

**CONTEMPORARY REVIEW**

# COVID-19, Social Determinants of Health, and Opportunities for Preventing Cardiovascular Disease: A Conceptual Framework

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**ABSTRACT:** The COVID-19 pandemic has disrupted the social, economic, and health care systems in the United States and shined a spotlight on the burden of disease associated with social determinants of health (SDOH). Addressing SDOH, while a challenge, provides important opportunities to mitigate cardiovascular disease incidence, morbidity, and mortality. We present a conceptual framework to examine the differential effects of the COVID-19 pandemic on SDOH across demographically diverse populations, focusing on the short- and long-term development of cardiovascular disease, as well as future research opportunities for cardiovascular disease prevention. The COVID-19 pandemic exerted negative shifts in SDOH and cardiovascular risk factors (ie, smoking, body mass index, physical activity, dietary behavior, cholesterol, blood pressure, and blood sugar). For example, evidence suggests that unemployment and food insecurity have increased, whereas health care access and income have decreased; changes to SDOH have resulted in increases in loneliness and processed food consumption, as well as decreases in physical activity and hypertension management. We found that policy measures enacted to mitigate economic, social, and health issues inadequately protected populations. Low-income and racial and ethnic minority communities, historically underserved populations, were not only disproportionately adversely affected by the pandemic but also less likely to receive assistance, likely attributable in part to the deep structural inequities pervasive in our society. Effective and culturally appropriate interventions are needed to mitigate the negative health impacts of historical systems, policies, and programs that created and maintain structural racism, especially for immigrants, racial and ethnic minorities, and populations experiencing social disadvantage.

**Key Words:** cardiovascular disease ■ COVID-19 pandemic ■ health disparities ■ social determinants of health

**C**ardiovascular disease (CVD) remains a leading threat to the American public and, in particular, racial or ethnic minority populations—including Black, Hispanic/Latinx, Asian American, Native Hawaiian and Pacific Islander, American Indian/Alaskan Native, low-income groups, and other groups experiencing disadvantage.<sup>1</sup> Mounting evidence suggests that CVD risk factors (eg, overweight, obesity, diabetes) and conditions (eg, coronary heart disease, myocardial infarction, stroke), which are more prevalent

among racial and ethnic minorities and low-income populations, heighten risk for COVID-19 disease severity.<sup>2</sup> Equally important, the pandemic itself and strategies developed to address the pandemic have resulted in a dramatic shift in many fundamental social determinants of health (SDOH) in the United States, including food and housing security, employment, dietary and sedentary behaviors, as well as physical activity, and will have untold effects on future CVD burden. However, less attention to date has focused on long-term effects

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## Nonstandard Abbreviations and Acronyms

<b>ARP</b>	American Rescue Plan
<b>CARES</b>	Coronavirus Aid, Relief, and Economic Security Act
<b>EIPs</b>	Economic Impact Payments
<b>FFCRA</b>	Families First Coronavirus Response Act
<b>SDOH</b>	social determinants of health
<b>SNAP</b>	Supplemental Nutrition Assistance Program

of COVID-19 on incident CVD risk factors and related CVD conditions.

The American Heart Association asserted in 2015 that addressing SDOH provides the greatest opportunities for reducing morbidity and mortality related to CVD.<sup>3</sup> In addition, the American Heart Association developed the Life's Simple Seven tool to help improve cardiovascular health through lifestyle behavior change.<sup>4</sup> Achieving optimal levels of the 7 risk factors (ie, smoking, body mass index, physical activity, diet, total cholesterol, blood pressure, and fasting blood glucose) identified in the tool can prevent CVD, and are associated with a lower incidence of coronary heart disease, myocardial infarction, and stroke, as well as reduced inpatient stay for cardiac and other related health events.<sup>4</sup>

The COVID-19 pandemic and concurrent events in 2020 have resulted in fundamental shifts to structural-level influences as well as individual lifestyle behaviors and habits of the American public. The gap between the lived experiences of lower-income populations and racial and ethnic minority communities—including Black, Hispanic/Latinx, Asian American, Native Hawaiian and Pacific Islander, and American Indian/Alaskan Native populations—versus higher-income groups and White individuals, was significant before the pandemic and has likely widened during the pandemic.<sup>5</sup> Determining the differential effects of the pandemic responses on SDOH and health behaviors is critical to understanding the potential cardiovascular health impacts and developing appropriate mitigation strategies.

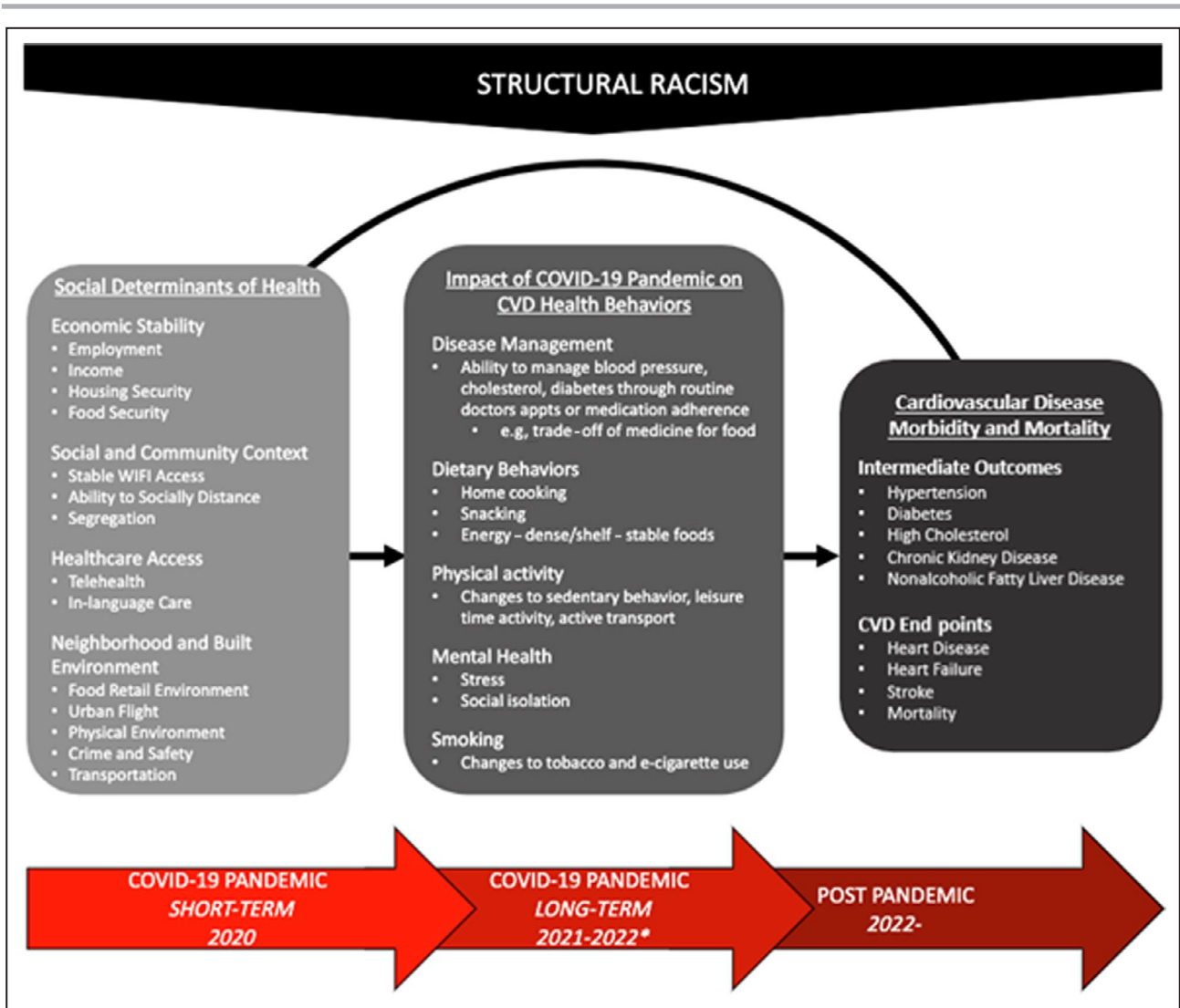
In this commentary, we propose a conceptual model to inform research priorities and guide effective, tailored, and equitable intervention development during the COVID-19 pandemic and postpandemic recovery period toward the primary and secondary prevention of CVD in the United States (Figure 1). We explore how mitigation strategies, financial relief packages, and recent events during the COVID-19 pandemic that targeted SDOH may have differentially affected diverse populations in the United States. Finally, we consider the anticipated effects of the various interactions of the

COVID-19 pandemic and SDOH on short- and long-term cardiovascular health.

## SOCIAL DETERMINANTS OF HEALTH AND THE COVID-19 PANDEMIC

SDOH encompass systemic social and economic factors, outside of individuals' control, that influence health. The Healthy People 2030 SDOH framework outlines 5 key, place-based areas that impact overall health and well-being, including economic stability, social and community context, health and health care, neighborhood and built environment, and education access and quality.<sup>6</sup> In this article, we discuss how the first 4 areas have been affected during the COVID-19 pandemic, including immediate changes resulting from the initial stages of the pandemic (1 year), as well as lasting changes (2–3 years) as a result of the responses designed to address the pandemic (Figure 1). While education access and quality are also important considerations for health across the life course, this theme pertains more to the child and adolescent experience. Herein, we discuss education in the context of the indirect effects on adults during the pandemic; for example, many families were left with limited options for child care, and parents, particularly women, faced increased pressure to manage their children's learning while also juggling their jobs. We focus primarily on the former 4 areas, as they are more aligned with the adult experience. Economic stability is defined by employment, income, housing and food security, and the social and community context encompasses social cohesion and discrimination. Health care access and quality are key drivers of health. Access to healthy foods, neighborhood crime and violence, and environmental conditions are vital aspects of the neighborhood and built environment that influence health-promoting behaviors.

We include structural racism as a fifth, separate dimension in the conceptual framework, which has an overarching effect on SDOH as well as cardiovascular risk and disease, in alignment with the recent American Heart Association statement declaring support for antiracist policies.<sup>7</sup> Structural racism has often been overlooked as a fundamental driver of population health and disparities. While discrimination is included in the social and community context of the SDOH framework, it fails to capture the embedded nature of racism in our systems and policies. Structural racism is the way systems are structured to advantage the White majority and disadvantage racial and ethnic minorities by isolating resources to privileged subsets of society while limiting access to stable employment and adequate and affordable food and housing, and reinforcing inequitable health care and criminal justice



**Figure 1. Effects of the pandemic on social determinants of health and short- and long-term cardiovascular disease (CVD).** \*Estimated time frame of the longer-term pandemic consequences.

systems for communities experiencing disadvantage.<sup>3</sup> Thus, incorporating structural racism into the framework as an underlying dimension affecting SDOH, CVD risk factors, and outcomes at all time points allows for a broader discussion of racial and ethnic discrimination experienced during the COVID-19 pandemic and the potential short- and long-term consequences of the pandemic on racial or ethnic minority populations (Figure 1).

**Economic Stability**

To address the mounting danger from SARS-CoV-2, the virus that causes the COVID-19 disease, US federal and state governments began enacting policies that reduced social movement and person-to-person interactions. Stay-at-home orders and closures of non-essential businesses were critical to reducing community spread of SARS-CoV-2 but resulted in massive

unemployment and financial hardships, as well as permanent business closures. Congress devised the Families First Coronavirus Response Act (FFCRA); Coronavirus Aid, Relief, and Economic Security (CARES) Act; and American Rescue Plan (ARP) Act to provide economic relief from the COVID-19 turmoil that has ensued. However, these policies in response to the COVID-19 pandemic have been rife with loopholes that inadequately protect populations disproportionately experiencing social or economic marginalization.

**Employment**

During the pandemic, most states suspended some business sectors to reduce transmission rates and only businesses deemed “essential” have been allowed to remain open. Generally, essential businesses include the following sectors: health care, energy, child care,

water and waste management, agriculture and food production, critical retail (ie, grocery stores, hardware stores), critical trades (ie, electricians, plumbers), and transportation.<sup>8</sup> There are key differences in the demographic and socioeconomic characteristics across the essential and nonessential workforce, as well as within the essential workforce. Lower-income households, racial/ethnic minority populations and immigrant communities are disproportionately represented in the essential workforce.<sup>8</sup> Nearly half of essential workers earn less than a living wage (estimated at \$16.42 per hour), many of whom work in close proximity to perform their jobs.<sup>9</sup> In addition to experiencing increased COVID-19 exposure at work, many low-wage employees commute to work on crowded mass transit. Yet, most low-wage workers have not received hazard pay during the pandemic despite enduring greater risks because of their employment.

The Paycheck Protection Program was created to provide aid to businesses within the nonessential sectors. Forgivable loans were distributed on the condition that the receiving businesses would use the funds for payroll expenses, enabling businesses to retain their employees. Yet many businesses that accepted funds still laid off employees.<sup>10</sup> Moreover, evaluations of the program have revealed that racial and ethnic minority- and women-owned businesses faced more obstacles and longer wait times to receive Paycheck Protection Program loan support and were less likely to receive support than larger, more profitable businesses.<sup>10</sup> Additionally, some already affluent individuals exploited the Paycheck Protection Program for personal gain, purchasing luxury items for themselves instead of paying their employees.<sup>11</sup>

Limited access to the Paycheck Protection Program loans and other assistance programs, including the Express Bridge Loan Pilot Program, may have contributed to the scale down and closure of businesses. Job loss resulting from the pandemic has reached the highest rate since the Great Depression, but unemployment rates have manifested differently across populations.<sup>12</sup> Low-income individuals and racial and ethnic minority adults were most likely to report that they or someone in their household were laid off or lost their job or experienced pay cuts attributable to the pandemic.<sup>12</sup> While the labor market has started to recover, low-income individuals are still being left behind; low-income adults who lost their jobs early in the pandemic are more likely to report remaining unemployed than middle- or upper-income individuals.<sup>12,13</sup>

While the FFCRA and CARES Act aimed to improve unemployment benefits, the confusing eligibility requirements as well as overburdened federal and state agencies and online portals prevented many businesses from applying for and accessing these resources; moreover, most of the supplemental

benefits—like the \$600 unemployment benefits from the CARES ACT—expired in August 2020. The most recent relief package, the ARP, included supplemental unemployment benefits, though this time of \$300, and extended the weekly supplement through September 6, 2021.<sup>14</sup>

Another provision of the FFCRA was emergency sick leave. Before this provision, 27% of all US employees and 17% of all US full-time employees were ineligible for paid sick leave. This percentage rose to >50% when looking at the food and accommodation industries alone.<sup>15</sup> While the FFCRA did not extend paid sick leave to all US employees, the act increased coverage to workers within businesses that employed fewer than 500 individuals. Expansion of paid sick leave helped flatten the curve of infections but also enabled individuals to retain their job rather than quitting, after becoming infected.<sup>15</sup> This was particularly helpful for lower-income essential workers, who were most vulnerable to infection and economic hardship during the pandemic.

Beyond mandatory shutdowns and paid sick leave availability, the closure of schools has significantly impacted the workforce, particularly women. For households with limited child care options outside of school, the closure of schools forced some parents and guardians to leave the workforce. Not only did individuals who were unable to engage in remote work quit but those who could “telecommute” also quit. The pressure of maintaining employment at home while supervising young children and assisting with remote learning put added, unendurable strain on many caregivers, mothers in particular.<sup>16</sup> A recent study, looking at heterosexual married couples, found that women took on greater child care responsibilities than men, even while both partners were working full time, and that individual well-being for women was significantly worse than their husbands.<sup>17</sup> Consequently, rates of job loss have been significantly higher for women than men, which is explained in part by entrenched sex roles and inequalities.<sup>16</sup>

Implications for the job losses related to child care are far reaching, especially as this disproportionately affects more women, low-income households, and particularly racial and ethnic minority communities. The intersectional effects of sex and race and ethnicity has led to disproportionate job losses among racial or ethnic minority women during the pandemic. While Hispanic and Latina and Black women accounted for only one-third of the female labor force, they were responsible for 46% of the total decrease in employment among women.<sup>18</sup> The differential job loss relates back to differences in the essential and nonessential workforce makeup. Racial or ethnic minority women are more likely to be employed in the service and hospitality industry, a sector that laid off more people than any

other.<sup>18</sup> Moreover, there is some evidence to suggest that racial or ethnic minority women are more likely to be hired last at companies, which during periods of financial instability contribute to greater job losses given a “last-hired-first-fired” dynamic.<sup>19</sup> Opportunities to provide greater support to these individuals and working families should be explored.

### **Income**

The CARES Act also created Economic Impact Payments (EIPs) to provide low- and middle-income earners with a short-term economic cushion in the wake of the financial strain the pandemic induced. Stimulus payments up to \$1200 with an additional \$500 per dependent were distributed to individuals who earn under \$75 000 a year and phased out for individuals who earn more than \$75 000 a year.<sup>20</sup> Use of the EIPs differed across income brackets. Households with gross incomes between \$75 000 and \$99 000 (ie, the highest eligible income for EIPs) were more likely to use the EIPs to benefit long-term goals, using the EIPs to pay off debt or add to savings. Conversely, households with gross incomes <\$25 000 were more likely to use the funds for immediate needs, using the EIPs to pay for basic living expenses, including rent, mortgage, utilities, and food.<sup>20</sup>

Similar to the other government relief programs, not everyone was eligible for EIPs, and many eligible individuals did not receive the EIP. One report found that nearly 9 million people who were entitled to stimulus payments did not receive them,<sup>21</sup> and a lower percentage of eligible Black and Hispanic adults received the stimulus payments compared with their White counterparts.<sup>22</sup> Missing from these reports were data on other racial and ethnic minority groups, including Asian Americans, who are among the hardest hit financially during the pandemic.<sup>23</sup> Other individuals who were ineligible for the funds include ~26 million people who were considered adult dependents (ie, older adults, people living with disabilities, college students) and 15 million people from immigrant families, according to an analysis by CNBC.<sup>24</sup> A second EIP of \$600 was authorized in December 2020, under the same eligibility guidelines. A third EIP of \$1400 was authorized in the ARP passed in March 2021, extending the payments to adult dependents.<sup>14</sup> Data on how these funds were used is not yet available given the recency of their distribution.

While the CARES and ARP Acts provided low- and middle-income households about \$2200 in EIP, it gave higher-income earners longer-term economic relief through provisions that allowed business owners to deduct more from their taxes, including retirement accounts, charitable donations, and investments, which amounts to hundreds of thousands of dollars in tax cuts. The tax loophole in the CARES Act benefits nearly all (95%) individuals with an annual income of

over \$200 000 and most (82%) individuals with an annual income of over \$1 million.<sup>25</sup>

### **Housing Security**

Federal and state government agencies have enacted moratoriums on foreclosures and evictions to prevent individuals from losing their homes during the pandemic and increase compliance with stay-at-home orders. The Federal Housing Finance Agency issued a mandate that restricted all government-sponsored mortgage lenders from foreclosing single-family homes for nonpayment of mortgage, that was originally set to expire August 31, 2020, and was extended to June 30, 2021.<sup>26</sup> However, this policy applies only to federally backed, single-family mortgages—which accounts for 65% of total mortgages—and does not provide any protection for other types of mortgages.<sup>26</sup> What remains unknown is whether there are distinct differences in the populations with and without protected mortgages.

Eviction protection for renters at the state level varies; many states had moratoriums that expired in the summer and fall of 2020. In response, the Centers for Disease Control and Prevention issued a national moratorium on residential evictions for nonpayment of rent or other fees. Protection was provided to tenants who completed and signed a declaration affirming they could not afford rent because of the COVID-19 pandemic.<sup>27</sup> However, landlords were not legally obligated to inform tenants of this Centers for Disease Control and Prevention order and could still file for eviction proceedings if tenants were unable to pay rent and unaware of the Centers for Disease Control and Prevention moratorium on residential evictions. Thus, low-income households or immigrant populations who lack the resources, English proficiency, literacy, or legal knowledge may be at greater risk of eviction even with the national moratorium.

Hundreds of thousands of individuals have been evicted during the pandemic,<sup>28</sup> and this number is anticipated to escalate as moratoriums expire. In the short-term, beyond the harms and traumas associated with eviction, are the increases in risk for SARS-CoV-2 spread because of not implementing or enforcing moratorium policies. Despite the benefits of the moratoriums in their ability to keep people at home during the pandemic, a major flaw with the moratorium policies is that they fail to provide monetary assistance. Without supplemental resources, these moratoriums are short-term solutions, simply delaying evictions rather than preventing them.

### **Food Security**

Mounting evidence suggests that food insecurity—ie, having inconsistent access to adequate food because

of limited financial and other resources—is reaching record highs. Moreover, limited resources are increasing food insecurity among households who were struggling with food insecurity before the pandemic as well as among households with no prior record of food insecurity.<sup>29</sup> Supply chain challenges from panic buying during the pandemic have further exacerbated food access issues for low-income, minority, and older adult populations.<sup>29</sup> The FFCRA outlined several provisions to expand federal nutrition assistance programs administered through the US Department of Agriculture's Food and Nutrition Service. For example, the requirements on items allowed for purchase using Women, Infants and Children Nutrition Program benefits have been relaxed, allowing for more substitutions, and the Supplemental Nutrition Assistance Program (SNAP) Online Purchasing Pilot has been expanded to cover 47 US states.<sup>30</sup> State agencies have also been authorized to issue pandemic electronic benefits to households with children eligible to receive free or reduced-price school meals.<sup>30</sup> The ARP extended the increase in SNAP and Women, Infants and Children Nutrition Program benefits, originally set to expire in June 2021, to September 2021.<sup>14</sup>

Yet even with expanded nutrition assistance benefits, some low-income families may face barriers to accessing food. Few retailers accept SNAP payments online—big businesses like Amazon and Walmart have profited from nearly all sales through the online purchasing platform<sup>30</sup>—and SNAP recipients cannot pay for delivery fees with their benefits, which limits choice and may deter use of the online platforms.<sup>31</sup> Additionally, low-income households shop differently than high-income families, often visiting multiple food stores in search of more affordable and SNAP- or Women, Infants and Children Nutrition Program-eligible items.<sup>32</sup> This is more difficult to do during COVID, as these households generally rely on public transit. Buying in bulk and shopping online, which is more common among high-income families, is also less feasible for low-income families.<sup>32</sup> Finally, federal nutrition assistance programs are used less among eligible low-income families because of stigma and immigration concerns.<sup>33</sup> These families rely on food banks and other charitable food donation organizations, which have been overwhelmed during the pandemic.<sup>34</sup> In New York City, a former epicenter of the COVID-19 crisis, 75% of emergency food services reported an increase in first-time visitors, families with children, laid-off or furloughed workers, and undocumented immigrants. Simultaneously, ≈40% of emergency food services closed because of workers at higher risk of SARS-CoV-2 infection (ie, older adults) and disruptions to the food system, with over 73% of closures in high-need neighborhoods.<sup>34</sup>

## Social and Community Context

The uncertainty related to the COVID-19 pandemic—economic challenges, parenting and homeschooling issues, work-life balance, marital conflict—has increased stress, burnout, and fear in communities across the United States. Social networks, which are important in promoting resilience to stress and trauma, have become disrupted as a result of the pandemic mitigation efforts and increased social isolation.<sup>35</sup> Groups most disproportionately affected by psychological harm as a result of isolation are children, older adults, minority groups, and lower-income populations.

Research investigating the effect of the pandemic on loneliness has predominantly focused on older adults, finding high levels of anxiety, depression, and poorer sleep quality.<sup>36</sup> Surveys of the US general population have similar findings, with loneliness and depression increasing during the stay-at-home mandates.<sup>37</sup> Limited data are currently available for racial and ethnic minority populations and low-income groups. The stay-at-home orders have required individuals to adapt and change their typical ways of connecting with family, friends, and colleagues. Creative ways to maintain and support social connections have emerged, but the majority are delivered through technology and online platforms. Videoconferencing platforms like Zoom, WebEx, and FaceTime have emerged as popular settings to hang out with friends, connect with relatives, and celebrate milestones. However, not all can afford this luxury. Low-income households and racial and ethnic minority families are less likely to have broadband access.<sup>38</sup> These groups may experience greater loneliness and social isolation given a more limited ability to connect with others virtually. Some Internet providers have reduced prices, waived late fees, and increased download speeds to bridge the digital divide. However, this response does not fully address Internet access challenges as many of these families are also less likely to have Internet-accessible devices.<sup>38</sup>

## Health Care Access

In places where the COVID-19 burden overwhelmed the health system, there was limited capacity to care for patients with non-COVID-related conditions.<sup>13</sup> Consequently, many state governments began limiting or prohibiting in-person elective or nonemergent medical procedures. Use of telehealth services, which allow patients to connect with health care personnel via telephone or audio-video interactions on smartphones, tablets, or computers, has surged as a result.<sup>39</sup> Patterns of health care use before the pandemic indicate that people who are low-income, uninsured, or undocumented or have limited English proficiency already exhibited greater challenges related to access to health care.<sup>40</sup> Preliminary studies indicate that

access to telehealth services for health care follow similar patterns; low-income groups and racial and ethnic minority populations used telehealth services less compared with higher-income households and White families.<sup>39</sup> Moreover, increases in xenophobia and immigration-related fears may serve as barriers to health care access for racial and ethnic minority and immigrant communities.<sup>41</sup>

### Neighborhood and Built Environment

Neighborhood food landscapes have changed dramatically during the COVID-19 pandemic, with restaurants closing at record rates.<sup>42</sup> Many small food retailers, farmers' markets, and mobile produce vendors, facing challenges adapting to new grocery shopping behaviors, have had to close. An evaluation of food outlets in New York City found that a greater percentage of food outlets closed in immigrant enclaves and low-resourced neighborhoods compared with high-income neighborhoods.<sup>43</sup> The closures of these businesses not only decrease food access but also reduce community gathering spots and increase property vacancies.<sup>42</sup>

Urban flight has also increased during the pandemic. Individuals living in densely populated cities are leaving to seek more space in the suburbs, and the populations leaving are disproportionately White and wealthy.<sup>44</sup> Evidence remains inconclusive on whether the migration is short or long term. However, urban flight may also contribute to business closures and property vacancies in some neighborhoods.

### Racism

Race-based trauma rose during the COVID-19 pandemic. High-ranking political leaders referring to the SARS-CoV-2 as the "China Virus" and COVID-19 as the "Kung Flu" fostered anti-Asian discrimination, leading to increases in hate crimes and violence against Asian Americans.<sup>45</sup> In a population-based sample of Chinese American families surveyed during the pandemic, nearly half reported being targeted by discrimination online or in person.<sup>46</sup> Increases in perceived racism were associated with poorer mental health.<sup>46</sup>

Concurrent with the pandemic were the racial justice movements in response to the murders of Breonna Taylor, George Floyd, and countless other named and unnamed Black Americans. In addition to physical traumatic effects of police brutality, psychological trauma is pervasive among Black Americans who are exposed to police brutality. In a national survey, approximately half of the Black respondents were exposed to one or more police killings of unarmed Black Americans in their state within 3 months of taking the survey.<sup>47</sup> Police killings were positively associated with the number of poor mental health days; individuals from groups who

experienced greater police killings also endured more poor mental health days.<sup>47</sup> A systematic review found that any police interaction (eg, police stops, searches, arrests, killings) were associated with significantly higher rates of adverse mental health conditions, psychological distress, depression, posttraumatic stress disorder, suicidal ideation/attempts, and anxiety.<sup>48</sup>

The COVID-19 pandemic disproportionately devastated racial or ethnic minority populations and response strategies inequitably distributed relief. Moreover, anecdotal reports of racism in treatment of COVID-19 racial or ethnic minority patients have revealed persistent racism in the health care setting during the pandemic. Stress from living through these overlapping events is likely to have compounding negative effects on the mental health and well-being of Black Americans.<sup>49</sup> Prior research has noted how individual psychosocial stressors accumulate to negatively affect CVD risk and outcomes.<sup>50</sup> Cumulative psychosocial stress has been inversely associated with ideal cardiovascular health, with differences seen by race and ethnicity. Black women were found to have higher cumulative psychosocial stress scores and lower ideal cardiovascular health than women from other racial and ethnic groups.<sup>51</sup> Future investigations should examine the accumulation of psychosocial stressors from the pandemic, acts of racism, and police violence to better understand and effectively mitigate CVD risk.

Responses to the racism exposed during the pandemic have been promising. Better mechanisms for reporting and tracking racial bias have emerged, awareness of the insidious harms of racism has increased, and civic engagement has reached record highs.<sup>52</sup> Moreover, efforts to advance cardiovascular health equity and eliminate disparities rooted in SDOH must continue to acknowledge and address racism broadly at the individual and systems levels to mitigate the detrimental effects of racism on health.

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## ACHIEVING AND MAINTAINING CARDIOVASCULAR HEALTH DURING THE COVID-19 PANDEMIC

Events during the COVID-19 pandemic have both directly and indirectly, through changes to SDOH, affected CVD risk factors and disease, including blood pressure, cholesterol, adiposity, blood sugar, physical activity, diet, and smoking.

As the pandemic escalated, people began avoiding the health care setting for fear of SARS-CoV-2 exposure.<sup>13</sup> Despite the promise of telehealth as an alternative, primary care visits in the second quarter of 2020 were lower than comparable months in previous years. Additionally, the content of telehealth visits differed from office-based encounters. Assessments for blood

pressure and cholesterol levels and treatment visits for diabetes decreased in 2020 compared with previous years, and the initiation and continuation of prescription medications also decreased.<sup>53</sup>

Financial strains before the pandemic led individuals to make trade-offs between using limited resources to purchase medications, medical care, or food.<sup>13</sup> Moreover, individuals may have poor medication adherence when they do not have enough food and may skip taking medication to avoid adverse side effects. These behaviors may be exacerbated during the COVID-19 crisis as financial strain and food insecurity have risen.<sup>54</sup> Decreases in the management and treatment of CVD risk factors, like diabetes, hypertension, and high cholesterol, have long-term health implications, given the negative link between these risk factors and CVD.

Long periods of home confinement has encouraged consumption of home-cooked meals for some.<sup>55</sup> Home cooking is associated with better dietary quality, as fewer additives and preservatives are included in food preparation, whereas food away from home is generally lower in nutritional quality and higher in energy density.<sup>56</sup> However, snacking behaviors have also increased,<sup>57</sup> and pandemic-related stress, discussed above, is prompting people to seek comfort in unhealthy and processed foods, including foods that are high fat, high sugar, and energy dense.<sup>58</sup>

Disruptions to the food system and reductions in grocery shopping frequency have contributed to spikes in produce prices and packaged food purchases.<sup>58</sup> These changes have been challenging for low-income populations, who already experience barriers to accessing healthy foods and rely on more shelf-stable, processed, and energy-dense foods.<sup>13</sup> Food hoarding has left low-income families at an extreme disadvantage because they are unable to afford bulk purchases, especially families relying on SNAP and the Women, Infants and Children Nutrition Program for whom food shopping is restricted to preapproved stores and items.<sup>32</sup>

Home confinement has also impacted physical activity levels. Social isolation, impaired sleep, and increased psychological stress, which have all been documented extensively during the pandemic, are inversely associated with levels of physical activity.<sup>59</sup> Moreover, limited outdoor space and closures of indoor recreation facilities have constrained options for physical activity.<sup>60</sup> As an alternative, people are increasingly turning to at-home workouts; Google Trends data revealed a significant increase in searches for “home-based exercise” and “high-intensity interval training” in the spring of 2020 compared with prior months.<sup>61</sup> However, socioeconomic demographics likely determine who engages in at-home workouts. Preliminary findings from Belgium suggest that older

age and lower education resulted in less exercise.<sup>62</sup> Income may also influence physical activity. Higher-income households may have dedicated spaces for working out, inside or outside their homes, whereas lower-income families tend to live in crowded housing. Additionally, higher-income individuals, who have more flexibility working remotely, may have more time to devote to working out.<sup>63</sup>

Pandemic-related stress has been associated with smoking. Boredom, social isolation, and new restrictions on e-cigarettes may have increased cigarette smoking.<sup>64</sup> Earnings reports from tobacco companies have revealed that cigarette sales, which have been trending downward for decades, are beginning to plateau, suggesting that the United States may experience a setback in the decades-long declines in cigarette smoking prevalence.<sup>65</sup> Conversely, reports of greater COVID-19 disease severity among smokers may have discouraged smoking.<sup>64</sup> Smoking patterns before the pandemic suggest that low-income adults may be less likely to quit, as adults living in poverty were not only more likely to smoke cigarettes, but they were also less likely to be successful in quitting than those living at or above the poverty line.<sup>66</sup> More research is needed to understand the effect of the pandemic on smoking habits and determine whether sociodemographic differences are linked to differences in behavior.

In recent years, the United States has experienced rising rates of alcohol use, high-risk drinking, and alcohol-use disorders, known risk factors for hypertension.<sup>67</sup> During the pandemic, alcohol use has increased in frequency and quantity.<sup>68</sup> In addition to the pandemic-related distress, for which people have used alcohol to cope, alcohol access has been largely uninhibited during the pandemic. Under most state guidance, liquor stores remained open even during the strictest shutdowns of the pandemic.<sup>69</sup> Moreover, in tandem with online grocery shopping trends, there has been a rise in online alcohol purchasing.<sup>70</sup> Methods to provide mobile and online support for people who may be at higher risk for alcohol abuse should be explored, especially with limited enrollment and outpatient services at treatment facilities during the pandemic.<sup>67</sup>

Evidence indicates that experiences of racism are important psychosocial stressors that lead to altered health behaviors and adverse health outcomes. Among Black Americans, internalized racism has been positively associated with alcohol consumption and psychological distress, in addition to overweight, obesity, blood pressure, and fasting glucose.<sup>71</sup> Other research has found that psychosocial factors, including cumulative stress and cumulative negative affect, as well as depressive symptoms, global stress, weekly stress, anger, cynical distrust, and major life events,



are related to greater prevalence of overweight, hypertension, and diabetes, and worse control of blood pressure and blood glucose.<sup>72</sup> The aforementioned psychosocial factors, which are related to exposure to discrimination and police violence, have likely been exacerbated during the pandemic. These stressors may compound changes in health and health behavior resulting from the pandemic. Attention should be paid to racial or ethnic minority populations to understand the intersectional effects of racism and the pandemic on cardiovascular health.

## LASTING EFFECTS OF THE COVID-19 PANDEMIC

Once touted as the “great equalizer,” the COVID-19 pandemic has amplified the health disparities that have beset our nation for decades.<sup>73,74</sup> Racial or ethnic minority populations and lower-income groups, already significantly burdened with CVD and other chronic health conditions, have experienced a disproportionate share of the COVID-19 morbidity and mortality.<sup>2,75</sup> While recent literature focuses on how inequitable distributions of SDOH contribute to increased COVID-19 risk and severity; prior reports have not examined how the pandemic interacts with SDOH to impact short- or long-term cardiovascular health. In this review, we described how the COVID-19 pandemic and the response to the pandemic may have impacted population-level, lifestyle, behavioral, and health risk factors for CVD among different sociodemographic groups and exacerbated health disparities.

COVID-19 has had profound effects on SDOH. The immediate effects, which we are already experiencing, include limited employment prospects, reduced income, increased rent burden, compromised access to health care, and lower physical activity levels, while future effects may include rising homelessness, increased store vacancies, greater neighborhood disrepair, and limited access to healthy foods. These factors will work synergistically to greatly magnify future CVD disparities. The lived experience of these effects will vary, and achieving optimal cardiovascular health may be more difficult for underresourced communities, including low-income households, immigrant communities, and racial and ethnic minorities, during the pandemic. A common theme to the relief packages passed during this time has been to provide immediate temporary relief, and then extend measures when devastation persists. Without strategic interventions that target both proximal causes and underlying distal determinants, difficulties will persist or intensify in the wake of the pandemic.

In recent years, the United States experienced a decline in CVD mortality, yet before the COVID-19

pandemic, evidence emerged suggesting a flattening of the decline and a possible increase in mortality attributed to rising obesity and diabetes rates.<sup>76</sup> The COVID-19 crisis will likely further exacerbate the upward trends in CVD mortality the United States was beginning to experience before the pandemic. Reduced access to preventive care during the pandemic may be responsible for immediate spikes in CVD burden, whereas limited ability to achieve optimal CVD-related lifestyles may result in lasting increases in the CVD burden and health disparities in the long term.

## USING SYSTEMS THINKING AS A WAY FORWARD

The pandemic illustrates the need for innovative analytical approaches that can be used to understand the dynamic interplay between SDOH and CVD and assess the long-term effects of mitigation strategies. As one of such analytical approaches, systems science connects systems-level thinking with computational models. The current volume and velocity of data allow researchers to better conceptualize the burden of CVD within complex systems beyond traditional epidemiological study designs, overly simplistic socioecologic and reductionist framing, and randomized controlled trials. Many effects of the COVID-19 pandemic have proven to be nonlinear (eg, the spread of the virus over time across communities with very different health profiles)<sup>77</sup> and, thus, using system science techniques, such as network analysis, system dynamics, and agent-based modeling, will allow us to better understand the effect of the COVID-19 crisis on CVD risk factors and outcomes.

Systems science can help us understand the complex relationships behind the characteristics of a population and community and assist in the development of more targeted interventions to improve health and advance health equity, by facilitating the evaluation of alternative policies and interventions.<sup>78</sup> In Australia, this approach was used to create a model outlining the determinants of inequity in healthy eating—the HE2 Diagram. Through a series of collaborative conceptual modeling workshops, expert stakeholders, community members, and research staff developed a systems model causal loop diagram that has helped create policy and intervention approaches that are both effective and equitable.<sup>79</sup> In the United States, a large-scale system dynamics model was developed to evaluate the impact of 19 local interventions on long-term CVD outcomes among all US adults.<sup>80</sup> The simulated interventions were broad, ranging from increasing access to and marketing of physical activity options, taxing junk food, and banning smoking at work and public places, to implementing air pollution control regulations.

Simulation results had been used by health planners and policymakers in counties such as Austin/Travis County in Texas to support local strategy and intervention design.<sup>81</sup>

To illustrate how systems thinking can inform future planning and efforts, Figure 2A and 2B depict a nonexhaustive and simplified example of the lived

experience of low-income versus high-income individuals with hypertension, and how COVID might impact their management of blood pressure. In Figure 2, among low-income populations, job loss reduces income, which in turn leads to increased stress, medication nonadherence, and poor dietary habits. Stress links to sedentary behavior and smoking, as well as



**Figure 2.** Example of applying systems thinking to understand the impact of the COVID-19 pandemic on blood pressure control among populations with hypertension. Feedback loops are identified with red arrows. Social determinants of health are denoted in blue, and health behaviors are denoted in brown. **A.** Depicts the hypothetical experience of low-income individuals. **B.** Depicts the hypothetical experience of high-income individuals.

poor dietary habits. In turn, medication nonadherence, poor dietary habits, sedentary behavior, and smoking all compromise blood pressure control. In contrast, among high-income populations, job security allows for stable income, with opportunities for telehealth visits, medication adherence, healthy dietary habits, and better mental health (Figure 2). A feedback loop exists between better mental health, at-home exercise, and healthy diet, wherein positive outlook improves diet, which encourages exercise, which improves mental health. Better mental health also links to increased exercise and decreased smoking, all of which facilitate blood pressure control.

This approach is complementary to the current epidemiologic practice of creating directed acyclic graphs to understand causal pathways of disease etiology, and from the exterior may seem the same. However, the systems approach has the added benefit of acting as an important precursor to systems science simulation modeling that can help to inform key levers for primary and secondary prevention and intervention design. This approach also accounts, at least in some part, for opportunities and barriers to intervene on an individual's health. In addition, the systems approach allows for valuable stakeholder input, such as community-based organizations and public health authorities through structured methods (ie, group model building). While the example presented in this article takes a more linear approach, the simplified model intends to account for some heterogeneity of populations, a landmark feature of systems science, and suggests the inadequacy of approaches that do not account for income level with regard to future COVID-19 research.<sup>82</sup>

## OPPORTUNITIES FOR CVD PREVENTION

In addition to exploring novel investigations, as described above, policymakers, researchers, and clinicians should use existing evidence from systems science and traditional epidemiological studies to explore methods for supporting healthful behavior change and CVD prevention.

For example, closures of businesses and restrictions to travel led to significant reductions in air pollution, like NO<sub>2</sub> and PM<sub>2.5</sub>, both of which have adverse effects on CVD.<sup>83,84</sup> As states begin to "reopen," methods to sustain air quality improvements should be explored. One potential approach is to expand Complete Streets in high-traffic areas, a design approach that encourages active commuting, with safe, dedicated spaces for pedestrians and bikers.<sup>83</sup> Previous systems science investigations have identified changes to the built environment (ie, expanded sidewalks and distinct bicycle lanes) as facilitators to physical activity.<sup>84</sup> Thus,

designing environments that support use of alternative transportation methods could improve the air quality and facilitate physical activity and better health.

Other issues related to the neighborhood environment, for example, urban flight, may in part be remedied by homeownership incentive programs. The US Department of Housing and Urban Development has the Community Development Block Program, which enables states to provide grants to local governments for the purpose of developing and preserving affordable housing.<sup>85</sup> The Department of Housing and Urban Development also created the Home Investments Partnerships Program, which grants local governments funds to build, buy, or rehabilitate affordable housing for rent or homeownership.<sup>85</sup> At the local level, governments offer homeownership incentive programs that award employees or residents financial incentives, for example, anywhere from \$1000 to \$15 000 incentives to become homeowners in cities in an effort to revitalize urban areas.<sup>86</sup> While limited evidence is available on the uptake and participation in these programs, a cost-effectiveness analysis found that these programs resulted in overall net benefits for society overall, including participants and nonparticipants.<sup>86</sup>

Increasing awareness of these programs, assisting individuals to check eligibility, and enrolling eligible people could help lead to greater recruitment and retention of individuals in urban neighborhood environments. New businesses may open, leading to fewer property vacancies and safer streets.<sup>87</sup> However, there are also some potential adverse consequences to investing in neighborhoods when predominantly lower socioeconomic status areas subsequently experience an increased influx of higher socioeconomic status residents.<sup>88</sup> While investments may lead to increased business, green space, and safety, they may also lead to increased cost of living, discrimination, and inequities. Certain populations are more at risk for negative health effects associated with gentrification; for example, older adults report higher levels of anxiety and depression, and Black individuals report lower levels of self-rated health when residing in gentrifying neighborhoods.<sup>88</sup> Efforts to revitalize neighborhoods should acknowledge the potential detrimental health effects and take care to safeguard populations experiencing marginalization who may be most vulnerable to these unintended consequences.

Among the many considerations of the behavioral shift from grocery shopping in brick-and-mortar stores to online platforms, 2 factors are important to address. The first pertains to the healthfulness of foods promoted and selected when shopping online, and the second focuses on barriers to online shopping for populations currently underusing the services (ie, immigrants and racial and ethnic minority groups).

Evidence demonstrating how online grocery shopping affects healthful food choice is mixed. While online shopping may reduce unhealthy impulse purchases, it may also hinder produce purchases.<sup>89</sup> Preliminary findings from an online purchasing simulation found that point-of-purchase prompts about fiber increased the purchase of healthier products containing greater amounts of dietary fiber.<sup>90</sup> Although some prior media campaign efforts and in-store education campaigns to encourage healthy food purchases have had limited effect, there appear to be opportunities to encourage healthful choices using targeted advertisements through online grocery platforms.

Often overlooked in the food environment, ethnic markets are important sources of food for immigrant communities and racial and ethnic minorities. Past research has identified cultural concerns (ie, in-language services, relevant foods) as obstacles to accessing foods in supermarkets for immigrant populations.<sup>91</sup> In New York City, a highly populated urban center with diverse immigrant populations, immigrants traveled further to go grocery shopping for culturally relevant foods, rather than shopping at local markets.<sup>92</sup> Food stores located in the ethnic neighborhoods within New York City were found to have limited Internet presence and lower rates of e-commerce compared with nearby neighborhoods during the pandemic (Russo RG, Ali SH, Mezzacca TA, Radee A, Chong S, Kranick J, Tsui F, Foster V, Yi, SS; unpublished data, April 2021). Therefore, online presence may be even more limited for ethnic markets in less populated or more rural settings.

Partnering ethnic markets with online grocery shopping platform provides an opportunity to address some of the aforementioned issues and would benefit both store patrons and owners. Patrons would have greater access to culturally relevant foods; resources used for travel costs to these markets could be used instead for delivery fees. Owners, who tend to be members of the communities they serve (ie, immigrant, racial or ethnic minority), may achieve greater economic successes with the opportunity to reach a broader consumer base online. Moreover, including ethnic markets in online grocery shopping platforms may also provide a level of protection, for store owners and patrons, from SARS-CoV-2 transmission as well as acts of racism. Race- or ethnicity-based discrimination hindered food access before the pandemic.<sup>91</sup> The recent spikes in racism and violence, in particular against Asian Americans, are likely contributing to food and economic security issues during the pandemic.

One opportunity to improve the online presence of these businesses would be to create an extension of the SNAP Online Purchasing Program focused on onboarding and maintaining smaller businesses/ethnic markets on the platform. The Food and Nutrition

Service Process and Technology Improvement Grants program provides an opportunity to apply for funding to improve the quality and efficiency of SNAP operations and processes.<sup>93</sup> State and local health should explore using this funding program to develop programs that onboard ethnic markets on the SNAP Online Purchasing platform. If successful at local levels, this type of program could be expanded to other states. Moreover, federal legislation, like the 2014 Farm Bill that established the SNAP Online Purchasing Pilot, could allocate additional dollars specifically to maintain ethnic markets and smaller businesses on the platform.

Related to SNAP online purchasing, and more broadly online grocery shopping, is the issue of broadband access. Moreover, broadband access was a significant impediment to telehealth service use during the pandemic.<sup>39</sup> Over 21 million people in the United States lack access to broadband Internet.<sup>95</sup> In the most recent COVID-19 relief bill, passed in March 2021, dollars were allocated to improving the access to and affordability of broadband. The Emergency Broadband Benefit Program provides families with discounts on broadband services of up to \$50 for eligible households and \$75 for eligible households on tribal lands. However, this benefit is limited to 1 month.<sup>14</sup> The Biden administration has proposed the Broadband Infrastructure Program, which devotes money to expanding broadband service to rural areas and improving speed of Internet services available.<sup>94</sup> To ensure the expansion and maintenance of broadband, additional legislation is needed to make these investments recurrent and long term. The inclusion of broadband into infrastructure plans, as the Biden administration proposed, would ensure that broadband access is a priority, which is imperative given its influence on a broad range of health behaviors.

As restaurants and opportunities for eating food away from home increase as the country reopens, cooking at home may drop to rates at or below prepandemic levels. Exploring methods to keep people engaged with cooking at home and excited to try healthy recipes could include campaigns that have instructional cooking videos, provide healthy recipes, and share tips like menu-building and sheet-pan dinners to expedite meal planning and prep.<sup>95</sup> Additional approaches could include connecting individuals with community supported agriculture projects for fresh produce pickup or delivery.<sup>96</sup>

Recently, the World Health Organization decided to leverage the increased attention cigarette smoking has been getting because of COVID-19 in their new “Commit to Quit” campaign. The United States was identified as a population of focus for this initiative. The multidimensional campaign combines tactics from national-level policies, community-level services, and individual-level support to empower tobacco users to

successfully quit.<sup>97</sup> Local stakeholders should seek opportunities to actively support and participate in this campaign to promote smoking cessation.

Addressing systemic racism, at all levels, may be the most pressing opportunity to broadly improve the health of populations and reduce health disparities. To do so, exposing and reporting bias across sectors and social determinants needs to continue. Additional steps include creating new policies and interventions to mitigate the effects of biases as well as dismantling existing policies and systems that perpetuate bias, whether unconsciously or consciously. One important area in which this needs to occur is in health care. A recent publication in the *New England Journal of Medicine* called out the use of race correction in clinical algorithms used across specialties.<sup>98</sup> In cardiology, the authors reference the Heart Failure Risk Score, which predicts the risk of death in patients admitted to the hospital. The inclusion of race (coded as Black or Non-Black) in this score ranks non-Black patients as higher need, which was found to result in lower admission rates for Black patients who presented with heart failure in the emergency room. The authors noted that while physicians should not ignore race, they should be aware of how inserting race into their tools may result in further exacerbation of health inequalities.

In another example, the Perelman School of Medicine announced that they would no longer consider race when testing for kidney functioning. The estimated glomerular filtration rate equation includes a race correction, causing Black patients to receive higher kidney function scores than those of other races. As such, many Black patients were referred to care late, and physicians missed opportunities to intervene on the kidney disease at early, more treatable stages.<sup>99</sup> This is a successful example of how health care institutions can revise outdated racial stereotypes to improve delivery of care. Eliminating racial bias within algorithms and guidelines can help physicians, researchers, and policymakers more appropriately address health problems and facilitate health equity.

## CONCLUSIONS

The COVID-19 pandemic has disrupted the social, economic, and health care system in the United States, shedding light on entrenched structural inequities and health disparities. Policies designed to respond to the pandemic—the distribution of EIPs, increase in unemployment benefits, and institution of eviction moratoriums—are short-term solutions to lasting problems for groups that have been marginalized. Finding a “new normal” after the pandemic provides opportunities to examine the systems, policies, and programs that created and maintain health inequalities, and

hopefully, transformative systems change to rebuild in a manner that enhances social justice and health equity. Given our focus on adults in this framework, we do not address implications for education, which is a major SDOH and has been severely affected during the pandemic. Future efforts should explore using a life course approach to understand how education access and disruption during the pandemic will affect future lifestyle behavior and health.

Application of systems science or systems thinking, which accounts for complexity and synergy between components of the system—in this case, demographic, socioeconomic, racial, and political—may be an ideal way to leverage new models of resilience that have emerged in the COVID-19 period and create lasting, structural change. Priorities for resource allocation and restructuring should be data driven, informed by quantitative and qualitative research engaging community members and partners. In turn, long-term, systematic, and comprehensive investments must be made to ensure equitable allocation and access to resources, which can facilitate better opportunities to promote health. Using this framework, we hope to guide researchers in acknowledging underresourced communities when measuring longitudinal changes to SDOH and health behaviors and creating interventions to mitigate potentially adverse effects on cardiovascular health.

## ARTICLE INFORMATION

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