidence ³⁹

Continued

Table 1. Continued.

Construct	CVD and CV risk factors ¹		Other long-term conditions		Management of COVID-19		Diagnosis, management, and prevention of long COVID	
	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome	Measure used	Related risk factor/ outcome
Job strain	Job content and demand-control questionnaires	Incident CV death with existing cardiometabolic disease ⁴⁰	Job strain and effort-reward imbalance according to job exposure matrices	Incident hospitalisations or deaths from type 2 diabetes, CHD, stroke, cancer, asthma, COPD, heart failure, and dementia ⁴¹	Unemployment rate, poverty rate	COVID-19 incidence ⁴²	Maslach Burnout Inventory score	Prevalence of long COVID ⁴³
ACEs	Whitehall II cohort study ACE assessment	Incident type II diabetes ⁴⁴	ACEs	Harmful alcohol use, smoking, illicit drug use, high BMI, depression, cancer, type 2 diabetes, CVD, stroke, and COPD ⁴⁵	ACEs	COVID-19 incidence and hospitalisation ⁴⁶	ACEs	COVID-19 vaccination hesitancy ⁴⁷
Depression	Clinical diagnosis for unipolar depression, or depressive mood measured by standardized psychometric tools	Incidence of MI or death due to CHD ⁴⁸	Depression	Incident long-term conditions including CVD, COPD, CKD, diabetes, stroke, cancer, and arthritis ⁴⁹	Depression	COVID-19 incidence and hospitalisation ³⁴	Depression	Incident long COVID ³⁵
Perceived discrimination	Lifetime discrimination scale	Incident CVD events ⁵⁰	Perceived racial and gender discrimination	Reduced kidney function according to eGFR ⁴⁷	Perceived discrimination	COVID-19 severity ⁵¹	Perceived discrimination	Prevalent long COVID ⁵¹
Loneliness and social isolation	Loneliness measured by a direct single-item question and a UCLA 3-Item Loneliness Scale	Incident CVD ⁵²	Living alone and loneliness by survey	Self-reported depression, severe mental illness ⁵³	Loneliness	COVID-19 and hospitalisation ³⁴	Loneliness	Incident long COVID ⁵⁴

ACE, adverse childhood experience; BMI, body mass index; CHD, coronary heart disease; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; CV, cardiovascular; CVD, cardiovascular disease; eGFR, estimated glomerular filtration rate; IMD, Index of Multiple Deprivation; MI, myocardial infarction; NEMS-S, Nutrition Environment Measures Surveys—Stores; UCLA, University of California Los Angeles.

* The extent to which racial/ethnic composition of an area deviates from mean racial/ethnic composition of surrounding area.

[†] Redlining was a racialized zoning practice in the US that blocked fair access to home loans during the 1930s.

multiple countries.⁸²⁻⁸⁷ These variations contribute in turn to disparities in social determinants of health for long COVID. Although the impact of COVID-19 has been far more than mortality, even that metric shows geographic and socioeconomic inequalities,⁸⁸ which are likely to be involved in many dimensions of COVID-19's direct and indirect effects, as well as from diagnosis through to care delivery.

Structural racism and discrimination

Inequalities by ethnicity were among the first to be noted across countries during the COVID-19 pandemic, such that ethnic minorities had higher risk of infection, hospitalisation, intensive care admission, and mortality.⁸⁹ A systematic analysis included 123 studies that investigated the underlying causes of these ethnic inequalities by comorbidities (n = 78), socioeconomic inequalities (n = 67), particularly neighbourhood infrastructure (n = 38) and occupational risk (n = 28), barriers to health care (n = 6), and consequences of infection control measures (n = 10). Only 11% of the 123 eligible studies theorised racism to be a driver of inequalities, which therefore limits the research that is available to study the impact of racism on COVID-19.⁹⁰ There is evidence that ethnicity interacts with neighbourhood-level factors from socioeconomic status to overcrowding, and that these factors are associated with higher COVID-19 mortality.⁸⁶ Racism and other forms of discrimination are associated with less trust in health systems and less likelihood of engagement with COVID-19-related health services.^{16,91} Globally, racism has manifested in many ways during the pandemic, highlighting the need to “decolonise” COVID-19 and future pandemic threats.⁹²

Socioeconomic status

Strong associations have been shown between socioeconomic status and poverty and COVID-19 care and outcomes.^{16,90} Low educational attainment⁹³ and poor access to health care²⁰ are also indicators of poor-quality COVID-19 care and higher hospitalisation and mortality rates. The impact of socioeconomic status is related to multiple factors, such as ethnicity, housing, overcrowding, and education. For example, there was a positive association between COVID-19 mortality and living in a multigenerational household in the UK. However, this association was greatly attenuated by adjusting for individual- and household-level characteristics (including age, geographic factors, socioeconomic characteristics, and measures of pre-pandemic health), and adjustment for socioeconomic factors had the strongest effect.⁸⁶

Neighbourhood and food environments

A poorly built environment at the neighbourhood level (eg, in terms of walkability) and deprivation are positively correlated with COVID-19 severity and mortality.²⁰ A poor social environment, in terms of trust in neighbours, norms of reciprocity in the neighbourhood, neighbourhood ties, and social participation, has been associated with worse COVID-19 care and outcomes.⁹⁴ The same is true for food insecurity.²⁷

Psychosocial factors

Chronic stress, low subjective social status, and job strain have been linked with higher risk of COVID-19.^{31,34,38,54} Adverse childhood experiences, depression, perceived discrimination, and loneliness are also relevant to COVID-19 severity and persistent post-COVID symptoms, ie, long COVID.^{38,42,51} There is evidence of worsening mental health during the pandemic from children and younger people⁴⁶ to older adults,⁹⁵ with differences by other social determinants of health, which may be related to long COVID as both a risk factor and an outcome.

Diagnosis, Management, and Prevention of Long COVID

Disparities and inequalities in long COVID have been described across the spectrum from prevention to diagnosis to treatment, in terms of both epidemiologic and health economic methods.^{24,96,97} Socioeconomic inequalities can interact with each other and with other inequalities to affect long COVID incidence and outcomes. For example, in a large population-based cohort study from April 2020 to January 31, 2022, in the UK, individuals in the most deprived decile had higher risk of long COVID compared with the least deprived decile.⁹⁶

Structural racism and discrimination

As well as ethnicity-related disparities in long COVID, there is stigmatisation of individuals with long COVID.⁹⁸ The structural barriers faced by those with long COVID are also along the lines of other demographic characteristics such as socioeconomic status, age, and sex. COVID-19 vaccination is the best evidence-based preventative measure for long COVID to date, and there is greater hesitancy in ethnic minority groups.⁹⁹

Socioeconomic status

COVID-19 vaccination and reducing risk of SARS-CoV-2 infection are the best ways to reduce risk of long COVID. Low access to education is associated with greater COVID-19 vaccination hesitancy,⁹⁹ and the same applies to access to health care across countries.¹⁷ Moreover, individuals with low socioeconomic status and low education are less likely to be aware of long COVID symptoms or to have good access to health care and social support and are more likely to face difficulty returning to work.¹⁰⁰⁻¹⁰² At a more global scale, research in long COVID has neglected low- and middle-income countries, and even in higher income settings it has not focused on more vulnerable populations.¹²

Neighbourhood and food environments

The urban-rural context and neighbourhood deprivation are important factors in reduced COVID-19 vaccination uptake.^{99,103} Compared with urban settings, rural communities may have reduced access to health professionals and health care infrastructure for chronic diseases,^{21,104,105} which may, in turn, hamper the diagnosis, management, and prevention of long COVID. COVID-19 vaccination hesitancy has been shown to be more pronounced in the Canadian context,¹⁰⁶ whereas the opposite appears to be true in

China.¹⁰⁷ The reasons for differences in barriers and facilitators to vaccination uptake are key factors in preventing and reducing the impact of long COVID.

Food availability and markers of the neighbourhood social environment such as burglary rate and aggravated assault rate have been associated with long COVID.¹⁰⁸ Neighbourhood and food environments may interact with other social determinants of health and with risk factors and diseases, leading to inequalities in long COVID presentation, care, and outcomes. An example is the relation between high neighbourhood cohesion and higher rates of physical activity during the pandemic.¹⁰⁹

Psychosocial factors

Similarly to their associations with long-term conditions and COVID-19, chronic stress, subjective social status, and job strain are also associated with increased risk of long COVID.^{28,35,110} Adverse childhood experiences are also linked with higher vaccine hesitancy.³⁹ There is increased risk of long COVID associated with depression, perceived discrimination, loneliness and social isolation.^{28,31,51}

Moving Toward Practical Research and Interventions

Taken together, the evidence base points toward a role for social determinants of health at multiple levels to increase disparities in long COVID presentation and care. Biological and pathophysiologic mechanisms have been postulated to explain the role of social determinants in CVD, including oxidative stress, immune dysfunction, atherosclerosis, and thrombosis.¹ Similar mechanisms are likely to be important in the development of inequalities in long COVID but are beyond the scope of this review. Some of these disparities, whether at the level of the individual's psychologic and physical well-being, neighbourhood, or health system, are present in underlying long-term conditions and in the epidemiology and health care pertaining to COVID-19 management overall. It is important that existing frameworks for social determinants of health are used to enable comparisons and validity of the emerging research base in long COVID rather than developing new frameworks. Future research should pay greater attention to the interplay between factors, such as psychosocial factors, structural discrimination, and neighbourhood environment, to better understand the relative roles of these factors in creating disparities. This evidence could, in turn, be used to inform the prioritisation of interventions to tackle inequalities in social determinants of health. Similarly, future research in long COVID health inequalities should attempt to investigate how much of reported inequalities can be explained by inequalities in long-term conditions and COVID-19 care. This type of methodology has previously been used in studying the impact of social determinants of health on mortality.⁹ Finally, the need and provenance of mixed-methods research in social determinants of health have been previously noted in order to increase the likelihood of actionable findings.¹

Over several decades, a growing body of scientific evidence has shown the important role of social determinants of health in all areas of human health and disease. There is clear evidence that similar disparities have been manifested throughout

the pandemic and in its "long tail," represented by the millions of people affected by long COVID. At the very least, whether long COVID or long-term conditions, the integration of health policies and considerations in development and implementation of policies in other sectors, including but not restricted to finance, housing, and education, should be prioritised by governments. This will help to ensure that disparities are not further widened during pandemics and their aftermath. The monitoring of social determinants of health and linkage with processes and outcomes in health and social care are essential for evaluation of interventions in a timely manner in both research and policy.^{43,86} Integration of social determinants of health in clinical care is challenged by the complexity of social determinants of health, lack of standardisation of definitions of individual social determinants (eg, socioeconomic status and neighbourhood environment), and lack of generalisability and transferability of electronic health record data within and across countries. However, "perfection should not be the enemy of action" and there are major opportunities for linkage of administrative data in many countries (eg, income, residential data, and occupation) and electronic health records to bring these factors to the forefront of monitoring and intervention in healthcare delivery and planning.

Conclusion

Long COVID, like long-term conditions and the acute phase of the COVID-19 pandemic before it, have highlighted numerous deep-seated social inequalities, acting at individual, community, population, and international levels. There is enough research to make the strong case for integration of health policy and care, integrated with other policy sectors, and this will yield benefits far beyond CVD and long COVID. It is now time to act on this research to reduce the predictable and preventable inequalities during and after pandemics through timely monitoring and intervention.

Patient Consent

The author confirms that patient consent is not applicable to this article because it is a review that has not undertaken any new data analysis or considered patient-level data.

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The author has no conflicts of interest to disclose.

References

1. Powell-Wiley TM, Baumer Y, Baah FO, et al. Social determinants of cardiovascular disease. *Circ Res* 2022;130:782-99.
2. Marmot M. Social determinants of health inequalities. *Lancet*. 365(9464):1099-1104.
3. O'Mahoney LL, Routen A, Gillies C, et al. The prevalence and long-term health effects of long COVID among hospitalised and

- nonhospitalised populations: a systematic review and meta-analysis. *EClinicalMedicine* 2023;55:101762.
4. Davis HE, McCorkell L, Vogel JM, Topol EJ. Long COVID: major findings, mechanisms and recommendations. *Nat Rev Microbiol* 2023;21:133-46.
 5. Mohamed MO, Banerjee A. Long COVID and cardiovascular disease: a learning health system approach. *Nat Rev Cardiol* 2022;19:287-8.
 6. Momtazmanesh S, Moghaddam SS, Ghamari SH, et al. Global burden of chronic respiratory diseases and risk factors 1990-2019: an update from the Global Burden of Disease Study 2019. *EClinicalMedicine* 2023;59:101936.
 7. Hayanga B, Stafford M, Bécarea L. Ethnic inequalities in multiple long-term health conditions in the United Kingdom: a systematic review and narrative synthesis. *BMC Public Health* 2023;23:178.
 8. Elovainio M, Ferrie JE, Singh-Manoux A, et al. Socioeconomic differences in cardiometabolic factors: social causation or health-related selection? Evidence from the Whitehall II cohort study 1991-2004. *Am J Epidemiol* 2011;174:779-89.
 9. 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:e33-41.
 10. Marmot M, Allen J, Bell R, Bloomer E, Goldblatt P. WHO European review of social determinants of health and the health divide. *Lancet* 2012;380(9846):1011-29.
 11. Braveman P, Gottlieb L. The social determinants of health: it's time to consider the causes of the causes. *Public Health Rep* 2014;129(1 suppl 2):19-31.
 12. Taghrir MH, Akbarialiabad H, Abdollahi A, et al. Inequity and disparities mar existing global research evidence on long COVID. *Glob Health Promot* 2023;30:63-7.
 13. Hossain MM, Das J, Rahman F, et al. Living with "long COVID": a systematic review and meta-synthesis of qualitative evidence. *PLoS One* 2023;18:e0281884.
 14. Kershaw KN, Osypuk TL, Do DP, de Chavez PJ, Diez Roux AV. Neighborhood-level racial/ethnic residential segregation and incident cardiovascular disease. *Circulation* 2015;131:141-8.
 15. Lee EK, Donley G, Ciesielski TH, et al. Health outcomes in redlined versus nonredlined neighborhoods: a systematic review and meta-analysis. *Soc Sci Med* 2022;294:114696.
 16. Paul E, Fancourt D, Razai M. Racial discrimination, low trust in the health system and COVID-19 vaccine uptake: a longitudinal observational study of 633 UK adults from ethnic minority groups. *J R Soc Med* 2022;115:439-47.
 17. Arsenaault C, Lewis TP, Kapoor NR, et al. Health system quality and COVID-19 vaccination: a cross-sectional analysis in 14 countries. *Lancet Glob Health* 2024;12:e156-65.
 18. Chandrabose M, Rachele JN, Gunn L, et al. Built environment and cardio-metabolic health: systematic review and meta-analysis of longitudinal studies. *Obes Rev* 2019;20:41-54.
 19. Wu Y, Shen P, Yang Z, et al. Association of walkability and fine particulate matter with chronic obstructive pulmonary disease: a cohort study in China. *Sci Total Environ* 2023;858:159780.
 20. Magesh S, John D, Li WT, et al. Disparities in COVID-19 outcomes by race, ethnicity, and socioeconomic status. *JAMA Netw Open* 2021;4:e2134147.
 21. Berini CR, Bonilha HS, Simpson AN. Impact of community health workers on access to care for rural populations in the United States: a systematic review. *J Community Health* 2022;47:539-53.
 22. Akwo EA, Kabagambe EK, Harrell FE, et al. Neighborhood deprivation predicts heart failure risk in a low-income population of blacks and whites in the southeastern United States. *Circ Cardiovasc Qual Outcomes* 2018;11:e004052.
 23. Bello AK, Peters J, Rigby J, Rahman AA, El Nahas M. Socioeconomic status and chronic kidney disease at presentation to a renal service in the United Kingdom. *Clin J Am Soc Nephrol* 2008;3:1316-23.
 24. Gandjour A. Long COVID: costs for the German economy and health care and pension system. *BMC Health Serv Res* 2023;23:641.
 25. Mayne SL, Moore KA, Powell-Wiley TM, et al. Longitudinal associations of neighborhood crime and perceived safety with blood pressure: the Multi-Ethnic Study of Atherosclerosis (MESA). *Am J Hypertens* 2018;31:1024-32.
 26. Muhammad T, Thakkar S, Balachandran A. Understanding depression in older Indians using diathesis-stress framework: the role of neighborhood safety and physical and functional health. *Int J Geriatr Psychiatry* 2023;38:e5961.
 27. Dombrowski RD, Hill AB, Bode B, et al. Assessing the influence of food insecurity and retail environments as a proxy for structural racism on the COVID-19 pandemic in an urban setting. *Nutrients* 2022;14:2130.
 28. Milde C, Glombiewski JA, Wilhelm M, Schemer L. Psychological factors predict higher odds and impairment of post-COVID symptoms: a prospective study. *Psychosom Med* 2023;85:479-87.
 29. Barrientos-Gutierrez T, Moore KAB, Auchincloss AH, et al. Neighborhood physical environment and changes in body mass index: results from the Multi-Ethnic Study of Atherosclerosis. *Am J Epidemiol* 2017;186:1237-45.
 30. Masdor NA, Mohammed Nawi A, Hod R, et al. The link between food environment and colorectal cancer: a systematic review. *Nutrients* 2022;14:3954.
 31. Wang S, Quan L, Chavarro JE, et al. Associations of depression, anxiety, worry, perceived stress, and loneliness prior to infection with risk of post-COVID-19 conditions. *JAMA Psychiatry* 2022;79:1081.
 32. Stewart RAH, Colquhoun DM, Marschner SL, et al. Persistent psychological distress and mortality in patients with stable coronary artery disease. *Heart* 2017;103:1860-6.
 33. Su G, Song H, Lanka V, et al. Stress related disorders and the risk of kidney disease. *Kidney Int Rep* 2021;6:706-15.
 34. Dioun S, Chen L, Hillyer G, et al. Association between neighborhood socioeconomic status, built environment and SARS-CoV-2 infection among cancer patients treated at a tertiary cancer center in New York City. *Cancer Rep* 2023;6:e1714.
 35. Selvaskandan H, Nimmo A, Savino M, et al. Burnout and long COVID among the UK nephrology workforce: results from a national survey investigating the impact of COVID-19 on working lives. *Clin Kidney J* 2022;15:517-26.
 36. Demakakos P, Biddulph JP, de Oliveira C, Tsakos G, Marmot MG. Subjective social status and mortality: the English Longitudinal Study of Ageing. *Eur J Epidemiol* 2018;33:729-39.
 37. Madigan A, Daly M. Socioeconomic status and depressive symptoms and suicidality: the role of subjective social status. *J Affect Disord* 2023;326:36-43.

38. Wang S, Quan L, Ding M, et al. Depression, worry, and loneliness are associated with subsequent risk of hospitalisation for COVID-19: a prospective study. *Psychol Med* 2023;53:4022-31.
39. Bellis MA, Hughes K, Ford K, et al. Associations between adverse childhood experiences, attitudes towards COVID-19 restrictions and vaccine hesitancy: a cross-sectional study. *BMJ Open* 2022;12:e053915.
40. Kivimäki M, Pentti J, Ferrie JE, et al. Work stress and risk of death in men and women with and without cardiometabolic disease: a multi-cohort study. *Lancet Diabetes Endocrinol* 2018;6:705-13.
41. Sørensen JK, Framke E, Pedersen J, et al. Work stress and loss of years lived without chronic disease: an 18-year follow-up of 1.5 million employees in Denmark. *Eur J Epidemiol* 2022;37:389-400.
42. Hanson JL, O'Connor K, Adkins DJ, Kahhale I. Childhood adversity and COVID-19 outcomes in the UK Biobank. *jech-2023-221147*. *J Epidemiol Community Health* (1978) 2023.
43. Thygesen JH, Tomlinson C, Hollings S, et al. COVID-19 trajectories among 57 million adults in England: a cohort study using electronic health records. *Lancet Digit Health* 2022;4:e542-57.
44. Deschênes SS, Graham E, Kivimäki M, Schmitz N. Adverse childhood experiences and the risk of diabetes: examining the roles of depressive symptoms and cardiometabolic dysregulations in the Whitehall II cohort study. *Diabetes Care* 2018;41:2120-6.
45. Hughes K, Ford K, Bellis MA, et al. Health and financial costs of adverse childhood experiences in 28 European countries: a systematic review and meta-analysis. *Lancet Public Health* 2021;6:e848-57.
46. Panagi L, White SR, Pinto Pereira SM, et al. Mental health in the COVID-19 pandemic: a longitudinal analysis of the CLoCk cohort study. *PLoS Med* 2024;21:e1004315.
47. Beydoun MA, Poggi-Burke A, Zonderman AB, et al. Perceived discrimination and longitudinal change in kidney function among urban adults. *Psychosom Med* 2017;79:824-34.
48. Wu Q, Kling JM. Depression and the risk of myocardial infarction and coronary death. *Medicine* 2016;95:e2815.
49. Bobo WV, Grossardt BR, Virani S, et al. Association of depression and anxiety with the accumulation of chronic conditions. *JAMA Netw Open* 2022;5:e229817.
50. Everson-Rose SA, Lutsey PL, Roetker NS, et al. Perceived discrimination and incident cardiovascular events. *Am J Epidemiol* 2015;182:225-34.
51. Thomason ME, Hendrix CL, Werchan D, Brito NH. Perceived discrimination as a modifier of health, disease, and medicine: empirical data from the COVID-19 pandemic. *Transl Psychiatry* 2022;12:284.
52. Valtorta NK, Kanaan M, Gilbody S, Hanratty B. Loneliness, social isolation and risk of cardiovascular disease in the English Longitudinal Study of Ageing. *Eur J Prev Cardiol* 2018;25:1387-96.
53. McElroy E, Herrett E, Patel K, et al. Living alone and mental health: parallel analyses in UK longitudinal population surveys and electronic health records prior to and during the COVID-19 pandemic. *BMJ Mental Health* 2023;26:e300842.
54. Kashefi F, Bakhtiari A, Gholinia H, Bakouei F, Faramarzi M. Subjective well-being predicts COVID-19 risk in the elderly: a case-control study. *BMC Geriatr* 2022;22:887.
55. Banerjee A, Pasea L, Harris S, et al. Estimating excess 1-year mortality associated with the COVID-19 pandemic according to underlying conditions and age: a population-based cohort study. *Lancet* 2020;395(10238):1715-25.
56. Palafox B, McKee M, Balabanova D, et al. Wealth and cardiovascular health: a cross-sectional study of wealth-related inequalities in the awareness, treatment and control of hypertension in high-, middle- and low-income countries. *Int J Equity Health* 2016;15:199.
57. MacRae C, Mercer SW, Henderson D, et al. Age, sex, and socioeconomic differences in multimorbidity measured in four ways: UK primary care cross-sectional analysis. *Br J Gen Pract* 2023;73(729):e249-56.
58. Kaluvu L, Asogwa OA, Marzà-Florensa A, et al. Multimorbidity of communicable and noncommunicable diseases in low- and middle-income countries: a systematic review. *J Multimorb Comorb* 2022;12:263355652211125.
59. Williams DR, Lawrence JA, Davis BA. Racism and health: evidence and needed research. *Annu Rev Public Health* 2019;40:105-25.
60. Anglin DM. Racism and social determinants of psychosis. *Annu Rev Clin Psychol* 2023;19:277-302.
61. Pichardo MS, Ferrucci LM, Molina Y, Esserman DA, Irwin ML. Structural racism, lifestyle behaviors, and obesity-related cancers among Black and Hispanic/Latino Adults in the United States: a narrative review. *Cancer Epidemiol Biomarkers Prev* 2023;32:1498-507.
62. Bailey ZD, Feldman JM, Bassett MT. How structural racism works—racist policies as a root cause of U.S. racial health inequities. *N Engl J Med* 2021;384:768-73.
63. Stuckler D, Steele S, Lurie M, Basu S. Introduction: “dying for gold”: the effects of mineral mining on HIV, tuberculosis, silicosis, and occupational diseases in Southern Africa. *Int J Health Serv* 2013;43:639-49.
64. van Ham M, Uesugi M, Tammaru T, Manley D, Janssen H. Changing occupational structures and residential segregation in New York, London and Tokyo. *Nat Hum Behav* 2020;4:1124-34.
65. Ahmad WIU, Bradby H. Locating ethnicity and health: exploring concepts and contexts. *Sociol Health Illn* 2007;29:795-810.
66. Stelkia K. Structural racism as an ecosystem: an exploratory study on how structural racism influences chronic disease and health and well-being of First Nations in Canada. *Int J Environ Res Public Health* 2023;20:5851.
67. Gatwiri K, Rotumah D, Rix E. BlackLivesMatter in healthcare: racism and implications for health inequity among Aboriginal and Torres Strait Islander Peoples in Australia. *Int J Environ Res Public Health* 2021;18:4399.
68. Chandola T, Mikkilineni S, Chandran A, et al. Is socioeconomic segregation of the poor associated with higher premature mortality under the age of 60? A cross-sectional analysis of survey data in major Indian cities. *BMJ Open* 2018;8:e018885.
69. Chang ES, Kanno S, Levy S, et al. Global reach of ageism on older persons' health: A systematic review. *PLoS One* 2020;15:e0220857.
70. García GG, Iyengar A, Kaze F, et al. Sex and gender differences in chronic kidney disease and access to care around the globe. *Semin Nephrol* 2022;42:101-13.
71. Ali MR, Nacer H, Lawson CA, Khunti K. Racial and ethnic disparities in primary prevention of cardiovascular disease [e-pub ahead of print]. *Can J Cardiol*. doi:10.1016/j.cjca.2024.01.028.
72. Schultz WM, Kelli HM, Lisko JC, et al. Socioeconomic status and cardiovascular outcomes. *Circulation* 2018;137:2166-78.

73. Lu W, Zheng F, Li Z, et al. Association between environmental and socioeconomic risk factors and hepatocellular carcinoma: a meta-analysis. *Front Public Health* 2022;10:741490.
74. Tannor EK, Chika OU, Okpechi IG. The impact of low socioeconomic status on progression of chronic kidney disease in low- and lower middle-income countries. *Semin Nephrol* 2022;42:151338.
75. Appleton AA, Holdsworth E, Ryan M, Tracy M. Measuring childhood adversity in life course cardiovascular research: a systematic review. *Psychosom Med* 2017;79:434-40.
76. 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. *Lancet Public Health* 2020;5:e42-50.
77. Bark P, Ramasawmy M, Hayward A, et al. Integrated approach to cardiovascular disease in people experiencing homelessness: a qualitative study. *Open Heart* 2023;10:e002235.
78. Al-Shakarchi NJ, Evans H, Luchenski SA, Story A, Banerjee A. Cardiovascular disease in homeless versus housed individuals: a systematic review of observational and interventional studies. *Heart* 2020;106:1483-8.
79. Boillot A, El Halabi B, Batty GD, et al. Education as a predictor of chronic periodontitis: a systematic review with meta-analysis population-based studies. *PLoS One* 2011;6:e21508.
80. Tazzeo C, Zucchelli A, Vetrano DL, et al. Risk factors for multimorbidity in adulthood: a systematic review. *Ageing Res Rev* 2023;91:102039.
81. de Rubeis V, Gonzalez A, de Groh M, et al. Obesity and adverse childhood experiences in relation to stress during the COVID-19 pandemic: an analysis of the Canadian Longitudinal Study on Aging. *Int J Obes* 2023.
82. Ponjoan A, Jacques-Aviñó C, Medina-Perucha L, et al. Axes of social inequities in COVID-19 clinical trials: a systematic review. *Front Public Health* 2023;11.
83. Ernst M, Niederer D, Werner AM, et al. Loneliness before and during the COVID-19 pandemic: a systematic review with meta-analysis. *Am Psychol* 2022;77:660-77.
84. Bajoulvand R, Hashemi S, Askari E, et al. Post-pandemic stress of COVID-19 among high-risk groups: a systematic review and meta-analysis. *J Affect Disord* 2022;319:638-45.
85. Soltan MA, Crowley LE, Melville CR, et al. To what extent do social determinants of health modulate presentation, ITU admission and outcomes among patients with SARS-COV-2 infection? An exploration of household overcrowding, air pollution, housing quality, ethnicity, comorbidities and frailty. *J Infect Dis Ther* 2021;9(suppl 2):1000002.
86. Nafilyan V, Islam N, Ayoubkhani D, et al. Ethnicity, household composition and COVID-19 mortality: a national linked data study. *J R Soc Med* 2021;114:182-211.
87. Packard SE, Susser E. Association of long COVID with housing insecurity in the United States 2022-2023. *SSM Popul Health* 2024;25:101586.
88. Kontopantelis E, Mamas MA, Deanfield J, Asaria M, Doran T. Excess mortality in England and Wales during the first wave of the COVID-19 pandemic. *J Epidemiol Community Health* (1978) 2021;75:213-23.
89. Irizar P, Pan D, Kapadia D, et al. Ethnic inequalities in COVID-19 infection, hospitalisation, intensive care admission, and death: a global systematic review and meta-analysis of over 200 million study participants. *EClinicalMedicine* 2023;57:101877.
90. Irizar P, Kapadia D, Amele S, et al. Pathways to ethnic inequalities in COVID-19 health outcomes in the United Kingdom: a systematic map. *Soc Sci Med* 2023;329:116044.
91. Qutami M, Hamdan Y. COVID-19 and gender inequality: a critique of the working woman's struggle. *Heliyon* 2023;9:e21852.
92. *Lancet Global Health: Decolonising COVID-19. Lancet Glob Health* 2020;8:e612.
93. Khanijahani A, Iezadi S, Gholipour K, Azami-Aghdash S, Naghibi D. A systematic review of racial/ethnic and socioeconomic disparities in COVID-19. *Int J Equity Health* 2021;20:248.
94. Murayama H, Nakamoto I, Tabuchi T. Social capital and COVID-19 deaths: an ecological analysis in Japan. *Int J Environ Res Public Health* 2021;18:10982.
95. Zaninotto P, Iob E, Demakakos P, Steptoe A. Immediate and longer-term changes in the mental health and well-being of older adults in England during the COVID-19 pandemic. *JAMA Psychiatry* 2022;79:151.
96. Shabnam S, Razieh C, Dambha-Miller H, et al. Socioeconomic inequalities of long COVID: a retrospective population-based cohort study in the United Kingdom. *J R Soc Med* 2023;116:263-73.
97. Cohen J, van der Meulen Rodgers Y. An intersectional analysis of long COVID prevalence. *Int J Equity Health* 2023;22:261.
98. Pantelic M, Ziauddeen N, Boyes M, et al. Long COVID stigma: estimating burden and validating scale in a UK-based sample. *PLoS One* 2022;17:e0277317.
99. Gaughan CH, Razieh C, Khunti K, et al. COVID-19 vaccination uptake amongst ethnic minority communities in England: a linked study exploring the drivers of differential vaccination rates. *J Public Health (Bangkok)* 2023;45:e65-74.
100. Heller O, Chun Y, Shapira S, et al. Prevalence of long-COVID among low-income and marginalized groups: evidence from Israel. *Int J Public Health* 2022;67.
101. Schiavi M, Fugazzaro S, Bertolini A, et al. "Like before, but not exactly": the Qualy-REACT qualitative inquiry into the lived experience of long COVID. *BMC Public Health* 2022;22:599.
102. Lukkahatai N, Rodney T, Ling C, Daniel B, Han HR. Long COVID in the context of social determinants of health. *Front Public Health* 2023;11:1098443.
103. Chen L, Li Z, Lu X, et al. Changes in COVID-19 vaccine hesitancy at different times among residents in Guangzhou, China. *Front Public Health* 2023;11:1164475.
104. Brundisini F, Giacomini M, DeJean D, et al. Chronic disease patients' experiences with accessing health care in rural and remote areas: a systematic review and qualitative meta-synthesis. *Ont Health Technol Assess Ser* 2013;13:1-33.
105. Vakil K, Dese TA, Manias E, et al. Patient-centered care experiences of first-generation, South Asian migrants with chronic diseases living in high-income, Western countries: systematic review. *Patient Prefer Adherence* 2023;17:281-98.
106. Yassi A, Barker S, Lockhart K, et al. Urban-rural divide in COVID-19 infection and vaccination rates in healthcare workers in British Columbia, Canada. *Can J Rural Med* 2023;28:47.
107. Wu J, Shen Z, Li Q, et al. How urban versus rural residency relates to COVID-19 vaccine hesitancy: a large-scale national Chinese study. *Soc Sci Med* 2023;320:115695.

108. Zhang Y, Hu H, Fokaidis V, et al. Identifying environmental risk factors for post-acute sequelae of SARS-CoV-2 infection: an EHR-based cohort study from the recover program. *Environ Adv* 2023;11:100352.
109. Hailey V, Bloomberg M, Hamer M, Fisher A. Association between neighbourhood cohesion and physical activity trajectories during the COVID-19 pandemic using data from Understanding Society: the UK Household Longitudinal Study & COVID-19 sub-study. *Prev Med Rep* 2023;35:102392.
110. Griffith LE, Beauchamp M, McMillan J, et al. Persistent COVID-19 symptoms in community-living older adults from the Canadian Longitudinal Study on Aging (CLSA). *Commun Med* 2023;3:36.