Research Square

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Tipping the Scales: A Theoretical Model to Describe the Opposing Effects of the COVID-19 Pandemic on Mortality

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Abstract

Background. The COVID-19 pandemic has resulted in changes in almost every aspect of life. The fatal consequences of the pandemic have been clearly reported, with direct and indirect effects; however, there is some evidence of a positive secondary impact, such as fewer motor accidents and reduced air pollution.

Methods. We present a model to describe the opposing effects of the COVID-19 pandemic on mortality, taking into account external pressures and internal resources and their relationship with resilience and health behaviors, which affect mortality risk. Individuals with lower resources and from more deprived communities are likely to be more negatively affected by the external changes occurring.

Results. The COVID-19 pandemic has had both a positive and negative impact on mortality.

Conclusions. Decision makers should consider ways to incorporate the positive changes which occurred as part of the exit strategy. Special emphasis should be given to populations most affected by external changes, in order to build resilience and reduce disparities.

Introduction

The first cases of novel coronavirus (COVID-19) were diagnosed at the end of December 2019 in Wuhan, China. Demonstrating a rapid global spread, it was declared a pandemic by the World Health Organization on March 11th, 2020. During the first 12 months, 191 countries were affected, over 77 million confirmed cases and 1.7 million deaths were reported globally.[1] Although most infected patients experience mild or moderate disease course and good prognosis, 14% of patients experience a severe course, requiring hospitalization, with case fatality rates (proportion of those infected who died) ranging from 0.8–2.2% of all confirmed cases.[2,3] It should be noted that poor prognosis characterizes mainly elderly patients and those with co-morbidities, like hypertension or diabetes. Patients aged 75–84, for example, have an 8-fold higher risk of hospitalization compared with 18—29 year olds.[4] More deprived and less affluent communities, as well as ethnic minorities, have demonstrated higher infection rates, more severe disease and higher mortality rates.[5]

In December 2020, the vaccines of two pharmaceutical companies were approved for emergency use by the US, British, Canadian and European Union regulatory authorities.[6] However, many health professionals believe that public health measures, which were the main defense mechanism during the first 12 month of the pandemic, are likely to remain in place during 2021 and maybe beyond. These measures include social distancing, face masks and hand washing and are aimed at reducing viral spread.[7] Certain countries imposed partial or total lockdowns (“stay at home” orders) for shorter or longer periods. This contributed to the emergence of “collateral effects” of the pandemic, including avoiding medical care for acute, life threatening conditions that might be fatal.[8] Many healthcare providers urged patients to avoid visiting community-based clinics and to use telemedicine instead, to reduce viral spread.

Furthermore, at least in the first peak of the viral spread, media reports on the overload of patients at hospitals contributed to the public's fear of getting infected from other patients or staff in the emergency departments, or the inconvenience of adding workload to the already overstretched healthcare teams.[9] The radical transformation of the health care system that had to take place in a very short period of time, together with the added burden of COVID patients, probably affected its ability to maintain high-quality care.[10] A considerable proportion of elective surgery was postponed, creating long waiting lists that might lead to poorer health outcomes.[11] Beyond the direct health effects of the pandemic, lockdowns led to drastic social and economic changes, creating mass unemployment and social isolation, which in turn affect health outcomes.[12] All of the above contributed to the direct and indirect effects of the pandemic on increased mortality rate.[9]

Alongside alarming reports on the death toll, new anecdotal reports on the other side of the coin – decreased mortality - began accumulating as early as two months after the beginning of the pandemic. For example, it was reported that tens of thousands of lives were saved in China due to decreased air pollution from factories and vehicles.[13] Other reasons mentioned as contributing to decreased mortality include a decrease in car accidents,[14] work related accidents,[15] surgery related complications, including complications of anesthesia[16] and hospital-acquired infections.[17]

Pooled European data from the first 18 weeks of the pandemic demonstrated excess all-cause mortality compared with previous years. Some of this mortality is attributed to COVID-19.[18] Data in some countries (including Israel, Iceland and Norway) showed no or very little excess mortality during the first 6 months of 2020, compared with previous years,[19] indicating that while COVID increased the death rate, the unplanned consequences of the pandemic led to a reduced death rate from other causes.[20]

In the current study we propose a theoretical model to explain these contrasting influences on mortality during the pandemic and elucidate the underlying mechanisms involved.

Development Of The Model

The theoretical model is designed to enable a better understanding of the components of the model, the relationship between them and their contribution to the outcome – mortality during times of health crisis.

The model (Fig. 1) is composed of three components: external pressures, individual & community resources and outcomes.

Part a: External Pressures

At a time of great upheaval such as the present pandemic, numerous external pressures or changes exert influence on individuals and communities, affecting their behavior and way of life, and ultimately their health outcomes and survival chances. These external pressures include Environmental factors (changes

in pollution levels, traffic, climate, access to green space), Economic factors (high unemployment rate, government handouts, failing economy), Political/Organizational factors (restrictions on movement, lockdowns, instability) and Social factors (social distancing, isolation, sense of community).

Part b: Individual And Community Vulnerability

Individual resources that a person possesses include wealth (including finances, property, savings); health (both physical and mental; comorbidities); employment (stability, income, job satisfaction, flexibility - the latter being particularly relevant to the current pandemic is the ability to work remotely); and social support (both practical and emotional). These resources determine the individual's resilience and ability to adapt to change.

The resources of the community in which the individual lives further influence resilience – the existence or lack of social capital, neighborhood safety, community centers, crowded housing, investment in education, green spaces, sports facilities, transport networks and crime rates. High individual and community resources increase the ability to adapt, and reduce mortality risk associated with the major event (eg. pandemic); while low resources reduce the ability to adapt and increase mortality risk. Furthermore, individual and community resources affect health behaviors, which in turn are associated with health outcomes, for example unemployment may lead to poorer nutrition and less physical activity, and social isolation may lead to depression or increased risk behaviors such as alcohol consumption, smoking, narcotic use or unhealthy eating. High individual and community resources may increase opportunities for positive health behaviors such as more free time to do sport, reduced work pressure, more family time due to working from home as well as increasing sense of control over events. Low resources may decrease opportunities for positive health behaviors and reduce sense of control.

Resilience

According to the Salutogenic model of health, a person's confidence that they have the resources to cope with change affects their health.[21] This confidence, sometimes called sense of coherence, can provide resilience against disease and has been linked both with health behaviors and disease outcomes.[22,23] In the context of COVID-19, high individual and community resources might increase resilience and the ability to adapt to external pressures and change, thereby reducing mortality risk.[24] In contrast, low resources might reduce resilience and the ability to adapt, increasing mortality risk.

A systematic review on factors associated with resilience, which included studies from 10 different countries, found sociodemographic factors that protected against health risk, including education, employment, marital status, income, area of residence and social relations as well as gender.[25]

Figure 2 presents a schema of the factors thought to be associated with decreased and increased mortality during the COVID-19 pandemic (part C of the model).

Part c- Outcome

Increased mortality rate

Alongside the deaths directly caused by COVID-19, there are rising concerns due to the dramatic decline in health care utilization leading to delayed diagnosis of disease, including acute life-threatening conditions. Despite increased availability of telemedicine services, patients who are not technologically proficient may be at greater risk of missing out on essential care. Patients with fewer resources, including older patients, those with a language barrier (immigrants), or without internet access, will have more obstacles to accessing telemedicine. It has been demonstrated, for example, that social networks influence individuals' adaptation to new technologies in organizations.[26] Older senior citizens (70+) have been found to use the internet less frequently. The increasing number of public and private services that are re-designed as online solutions, and the emergence of new applications, further excludes those seniors, and others with low digital literacy, from active participation.[27] In times of a health crisis, access to online sources of information and advice is especially important.

In Israel, during the first wave of COVID-19 in April 2020, emergency departments (ED) reported a decline of 80% in visits, 40% in surgery rates and 30% in pediatric visits. Compared to the previous year, there has also been a worrying declining trend in the use of community medical services, including fewer physician consultations (by ~ 40%), lab testing (by ~ 50%) and referrals to imaging units (by ~ 40%).[28,29] Emergency medical services also reported a 22% increase in the mortality rate for patients outside of hospitals.[30] Populations at higher risk, such as breast cancer patients, reported less contacts with health care professionals during April 2020.[31]

Additionally, social distancing used as the main mitigation strategy during the current pandemic, has had a substantial impact on both the economic situation and mental health state of individuals. The prevalence of depression has increased by approximately three-fold.[32] Mounting experience shows that large scale events such as the current pandemic are almost always accompanied by a myriad of mental health consequences with increased rates of depression, post-traumatic stress disorders, substance abuse, domestic violence and child abuse. [33]

As such, there are great concerns about a significant rise in suicide rates and acute stress-related medical conditions, such as acute myocardial infarction or acute ischemic stroke—which can ultimately result in increased mortality.[33] Individuals with pre-existing mental health issues or at risk of social isolation, start from a more precarious point, and are more likely to feel the negative effects of the changes.[34,35]

Individuals with lower social resources, lower economic resources and greater exposure to stressors (losing a job, death of a family member from COVID-19, experiencing financial problems) were more susceptible to depression in a US study:, with respondents with lower income at 2.37 times higher risk of depression.[36] A survey conducted before the pandemic demonstrated that people with low family savings

had more depressive symptoms.[37] In times of health and economic crisis like the current pandemic, the absence of a financial safety net in the form of family savings, job security or property might explain the higher prevalence of depression among the weaker segments of the population.

Depression increases mortality rate via two main mechanisms: Increasing suicide rates and poor health outcomes related to lower adherence to treatment and fewer health promoting behaviours. For example, depression in patients with diabetes is associated with poor diabetes control and increased mortality.[38]

Decreased mortality rate

Mitigation strategies implemented across the world have included temporary lockdowns for a majority of the population, and social restrictions, with continued employment allowed solely for those considered essential workers. Less traffic has led to lower rates of car accidents (a decrease of ~ 20%),[39,40] work-related accidents (~ 70%)[15] and air pollution (~ 30%).[13] Lower rates of in-hospital procedures have also been reported, resulting in a decrease in hospital infection rates (by ~ 20%) and other complications, such as those related to anesthesia.[41] The isolation strategy forced the closure in many countries of all educational institutions, as well as most leisure activities, keeping children at home and under their parents' supervision, which may explain decreased child injury such as falls or motor vehicle accidents.[42] Imposed restrictions initiated by the pandemic may also have had a positive influence. Transitions to remote working from home may reduce stress related conditions often associated with hectic working and commuting routines. However, remote working is only possible for those in certain jobs, generally more stable and better paid professions, while individuals in physical or menial jobs, often more precarious to begin with, do not reap this benefit.

Discussion

The COVID-19 pandemic has impacted the entire world, causing a global health challenge, and an escalating number of deaths. The pandemic has affected every sphere of daily life, influencing health, social life, employment and environment. While in some countries significant excess mortality has been reported, in others, excess mortality has not been demonstrated in 2020, with COVID deaths compensated for by decreased mortality in other spheres. While evidence of this secondary positive impact is encouraging, and possibly a 'silver lining' of the pandemic, the worrying fact is that disadvantaged groups, with lower resources at their disposal are likely to bear the brunt of the pandemic.

Sociodemographic characteristics affect the impact of COVID on individual behaviors, whether in a positive or negative direction, with the most disadvantaged members of society – with less resources and resilience - potentially suffering more, as has been demonstrated in some countries.

One notable example is the move to home working arrangements for many businesses, which has led to a significant reduction in air pollution and a reduction in the rate of car accidents, however this arrangement is only available to a proportion of workers, leaving those with more precarious menial jobs at an even greater disadvantage. Furthermore, individuals with low digital literacy are left behind in the

current pandemic in terms of social support, receiving information and accessing resources which have all transferred to online versions.

Short and long-term impact

In the short term, closure of businesses and remote working from home led to a reduction in both work related accidents and traffic accidents, as well as a drop in ED visits. In addition, due to media campaigns and government policies, the importance of hygiene has been emphasized and increased, potentially reducing the spread of other viral illnesses. While reduced exposure to healthcare services may involve reduced medical errors and in-hospital infections, a decrease in community medicine referrals alongside continuing decrease in ED visits, may lead to chronic patients and high-risk populations avoiding treatment. For example, patients with ischemic stroke who hesitate before going to the ED might arrive too late for intervention that might reduce long-term complications.[43]

Long term social, economic and health impacts are expected to comprise the largest challenge for health care systems. The pain and suffering of the pandemic are not equally borne, with the pandemic imposing disproportionate risk and impact based on structured ethnic, class and occupational inequalities. In the words of Lisa Boleg, with 32-years' experience with the HIV/AIDS epidemic in the United States, "We're Not All in This Together".[44]

The economic and social implications of the pandemic are still only partially understood. However, it is clear that job losses are greater for ethnic minorities and less educated individuals. [45] Vulnerable populations are over-represented in occupations that require more interpersonal contact and cannot be performed remotely, and are therefore both at greater risk of exposure, and more prone to unemployment, with all its negative consequences.[5,46]

Despite the positive influence of decreased air pollution and hospital acquired infections, quarantine and isolation is expected to increase the rate and severity of mental illness and suicides. This is also likely to disproportionately affect individuals with low resources and resilience. For example in the South Korean economic crisis of 1997, suicides were more prevalent in those with lower educational level.[47]

Additionally, avoiding medical treatment due to fear of infection or overload on the healthcare system, may delay timely diagnosis of diverse risk factors and health conditions, including for example abnormal lipid profile, hypertension and pre-diabetes. In the long-run this will cause an increase in the prevalence of diabetes and cardiovascular diseases leading to increased mortality rates for acute conditions such as myocardial infarction and stroke.

The proposed theoretical model might help policy makers, healthcare professionals and researchers to have a better and more holistic perception of the consequences of the pandemic. Implicitly, the mission is to create a better balance between the opposing forces of the scale, with reduced overall mortality. Indeed, not all the components on both sides of the scales are amenable to intervention within the health system; some - like the economic burden that contributes to ill health – are beyond its scope of influence,

yet should be taken into consideration by government decision-makers. Yet, much can be done while the pandemic is ongoing, as well as after it abates. Special attention should be paid to the vulnerable segments of the population, where most preventive measures should be directed to reduce the health consequences of this crisis.

While developed in relation to the COVID-19 pandemic, the model is also relevant to the impact of other major events, including war, natural disaster and economic depression. The external pressures may vary, but the mechanism and essential effect of internal resources remain the same.

With both positive and negative impact on mortality, it remains unclear which way the scales will tip. However, as the long-term effects of the pandemic are likely to stay for some years, decision makers should consider diverting the resources gained from decreased mortality to better support vulnerable populations during the pandemic and as part of the exit strategy.

By shedding light on the underlying mechanisms and human behaviors that influence the outcomes of a health disaster, the model developed here can improve preparedness of the healthcare system and society at large by directing efforts to the most vulnerable populations. Based on the lessons learned from the theoretical model, it is recommended to define a governmental body responsible for identifying and caring for populations at risk during a health disaster. Such a body would examine how to prevent or at least reduce the widening of disparities, in order to tip the scales towards lower mortality.

In mid-December, with the start of the vaccination program, the light at the end of the tunnel is beginning to emerge. However, given limited initial supplies of the vaccine, which should eventually dramatically decrease viral spread, it might still take many months before a considerable part of the world will be vaccinated. Being able now to look beyond the pandemic, it is important to delineate which factors move the arms of the scales in the "right" direction and try to preserve these processes when life returns to some kind of normal.

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Figures

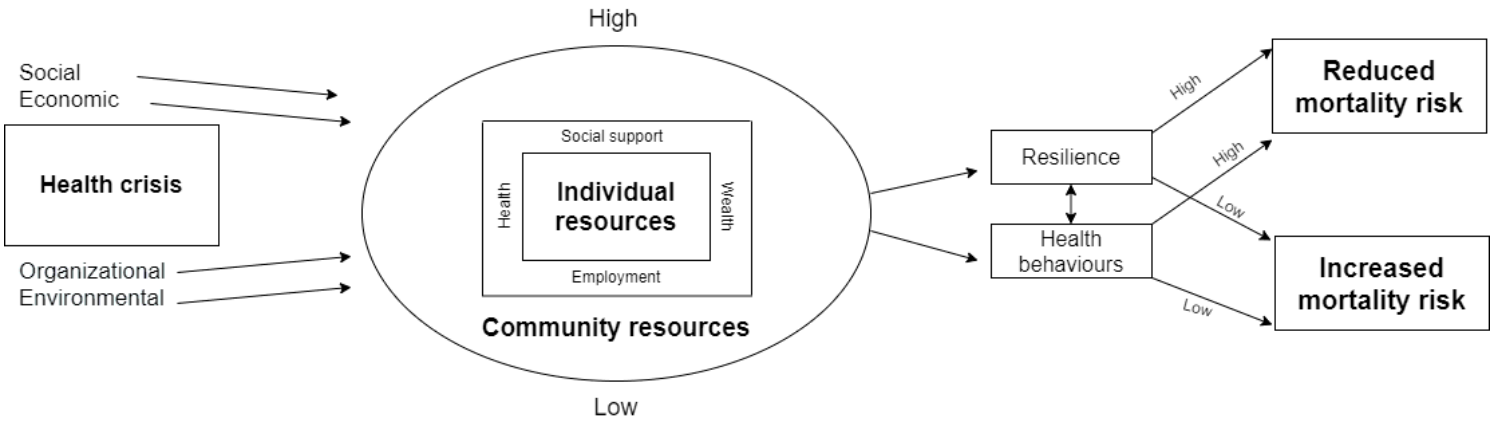

Figure 1

A theoretical model describing the opposing factors influencing mortality during a health crisis.

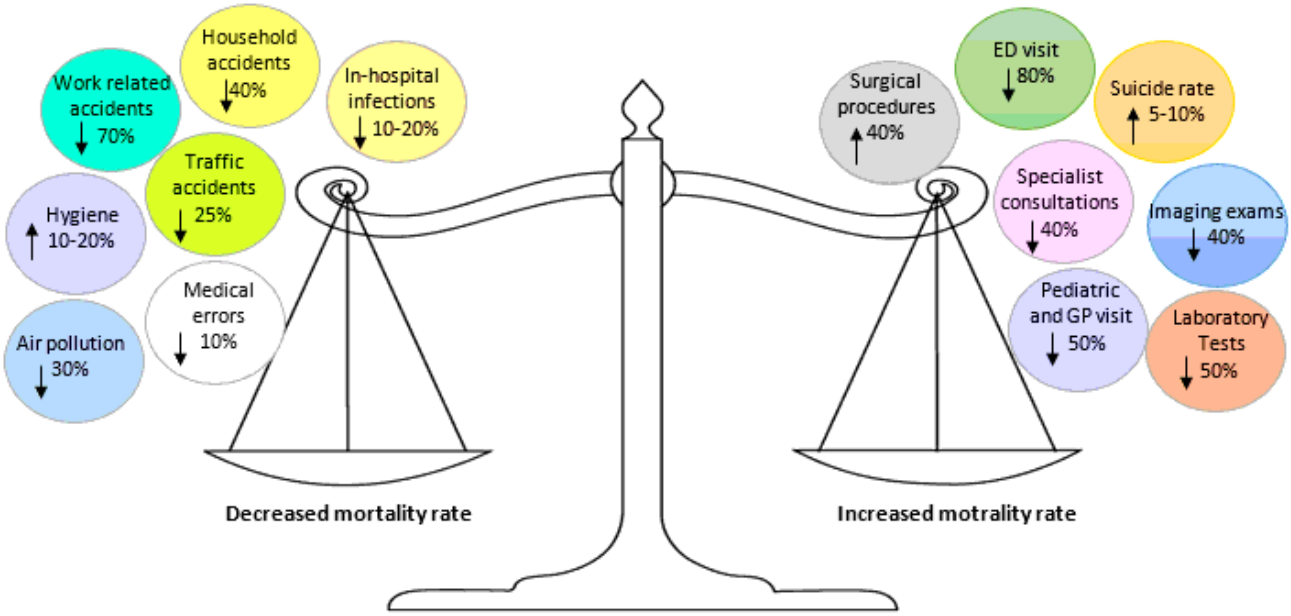

Figure 2

Mortality scales: Factors that increase or decrease mortality during the COVID-19 pandemic.