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Refining the role of behavioural and social sciences in pandemic response post-COVID-19

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Note. The SI provides additional examples of data illustrating why individuals could reasonably have been heterogeneously rational during COVID-19 (i.e., why some may have been more or less concerned or more or less supportive of uniform measures). These tables are not exhaustive, nor are they intended as a policy-making reference or an endorsement of any particular viewpoint. Their content does not imply the superiority of one perspective over another, as exceptions and further nuances exist on both sides of the claims. Rather, they illustrate why individuals might reasonably experience heightened or lowered concern.

Table 1: *Reasons Why COVID-19 (C19) Might Evoke Heightened (vs. Reduced) Concern*

CATEGORY	REASONS WHY C19 MIGHT EVOKE UNIFORM HEIGHTENED CONCERN	REASONS WHY C19 MIGHT NOT EVOKE HEIGHTENED CONCERN FOR ALL
Deaths	By December 31st, 2020, the official death toll around the world was 1,813,188.[1] *Vulnerable* individuals might be more concerned, as C19 is more lethal for those who are > 65[2] or who have comorbid health conditions (e.g., lung or heart disease, diabetes,[3] obesity). Several studies support this pattern. • Early studies[4,5] showed that fatality was highest in persons aged ≥85, ranging from 10% to 27%.[6] • Early data from Italy outbreak suggested the median age of individuals infected with SARS-CoV-2 who died was 80 years[7]. • In the US in 2020, 81% of C19 deaths occurred among those over the age of 65;[2] other estimates note that individuals over 80 accounted for approximately half of all C19 deaths.[8] • In many places, the majority of documented C19 deaths in 2020 occurred in elderly care facilities: 75% in Australia,[9] 61.3% in Belgium,[10] and more than 81% in Canada.[11] Other places (Hungary, Slovenia) observed lower percentages of C19 deaths in such facilities (7 and 9%, respectively).[11] In the US, residents of long-term care facilities accounted for more than 35% of all C19 deaths, despite comprising less than 1% of the population.[12] • Among the non-elderly, risk predisposition was driven by comorbidities. • CDC reported that there were 4 additional causes or conditions per death, for deaths with conditions or causes in addition to COVID-19.[13]	The same data from the left column suggests that in contrast to the vulnerable individuals, those who are < 65 and without severe comorbidities[5,13] experienced low likelihood of death. • Risks of dying from C19 were heavily stratified by age and risk factors[6,12] since the beginning of the pandemic. • Based on CDC data reported early in the pandemic, individuals aged 85 years and older had an estimated 630-fold higher death rate than individuals aged 18 to 29 years.[16] • Early studies[17] showed <1% fatality for individuals below 54 years. • Deaths to children remained exceedingly rare[6] (e.g., the first study of C19 in US showed no fatalities for people 19 and younger).[6]

	• While other comorbidities may be contributing causes to deaths, a UK study on hospitalized cases noted that people with a positive SARS-CoV-2 PCR test died as a *direct* result of C19 infection (rather than C19 being an incidental cause).[14] Another study in Germany (2021) reached a similar conclusion.[15]	
Excess Deaths	The statistics regarding all-cause excess deaths - sudden upticks in deaths beyond what is typically expected - may be a critical indicator of pandemic severity. This data may be interpreted as further evidence of C19 dangers. • WHO estimates suggested an excess mortality in 2020 to be at least 3,000,000.[1] • Numerous countries documented more deaths than what is typical.[18-20] In Europe, for instance, Spain and Italy observed the highest excess mortality rates during the early stages of the pandemic (54.3% and 49.6%, respectively).[20] • 74% of funeral homes in the US observed an increase in the number of families they served.[21] • Excess deaths may result from both (un)documented C19 infections and non-C19 causes, such as delayed medical care or mental health crises.	As noted in the left column, excess deaths may result from both (un)documented C19 infections but also from *non-C19 causes*, such as delayed medical care or mental health crises. • Individuals may delay preventive or therapeutic care due to fear of C19.[22] • By June 2020, 41% of US adults had delayed or avoided medical care because of concerns about C19.[23] • In US, there were delays and decreases in identifying new cancers and delivery of treatment.[24] • Delays in, or discontinuation of cancer treatment particularly impacted members of racial and ethnic minority groups, and those who are residing in socioeconomically disadvantaged areas.[25]
Hospitalizations and Preservation of Healthcare Systems	There was a sharp rise in hospitalizations and risk of overwhelming health care systems to the point where they are unable to deliver appropriate care to others.[26] • Elderly individuals and those with severe comorbidities were at far greater risk of needing hospital care.[27-31] • Obesity was a major comorbidity, with 50.8% of adults diagnosed with C19 in US hospitals from March to December 2020 classified as obese and 28.3% as overweight.[30]	Risk of hospitalization was stratified by age and pre-existing health conditions; individuals who are <65 and without severe comorbidities were at low risk of needing hospitalization.[27-31] • For instance, the risk of hospitalization can range between 0.80% (ages 18-29) to 12.43% (ages 55-64), with pre-existing conditions further increasing the likelihood of hospitalization.[17] • Certain measures significantly limited hospital capacity.[32,33]
Post-Acute Sequelae of COVID (PASC or known as Long Covid)	While deaths and hospitalizations disproportionately affected elderly individuals and those with pre-existing conditions, anyone infected could develop PASC.[34] It may evoke concern even among otherwise healthy individuals and children.[35]	Vulnerability to PASC varies by risk factors. In addition, individuals might not be greatly concerned due to the following reasons: • It remains unclear if PASC differs significantly from other post-viral syndromes.[39] Definitional challenges

	• Purported to affect between 10-30% of non-hospitalized cases, and 50-70% of hospitalized cases.[36] • Reviews suggested that most PASC cases were among non-hospitalized patients who had a mild acute illness.[36] • Symptoms may persist for up to two years, and in some cases, may be lifelong.[36] • There are more than 200 symptoms associated with PASC.[37] • Due to its potential impact, it was labeled as a 'mass disabling event.'[38]	and absence of consensus regarding PASC complicate research consistency.[40] • Influenza recovery can be debilitating, too[41] and it can severely affect lung and brain function.[42] Major complications from flu may emerge even among healthy individuals.[43] • One study found that both individuals with and without C19 antibodies reported similar PASC-like symptoms, suggesting that such symptoms may not be exclusive to prior infection.[44] • Heightened focus on PASC may have also generated hypervigilance about its symptoms, which was also linked to lowered well-being.[45] • Some instances of long C19 are predicted by a person's pre-infection level of psychological distress.[46]
Comparison to Influenza	By numerous metrics outlined above (hospitalizations, deaths, and cases), C19's impact surpasses the endemic viral illnesses, such as influenza. C19 might evoke greater concern because in contrast to influenza, C19: • Is more contagious.[47] • Results in longer periods of testing positive.[47] • It may lead to more respiratory complications[31] and higher mortality.[48] • One study[31] found that mortality among hospitalized individuals was higher in younger patients with C19 (vs. influenza), even though children were at a lower risk of hospitalization for C19. • Recent analyses[49] of 2022-2023 data show C19 was associated with more severe disease outcomes than influenza (or RSV), though those differences were less pronounced in 2023-2024.	C19 and influenza hospitalization records are not directly comparable, primarily due to differences in testing policies, hospitalization criteria, and coding practices. In contrast to C19, influenza surveillance did not require or encourage the following tracking: • Testing of symptomatic and asymptomatic individuals. • Routine testing of all patients who sought medical care. • Influenza virus testing was not required for diagnosing influenza in outpatients with suspected infection but was recommended for all hospitalized patients with suspected influenza; routine testing of asymptomatic individuals was not recommended.[50] • Because asymptomatic influenza infections are rarely tested, direct comparisons of total cases or mortality are limited.

Cases and Tracking	C19 spread at an unprecedented rate, with millions of confirmed cases worldwide in a short time. • By December 31st, 2020, there were more than 83,000,000 cases around the world; more than 200,000,000 new cases were documented in 2021.[51] • Unlike other respiratory illnesses, C19 had a significant proportion of asymptomatic or presymptomatic carriers, making transmission difficult to detect and control.[52] • Super-spreader events demonstrated how a single individual could infect dozens or even hundreds of people, amplifying the need for strict containment measures.[53] • The emergence of new variants increased the risk of reinfection and prolonged the pandemic. Some evidence pointed towards newer variants increased transmissibility and severity.[54]	While disease tracking itself is routine,[55-57] sustained tracking methods for C19 were incomparable to any other recent illnesses in important ways. • Widespread campaigns encouraged testing of both asymptomatic and symptomatic individuals, and this approach was sustained for many months, deviating from practices used for other novel illnesses (e.g., including H1N1, although those were also tracked[57]). • Moreover, as part of efforts to monitor an evolving crisis, deaths occurring within 28 or 60 days of a positive test were included in certain COVID-19 surveillance counts in some jurisdictions.[58-60]
Forecasting Information	Early models indicated significant risks of widespread cases, hospitalizations and deaths, which then encouraged the spread-reduction campaigns (e.g., 2-weeks to stop the spread). • In BSS, researchers estimated that the "catastrophic death toll was largely preventable."[61] • The sheer uncertainty in modeling complex, evolving threat can lead to either over-estimating, or under-estimating the spread and impact.[62] Because of the inherent uncertainty, modelers recommended efforts to reduce the spread.[63]	C19 models were criticized for insufficiently accounting for stratified risk factors, treating populations as homogenous rather than recognizing the vast differences in vulnerability.[64-68] • Furthermore, compared with previous respiratory outbreaks, C19 was subject to extensive tracking, contact tracing, and repeated testing, complicating assessments of its actual impact.

Table 2: *Reasons for Support and Skepticism Towards Different Interventions*

INTERVENTIONS*	REASONS FOR SUPPORT	REASONS FOR SKEPTICISM
Vaccination Against Symptomatic and Severe Outcomes (Severe Disease, Hospitalizations, and Deaths).	• Early trials showed that C19 vaccines had high efficacy against symptomatic C19 in previously uninfected individuals, with several vaccines reporting relative risk reductions >90%.[69-73] Many studies also indicated protection against severe outcomes, making the vaccines central to pandemic strategies, particularly for protecting high-risk populations. • Older adults and those with comorbidities experience a greater absolute reduction in severe disease and hospitalization.[73] • At the population level, widespread vaccination significantly reduced hospitalizations and mortality. Vaccination can not only reduce an individual's own chances of adverse outcomes, but they can help reduce the burden on the healthcare systems.[74] • Vaccines may be effective at reducing the prevalence of PASC.[75-77] • Even a small drop in absolute risk reduction may be substantial at the population level.	• The > 90% efficacy figures reflect relative risk reduction (i.e., risk reduction compared with an unvaccinated group), not absolute risk reduction (i.e., the difference in event rates between vaccinated and unvaccinated groups).[78,79] In pivotal trials, the absolute risk reduction for symptomatic COVID-19 was 1.2% for Moderna and 0.84% for Pfizer-BioNTech.[79] • To an individual with a low baseline risk of hospitalization and severe outcomes,[80] the absolute benefit of vaccination is naturally smaller, since their risk of serious illness is already minimal.[73] • The absolute risk reduction for hospitalization, severe disease, and death were below 1%, based on data from the AstraZeneca[81] and Pfizer[82] reports. • Prior infection might further obfuscate the reported effectiveness of the vaccine, leading to significant country-level differences in rules. For instance, US public health guidance generally recommended vaccination even after prior infection, while EU recognized certificates of recovery for up to 180 days.[83]

Vaccination Effectiveness In Reducing Transmission	• C19 vaccines may reduce transmission of the virus.[84] • Early public health messaging suggested that vaccines stop transmission,[85] which was echoed in media.[86,87] • AstraZeneca testing[81] showed the potential for their vaccine to reduce asymptomatic transmission of the virus, showing "first indication of reduction in disease transmission of up to 67%."[71] • Vaccination helped individuals clear the virus faster.[88]	• Transmission reduction was not tested for Moderna and Pfizer.[89] AstraZeneca noted that transmission studies were not included in the analyses, but relied on a surrogate (weekly swabs from volunteers) to infer the potential effects on transmission; they acknowledged the exploratory nature of the results and invited future investigation.[81] • At the height of their infection, both groups (i.e., vaccinated and unvaccinated) had similar viral loads,[90] which is a common proxy for infectiousness, although the relationship between viral loads and infectiousness is not fully established.[91]
Vaccination Mandates	• BSS assessments of evidence showed that vaccination policies (mandates, passports, or financial incentives) can increase vaccination uptake.[92]	• Not all individuals were vulnerable to serious C19 outcomes in the first place, making the mandates to low-risk groups such as university students practically questionable.[80] • Mandates were most effective for individuals who were at low-risk of getting seriously ill from C19 (especially those who were under 30[93,94]).
Masks	• Early reviews indicated that public mask-wearing was most effective in limiting virus spread when compliance rates were high. Due to shortages of medical masks at the time, experts recommended the widespread use of cloth masks as a source control measure, alongside hygiene practices, physical distancing, and contact tracing efforts.[95] Others similarly recommended adoption of widespread mask wearing.[96] • CDC data showed that cloth masks, surgical masks, and respirators were associated with 56%, 66%, and 83% lower odds of testing positive for C19, respectively.[97] • A widely cited Bangladesh mask study[98] noted that surgical masks reduced the probability of exhibiting C19 symptoms from 8.60 to 7.63%, with symptomatic seropositivity reduced from 0.76% to 0.68%. • Another study[99] measured the difference between cases during masking mandates and no mask mandates in the	• Relying on evidence up to October 2022, the Cochrane review concluded: "There is uncertainty about the effects of face masks."[101] • The fine print of the CDC infographic[97] notes that the difference between no mask and cloth mask is not statistically significant, although it is visually striking. • Out of the studies that show support for masks, the reduction in cases might not be seen as significant, especially if individuals are already at low-risk of getting seriously ill from C19. Moreover, Bangladesh study re-analysis showed non-significant results[103] and school-based investigation could have been influenced by confounds.[104] • While respirators, such as N95s, offer better protection against respiratory infections, medical mask efficacy was uncertain.[105] On the other hand, one study[106] found that N95 respirators were not significantly better than

	number of cases per 1,000 (ranging from 39.9 for students to 81.7 for teachers). • Stronger evidence supports the effectiveness of well-fitted N95 masks in healthcare settings.[100] • Masking would have been more effective, had individuals complied with the mandates and worn properly fitted masks. • The quality of evidence challenging mask effectiveness, including the Cochrane review[101] cited in the right column, has been subject to debate (due to, for instance, confounding factors, inconsistent mask usage).[102] Moreover, the Cochrane review does not directly settle whether mask wearing itself reduces individual risk of contracting or spreading respiratory viruses.	medical masks at preventing C19 infection among healthcare workers during routine care, given multiple opportunities for transmission in non-health care service areas (e.g., lunch rooms).
Quarantine and Travel Restrictions	• Countries that implemented early quarantine and travel bans (e.g., Australia, New Zealand) saw significantly lower transmission rates.[107-109]	• Lockdowns and similar restrictions had significant economic and psychological consequences, disproportionately impacting lower-income or younger populations.[110-113] • Moreover, although Sweden experienced higher excess mortality earlier in the pandemic than neighbouring Nordic countries with stricter initial restrictions, one analysis of 2020-2022 found that its cumulative excess mortality was comparable to estimates for Denmark and Norway, and lower than that for Finland.[114] This raises questions about the trade-offs between immediate crisis management and long-term societal impacts of interventions.

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