Review

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

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ABSTRACT

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-
Social determinants of health have been implicated in the causal pathways for the majority of disease processes. Up to 45% of individuals surviving COVID-19, regardless of hospitalisation status, experience a range of unresolved post-COVID symptoms at 4 months. 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." Cardiovascular disease (CVD) and other long-term conditions are relevant to COVID-19 and long COVID as risk factors, comorbidities, and sequelae. Social determinants of health are the economic, social, environmental, and psychosocial factors that influence health. Disparities in social determinants of health are well documented for CVD and long-term conditions. 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"). 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, and international consensus policy statements have included social determinants of health and CVD to address global inequalities.

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, 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. 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." These structural, higher-level determinants affect intermediary determinants, including "social and community context.
(ie, food environment, social environment, and psychosocial factors), which ultimately defines social risk through housing instability, food insecurity, financial strain, or limited transportation. 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. 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.

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. 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 considering acute care, social isolation policies, or vaccination strategies. 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. 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. 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. 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. The evidence for CVD and cardiovascular (CV) risk factors has been reviewed by Powell-Wiley et al 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 conditions 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. Segregation occurred in many other countries, whether occupational diseases linked to earlier policies, such as apartheid in South Africa, megatrends in urban change with “suburbanisation of poverty,” and poverty-related diseases, or a country’s history regarding slavery and colonialism. Structural racial inequalities have led to increasing calls for “decolonised” approaches to long-term conditions. Other forms of structural discrimination, including age, sex, and socioeconomic status, have been linked with long-term conditions across countries. 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.

Socioeconomic status

Socioeconomic status includes income level, educational attainment, employment status, and environmental factors. 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. 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. 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, 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. 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. Access to education is also a major factor in long-term conditions as well as multimorbidity. These proximal social inequalities may lead to inequalities in long COVID and its care.

Neighbourhood and food environments

Neighbourhood built environment describes the design of the area where an individual resides. It affects lifestyle through...
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. Neighbourhood social environment is often approximated by country-specific neighbourhood deprivation indices and has been associated with both incident heart failure and CKD. 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. 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. Poor food availability measures have been linked with long-term conditions from obesity to colorectal cancer.

Psychosocial factors

There are a range of psychosocial factors associated with development and progression of long-term conditions. Chronic psychologic stress is a risk factor for CV death in individuals with established coronary heart disease and for progression of CKD. Subjective social status has been associated with CV death and depression. Strain during employment (“job strain”) was associated with incident CV death in individuals with existing CVD or diabetes, and with hospitalisations or deaths from type 2 diabetes, coronary heart disease, stroke, cancer, asthma, chronic obstructive pulmonary disease (COPD), heart failure, and dementia. Adverse childhood experiences are linked with type 2 diabetes, harmful alcohol use, smoking, illicit drug use, high body mass index, depression, cancer, CVD, stroke, and COPD. Incidence of long-term conditions, including CVD, COPD, CKD, diabetes, stroke, cancer, and arthritis, has been associated with depression. Perceived discrimination and loneliness are also risk factors for long-term conditions, including CVD, CKD, and depression. 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 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

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. under Creative Commons Attribution 4.0 International (CC BY 4.0 DEED) license.
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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.

¹ Redlining was a racialized zoning practice in the US that blocked fair access to home loans during the 1930s.
multiple countries. 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, 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. 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. 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. 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. Globally, racism has manifested in many ways during the pandemic, highlighting the need to “decolonise” COVID-19 and future pandemic threats.

**Socioeconomic status**

Strong associations have been shown between socioeconomic status and poverty and COVID-19 care and outcomes. Low educational attainment and poor access to health care 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.

**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. 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. The same is true for food insecurity.

**Psychosocial factors**

Chronic stress, low subjective social status, and job strain have been linked with higher risk of COVID-19. Adverse childhood experiences, depression, perceived discrimination, and loneliness are also relevant to COVID-19 severity and persistent post-COVID symptoms, i.e., long COVID. There is evidence of worsening mental health during the pandemic from children and younger people to older adults, 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. 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.

**Structural racism and discrimination**

As well as ethnicity-related disparities in long COVID, there is stigmatisation of individuals with long COVID. 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.

**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, and the same applies to access to health care across countries. 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. 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.

**Neighbourhood and food environments**

The urban-rural context and neighbourhood deprivation are important factors in reduced COVID-19 vaccination uptake. Compared with urban settings, rural communities may have reduced access to health professionals and health care infrastructure for chronic diseases, 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, whereas the opposite appears to be true in
thrombosis. Similar mechanisms are likely to be important in oxidative stress, immune dysfunction, atherosclerosis, and explain the role of social determinants in CVD, including and pathophysiologic mechanisms have been postulated to disparities 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.

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. Adverse childhood experiences are also linked with higher vaccine hesitancy. There is increased risk of long COVID associated with depression, perceived discrimination, loneliness and social isolation.

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. 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. 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.

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. 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.

Ethics Statement

As a review article, this manuscript did not require ethical approval.

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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Disclosures

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