

*Perspective*

## Population Health in the Time of COVID-19: Confirmations and Revelations

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THIS HAS BEEN AN INCREDIBLE PERIOD FOR PUBLIC HEALTH: A time of unprecedented discussion of the science of population health in the media and in society, and a time of uncertainty but also of dramatic social action to protect health in ways that none of us would have predicted just a few months ago. Many aspects of the pandemic we are living through are linked to specific characteristics of the SARS-CoV-2 virus: how it is transmitted to and infects individuals, what symptoms it causes and when, how it interacts with other diseases and conditions, what sorts of immune responses it triggers, and how this affects both its clinical manifestations and the presence and duration of immunity after infection. These factors acting together drive many manifestations of the pandemic in the population. In this sense, what we are experiencing is a unique health crisis resulting from the emergence of this specific virus at this time. But more fundamentally, the pandemic is also illustrating vividly and with great immediacy some very basic facts and challenges related to population health and to how we as a society are acting (or are failing to act) to protect our health. In this essay, I reflect on some of these facts and challenges and highlight some implications for the future. I also discuss how the pandemic may be producing unanticipated opportunities for population health, by illuminating (in ways that were often unintended) how we can use our power as a society to change the way we live and to create systems and environments that promote health and health equity.

## Systems Thinking as Key to Understanding and Identifying the Most Effective Interventions

Public health practitioners and scientists across a range of disciplines have repeatedly noted that a full understanding of the drivers of population health and of the interventions and policies that might be most effective at improving health requires a systems approach. A systems approach means recognizing the impact of multiple levels of organization (countries, states, neighborhoods, families, individuals) and heterogeneous units (individuals, families, workplaces, neighborhoods), as well as accounting for the presence of feedback mechanisms (both reinforcing and buffering) and dependencies (eg, individuals influencing one another, or places and individuals influencing one another). These four features—multiple levels of organization, heterogeneous units, feedback mechanisms, and dependencies—are the cardinal features of complex systems.<sup>1</sup>

More than 50 years ago, Forrester stated that in a complex system, “causes are found not in prior events but in the structures and policies of the system.”<sup>2(p23)</sup> The COVID-19 pandemic is yet another demonstration of why systems thinking is fundamental to population health. Infectious disease epidemiologists have long used systems modeling approaches to predict the evolution of epidemics. Today, these models form the basis for many projections of the evolution of the COVID-19 pandemic.<sup>3</sup> They can be used to capture the processes of disease transmission under different conditions (eg, different degrees of social contact) and to evaluate the impact of various interventions on the numbers of cases and deaths. But the importance of systems thinking in understanding the population health impact of COVID-19 extends beyond the already complex mechanisms captured in traditional systems models of infectious disease transmission.

As the media have repeatedly shown, the ultimate health consequences of the pandemic are conditioned on a range of systemic factors. These include the social and economic structures driving inequities; historical processes of racism and segregation; labor laws influencing sick leave policies and unemployment benefits; physical environment features like land use and population density, air pollution, and transportation; the health care system’s organization; and even the economic systems producing and distributing basic medical supplies like personal

protective equipment and masks. Systems thinking is also essential to understanding how social distancing and stay-at-home orders may affect population health beyond the impact of COVID-19, resulting in both intended and unintended consequences that can be either good or bad for health.

### **The Critical Need for Data and the Imperative to Act in the Face of Incomplete Information and Uncertainty**

The pandemic has revealed the critical need for basic population health data to guide decisions and policies. Certainly, we need sophisticated evidence regarding the impact of specific policies and interventions under varying conditions. But even more profoundly, there is a critical need for basic descriptive data on the population impact of health conditions, their distribution across social groups, and their evolution over time; that is, the basic epidemiologic metrics discussed in countless public health and epidemiology textbooks.

Despite early calls to set up the systems and studies needed to obtain this vital epidemiologic information for COVID-19,<sup>4</sup> there have been notable challenges in characterizing basic features, such as incidence rates and case-fatality rates in specific populations, clinical manifestations and how they vary (including proportions of asymptomatic infections), transmissibility over the course of infection and the relative importance of different modes of transmission, and the presence and duration of immunity after infection. Some of these challenges are understandable, given that COVID-19 is a novel virus that has advanced rapidly through populations, as well as the inherent difficulties in estimating even what appear to be simple parameters (such as the case-fatality rate) in the midst of a pandemic.<sup>5</sup> But the pandemic has also shown us how unprepared even a wealthy country like the United States (a country that spends a significant proportion of its GDP on health care) was to mount a coordinated population effort to collect basic data critical to guiding the societal response to COVID-19. This basic data includes the systematic characterization of the evolution of the pandemic in social groups characterized by race and ethnicity, social class and neighborhood.

At the same time, the pandemic has illustrated how we cannot always wait for complete data and that we must take action despite the uncertainties. In the case of COVID-19, these uncertainties have been magnified by the lack of epidemiologic data, as demonstrated by the disparate and varying projections of different pandemic models. Some uncertainty is inherent in all public health decisions. Nonetheless, we still must make value judgments and factor in the price of inaction along with the unintended adverse consequences of our actions. The need for considering this balance, and particularly the challenges of assessing it in the face of limited data, have been perhaps one of the greatest lessons of COVID-19, not just for public health but also for society in general.

### **Coordinated Government Action Is Critical to Protecting the Public's Health**

Another key theme reinforced by the COVID-19 pandemic is the critical role of coordinated government action to protect the public's health. In the United States, the lack of a national coordinated response has been manifested in many ways, including the severe shortages and misallocations of personal protective equipment and testing supplies, which even resulted in states bidding against one another for them. The COVID-19 pandemic has also made abundantly clear that the market cannot rationally allocate needed resources in times of crisis. This is another example of the inadequacy and inefficiency of relying on market mechanisms in health care more generally. The persistent inequities in access to care in the United States are a long-standing manifestation of this failure.

The need for coordinated government action goes beyond the appropriate allocation of testing and health care resources. It extends to the need for a coordinated system to gather and process the population data and evidence needed to guide policy. Recent reports have highlighted inconsistencies in how cases and deaths attributed to COVID-19 have been counted. Some of this is understandable in the context of a pandemic, will be resolved over time, and may or may not significantly affect key conclusions. But these inconsistencies reinforce the need for central guidance. Only relatively late in the pandemic did the Centers for Disease Control and Prevention launch a series of population studies designed to characterize the disease's basic epidemiologic features.<sup>6</sup> In

the absence of a coordinated response, scientists have stepped in, often publishing their work on prepublication websites. Even though relying on entrepreneurial scientists to produce information and evidence has worked before and has generated answers to many important scientific questions, it may not be the most effective or efficient way to gather urgently needed information in the midst of a pandemic.

Another critical factor highlighted by COVID-19 is the need for a robust public health infrastructure to monitor health and implement and evaluate public health measures. Even in rich countries like the United States, historical cuts to public health infrastructure have severely affected the resources and expertise available, with stark consequences today. A solid public health infrastructure is critical to the identification and contact tracing of cases that are necessary for any efforts to reopen the economy, but is also essential to many other public health functions that will continue to be needed after the pandemic is over.<sup>7</sup> It remains to be seen whether the significant government resources that some countries are investing in response to the economic impact of stay-at-home orders (much of it to support businesses, often large businesses and corporations) will be accompanied by significant long-term investments in public health.

The need for coordinated government action extends to global coordination as well. The pandemic has shown that both the health of countries and that of regions are interconnected. Today, neither travel bans nor other movement restrictions can overcome the fact that one country's health affects other countries' health through various mechanisms. Even though this interconnection is clear in the case of highly contagious diseases like COVID-19, it also is true for other health conditions and drivers of population health like environmental factors (eg, air pollution and climate change), economic factors (food systems, global production of tobacco, alcohol, and processed foods), and social factors (working conditions, violence, social unrest).

### **The Elephant in the Room: Social Structure as a Key Determinant of Levels and Distributions of Ill Health**

A remarkable aspect of the pandemic has been the discovery of health inequities by politicians and the press. Initial statements like “the

COVID-19 virus does not discriminate” and “we are all equally at risk” quickly gave way to presentations of stark statistics showing how incidence, severity, and mortality from COVID-19 are strongly patterned by race, ethnicity, and social class. The fact that social structure is a key determinant of the levels and distributions of ill health is not news to anyone in population health. Nonetheless, by shining a bright light on health inequities, the pandemic has spurred an unprecedented discussion in the media and the public of health inequities, including their presence, magnitude, and potential causes.

The pervasive way in which the pandemic is affected by social processes is manifested in different ways and reflected in differences in disease outcomes across people (by race, ethnicity, and social class), locations and neighborhoods (by levels of poverty or racial segregation), and countries (by levels of wealth and inequality). The mechanisms driving these differences are multifaceted and reflect historical interconnected systems of income inequality, racism, and residential segregation. These systems affect exposure to the virus (eg, overcrowding, population density, job exposures), affect the likelihood of becoming infected (stressors and underlying health conditions), and affect the severity and fatality of disease among those infected (underlying chronic diseases, access to quality care). There are, of course, specific differences unique to infectious diseases and to COVID-19 in particular, but generally the same types of factors determine the social distribution of virtually all health outcomes.

It remains to be seen whether these public discussions of health inequities initiated by COVID-19 will lead to significant changes in the way in which the public at large thinks about the drivers of health inequities. Some explanations in the media have emphasized the presence of chronic health conditions as key drivers of differences in mortality across social groups (specifically between Blacks and whites in the United States). This is surely an important contributing factor, but differences in the prevalence of chronic diseases are themselves linked to antecedents rooted in structural social and economic conditions. Ensuring that this explanation is not used to reinforce an understanding of health inequities based on individual choice and “life style” and thereby recognizing broader social and economic forces, including income inequality, racism, work conditions, and segregation among others remains a major challenge.

There is little doubt that inequities in the effect of the virus will become more evident as the pandemic advances. Inequities in both

incidence and mortality from COVID-19 may increase as social distancing is relaxed and businesses reopen, given the inequities in the levels of risk in jobs and the ability to continue to social distance even as the economy reopens for individuals of different social classes and race/ethnic groups. An aspect of inequities that is only beginning to emerge but will likely become more significant over time is global inequity. Only recently have we begun to see the pandemic advance in lower- and middle-income countries. The lack of public health infrastructure, inadequate health care systems, informal economies, and living and working conditions that make impossible the basic recommendations of hand washing and social distancing makes these countries and particularly certain populations within these countries, especially vulnerable to COVID-19. Examples of the dramatic toll that COVID-19 may have in lower- and middle-income countries can be found in cities like Guayaquil, Ecuador; Manaus, Brazil; Mumbai, India; and Nairobi, Kenya. We will likely see these inequities grow in many other ways as the pandemic evolves. For example, when and if we develop a vaccine, who will get it, and who will pay for it? The sad spectacle of wealthy countries (where the laboratories leading the development of the vaccines are often based) fighting to ensure that the vaccine is available for their populations first is a troubling signal of what may lie ahead.

## **Unprecedented Collective Action to Protect Health Is Possible**

A remarkable aspect of the response to the pandemic is that protecting health has taken precedence over the economy. Stay-at-home orders across the United States, and indeed all over the world, have stopped economic activity in order to “flatten the curve” and slow transmission. No other silent killers in our lifetime—the 4.2 million deaths attributable to air pollution every year,<sup>8</sup> the 1.35 million road traffic fatalities worldwide each year,<sup>9</sup> and the more than 250,000 annual deaths caused by firearms<sup>10</sup>—have motivated anywhere near this level of intervention. Neither has the unrelenting increase in global temperatures due to climate change, with all of its multifaceted health and environmental consequences and implications for the survival of our species. It is likely that the infectious nature of the health threat, the fear of contagion, and the recognition that everyone (even the rich and powerful) is at risk had a lot

to do with the willingness to take such drastic action. Nevertheless, the global response to the pandemic stands as an example of how dramatic collective action to protect the health of the public is indeed possible.

Social distancing and stay-at-home orders have had a significant impact on the pandemic, reducing the number of cases and deaths. But there are undoubtedly many other impacts, both positive and negative. The global response to the pandemic has provided an unprecedented natural experiment that can show us the many ways in which the social and economic systems we have created for ourselves affect our health in ways large and small, good and bad. Certainly, some impacts of the economic shutdown and stay-at-home orders may be bad for health, such as the individual-level effects of job loss on physical and mental health, the stress and mental health consequences of social distancing and of the disease itself, including illness and deaths of loved ones, as well as the possible consequences of delaying medical care for other conditions. But the economic shutdowns have also illustrated ways in which our economic system can generate ill health. As a result of the shutdown, we have seen less traffic, lower air pollution,<sup>11</sup> and lower carbon emissions.<sup>12</sup> Some initial reports also suggested less violence, although more recent reports find more mixed impacts on violence, with gang violence and homicides, as well as domestic violence, increasing.<sup>13,14</sup> There are many other potential health impacts that we do not yet know about. How have the shutdowns affected diet (eg, more or less consumption of fast food, more consumption of locally sourced foods)? And what about drinking, smoking, and substance abuse? What about work-related stress? What has been the impact on physical activity when we have more time for leisure and when commutes disappear? Earlier investigations have shown how the impact of economic expansions and recessions on health can be complex,<sup>15,16</sup> so it would not be unexpected to see both adverse and positive impacts.

At the time of this writing, the existing data on excess deaths suggest that the death toll of the virus far exceeds any beneficial impacts of the economic slowdown on mortality (such as might be seen from reduced air pollution or traffic-related deaths), at least in places like New York City where the pandemic has hit hard.<sup>17</sup> It also appears reasonable to assume that the number of deaths prevented as a result of social distancing<sup>18</sup> is likely to be higher than the excess deaths generated by the economic slowdown. We will have much to analyze when we have complete data. The consequences for health of both the pandemic and our



response to it are likely to vary significantly over time and place. Population health researchers and social scientists will have much to study regarding not only the impact of the shutdown but also what happens as the economy begins to open up again. We have much to learn and much insight to gain from the pandemic and its aftermath concerning how our economic system can affect our health and how, perhaps, things could be different.

## **Two Paths Forward**

In my mind, there are now two divergent paths forward for population health. The first path entails a return to “business as usual,” but with COVID-19 in the mix (because, as we know, the virus will likely not disappear any time soon). This may involve recurring endemic transmissions of the virus in certain vulnerable groups, with periodic localized outbreaks contained more or less successfully depending on the social and economic context and with variable consequences for morbidity and mortality. Alternative scenarios could include periodic waves or even large waves linked to seasonal respiratory infections.<sup>19</sup> In all these contexts, there is no doubt that some people will be better protected than others, and inequities in the impact of COVID-19 will persist and likely increase. Concern with the virus will cause many people to shun public transportation and attempt to return to their cars (if they have them) and avoid high-density cities, resulting in disinvestment in the high-density and pedestrian-oriented living style that is so important to population health for other reasons and to the future of the planet. A vaccine or treatment may eventually emerge, but it will likely be distributed inequitably and inefficiently. Other social determinants of health—income inequality, racism, incomplete and unequal access to health care, inadequate housing, limited or no sick leave and unemployment benefits, and other limits to social safety nets—will remain largely unchanged.

But there is also a second path. In this path we develop a government public health system that is more coordinated, better supported, and able to use our resources and knowledge more effectively through the planning and partnership of both practitioners and researchers. It is also more integrated, recognizing the links between infectious and chronic diseases, the ways in which environmental factors influence health directly and interact with infectious agents, and the tight relationship between social policy and health policy.

In this second path, we are open to re-envisioning what a healthier society could look like. Yes, we have ways to develop vaccines and treatments quickly for new emerging infections and health care available for all, but we also have fewer cars, more active transportation with less travel, more open public spaces, less air pollution, equity in access to sick leave and decent housing, and increased consumption of unprocessed foods produced locally. We actively recognize and act on reducing inequities and eliminating racism in all its forms as strategies to promote population health. Most importantly, and I know this is radical, we explicitly reconsider how we are organized and the systems in which we live, and we structure our society and our economy so that they serve all of us and produce well-being and health for everyone.

The second path is utopian. Even so, we are living through unprecedented times—things that none of us would have predicted are happening and health inequities and the trade-offs between health and “the economy” are being debated as never before. Governments are doing things (reconsidering incarceration, making payments to individuals, closing streets to automobile traffic) that in other times would be considered radical. Social movements are making more visible than ever the injustices of racism and inequality, as well as their consequences for life and death, and demanding action. At the same time, some of the actions that have been taken in the context of the pandemic reinforce previous patterns: unequal and inefficient allocation of government subsidies, gun shops designated as “essential businesses,” limited unemployment benefits, the resurgence of transport by private car, among other worrisome trends. It is difficult to predict what direction we will go. Some recent developments, including major employment and income consequences of the shut-down for the most vulnerable, sadly suggest that we are more likely to be on the first path than the second. But the story is not over, and continuing the discussion about health and what we as a society can and should be willing to do to promote the health of all people provides some room for hope and, most important, provides an opportunity, a crack in the door, for population health.

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