COVID-19 zugzwang

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Commentary

COVID-19 zugzwang: Potential public health moves towards population (herd) immunity

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ABSTRACT

COVID-19 is pandemic, and likely to become endemic, possibly returning with greater virulence. Outlining potential public health actions, including hygiene measures, social distancing and face masks, and realistic future advances, this paper focuses on the consequences of taking no public health action; the role of natural changes such as weather; the adverse public health consequences of lockdowns; testing for surveillance and research purposes; testing to identify cases and contacts, including the role of antibody tests; the public health value of treatments; mobilising people who have recovered; population (a synonym for herd) immunity through vaccination and through natural infection; involving the entire population; and the need for public debate. Until there is a vaccine, population immunity is going to occur only from infection. Allowing infection in those at very low risk while making it safer for them and wider society needs consideration but is currently taboo. About 40–50% population immunity is sufficient to suppress an infection with a reproduction number of about 1 or slightly more. Importantly, in children and young people COVID-19 is currently rarely fatal, roughly comparable with influenza. The balance between the damage caused by COVID-19 and that caused by lockdowns needs quantifying. Public debate, including on population immunity, informed by epidemiological data, is now urgent.

1. Introduction

In public health, as in chess, planning well-ahead is essential. Many leaders, however, are hesitant about articulating long-term plans for tackling the COVID-19 pandemic. Discussing future options might distract from the stay-at-home and social distancing messages. Leaders are focused on immediate tasks including 'the peak' of hospitalisations and deaths, but reaching it will mean negotiating treacherous downhill terrain [1].The COVID-19 pandemic has placed us in zugwang-a position in chess where every move is disadvantageous where we must examine every plan, however unpalatable.

Curative treatments and vaccines may be long-delayed and lockdowns harm the public's physical and mental health and not just the economy. Mass testing will not be feasible globally especially in many low and middle-income countries, as it is in the well organised, advanced economies like the US and Germany. We need to think beyond these interventions.

An overview of public health options is summarised in Table 1, constructed around the classic public health triad of primary (stop it occurring), secondary (pick it up early) and tertiary prevention (minimise the consequences) and interventions on the viral agent, host/population and environment [2]. This classification is normally applied to individuals but in this paper I also use it for populations. This analysis fits with the WHO strategy update published on 14 April 2020(3) and subsequent updates on its website, and an outline of options by Bedford et al. [4].

I focus on 10 core public health issues considering their relevance to population immunity, commonly called herd immunity, and used here as a better synonym. This is the protection from a contagious disease that the community enjoys because a high proportion of people are immune, thereby impeding transmission of infection from person to person. It is normally invoked through vaccination but also occurs naturally [5,6].

Many important matters are in the table that are not fully discussed in this paper e.g. that research on the transmission, infective dose and changing genetics, and especially virulence of the virus (agent), is essential (column 1, Table 1). Pinpointing the causes of the high risk in older populations, males, and people with cardiovascular disorders and type-2 diabetes is paramount. I assume that interventions targeted on the host/population including hygiene measures, avoiding handshaking and social distancing will be prolonged, that lockdowns will be imposed perhaps intermittently and with variable intensity, and that the role of face masks and temperature checks in public life will become clearer

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Table 1
The levels of prevention in relation to the causal triad of virus (agent), the human host and the environment (physical and social) and the control of Covid-19, applied at both individual and population levels (or both).

Levels of prevention	The causal triad of agent, host and environment		
	Virus (agent)	Human host	Environment (physical and social)
Prevention before disease occurs (primary)	Research and actions to reduce the risk of cross-species crossover of microbes Genetic and other research on viral transmission, role of asymptomatic people in transmission, duration of infectivity, role of super spreaders, infective dose, virulence factors and pathogenesis Public health actions, therapies and vaccines guided by the above research	Social/physical distancing Lockdowns restricting movement of individuals and populations Hand hygiene, including avoiding touching the face Cough hygiene (including face coverings/masks) Research on efficacy of different kinds of facemasks for use in public settings Personal protective equipment for healthcare and social care staff and others at high risk of acquiring or transmitting infection Vaccination (in future) to induce personal and population (herd) immunity Shielding of people at high risk e.g. the elderly and those with underlying disorders, especially immune disorders, diabetes, cardiovascular diseases and chronic respiratory disorders Isolation of suspected cases and quarantine of definitive cases to prevent transmission to uninfected people Genetic, clinical, epidemiological and other research to establish susceptibility factors to guide preventive strategies	Public health surveillance & research, including analysis by subpopulations e.g. by sex, age group, social-economic group, ethnic group etc Global cooperation in developing interventions Physical, social and legislative environment that allows everyone to participate fully in the measures required, especially incentives for self-isolation and quarantine Health services, care services and isolation/quarantine services Improved housing (including housing the homeless) Environment reorganised to enforce or promote social/physical distancing e.g. 2 m markings on the floors of shops Closure of public places (lockdown) on an intermittent and variable basis according to resources and local context Hygiene facilities in public places Workplaces where social/physical distancing and hygiene measures are in place Manufacturing and distributing protective equipment Maintenance of an environment that minimises diseases e.g. reduced air pollution and avoidance of further climate change through greenhouse gases Reduce impact of inequity in the incidence of infection by social and environmental change
Minimise the adverse effects of infection upon individuals and communities through early detection once it has occurred in individuals or populations (secondary)	Research on how the virulence of the virus is changing over time to prepare early for future waves Research on how the virus is transmitted Research on the infective dose Research on whether people who are shedding the virus after recovery are still infective.	Testing for early detection of individual cases and their contacts for early detection and optimal management Facemasks for people shedding the virus to reduce transmission to others Hygiene measures as above in primary prevention	Surveillance as above with special consideration to people who are seriously ill and in health and social care facilities Temperature and other measurements in public places and workplaces for early detection Apps that alert people they have been near someone who has developed COVID-19 Hygiene measures in environments e.g. cleaning metal and plastic surfaces Comprehensive health and other care, including financial help, for all people within a country Reduce inequity in adverse impacts of COVID-19 infection by social and environmental change
Reduce adverse consequences for individuals and populations already affected (tertiary)	Implement acquired knowledge on how to reduce transmission, virulence and severe pathogenicity of the virus. In future, measures to reduce the virulence and pathogenicity of the virus.	Devise new treatments to reduce adverse consequences including long-term disability and death. Treatment to reduce morbidity and mortality and reduce transmission through prolonged coughing and sneezing Population (herd) immunity from natural infection Consider allowing acquisition of population immunity from natural infection more safely e.g. in young, healthy people Accept varying levels of the reproductive rate in different subpopulations e.g. higher in younger people and lower in older people At the frontline give preference to people who have recovered and will have higher immunity than those who have not been infected	Surveillance as above, especially of outbreaks to identify risk factors, both in care settings and in population settings Hygiene and other measures as above for primary and secondary prevention in settings where the infection has already occurred Comprehensive health and other care, including financial help and housing, for all people to stop or reduce morbidity and mortality from the infection including from indirect effects e.g. starvation

(column 2, Table 1) [7,8]. Public health surveillance systems and epidemiological research must be strengthened with more accurate data on incidence, prevalence, and death rates examined by both demographic variables including age, sex, socio-economic status and ethnicity/race and clinical risk factors (column 3, Table 1). Environmental changes, permitting behavioural changes including social distancing and hygiene, especially in overcrowded housing and working settings, will be needed (column three, Table 1) as will effective, comprehensive healthcare together with financial aid for industries (column 3, Table 1).

2. Allowing the pandemic to unfold naturally

Early and even ongoing trivialisation of COVID-19 as 'just like flu' was incorrect for it is somewhat less severe in children but much more severe in older people (Table 2) [9].The World Health Organisation (WHO) estimates that about 20% of those diagnosed become seriously ill, 5% critically, and 3% die. [3] (As the number of people infected is usually unknown the infection fatality rate is variably estimated at between 0.1 and 0.5%.) If 60–80% of the world's population was infected without interventions there could be about 5-6 billion people infected with COVID-19, one billion seriously sick and up to 30 million dead prematurely. There will be indirect consequences from the infection and economic damage e.g. starvation, homelessness, poverty and mental health and physical morbidity and death. The collateral damage will be especially high in low and middle income countries and in children [10]. That happened with the Spanish flu epidemic in 1918/19 [11]. The COVID-19 pandemic arises during one of the most prosperous periods in human history permitting a more vigourous response than in 1918. Allowing the pandemic to unfold uncontrolled would rapidly produce population immunity, but this is not a palatable public health response, hence is not in Table 1.

Table 2
Illustrative data from the USA, Centres for Disease Control up from 1st February 2020 to 8th of May 2020 to show the numbers and proportions of deaths from COVID-19 and influenza (data for the age groups from 0 to 14 years combined and percentages calculated by RSB).

Country and age-group (denominator of deaths)	COVID-19 -number of deaths[a]	COVID-19 as a proportion of all deaths (denominator)	influenza-number of deaths[2]	influenza as a proportion of deaths (denominator)
US				
0–14 years (5520)	9	0.16 %	81	1.47%
15–24 years (6385)	42	0.66%	41	0.64%
25–34 years (13,532)	278	1.5%	130	0.60 %
35–44 years (19,539)	707	3.62%	206	1.05%
Data on intermediate age groups at the website below				
75–84 years (177,917)	10,196	5.73%	1308	0.76%
85 years and over (225,944)	11,458	7.35%	1210	0.54%
All ages (719,438)	37,308	5.18%	5846	0.81%

https://www.cdc.gov/nchs/nvss/vsrr/COVID19/.
(accessed 13/5/2020).
Relevant notes of explanation from the website.
Number of deaths reported in this table are the total number of deaths received and coded as of the date of analysis and do not represent all deaths that occurred in that period.
Data during this period are incomplete because of the lag in time between when the death occurred and when the death certificate is completed, submitted to NCHS and processed for reporting purposes. This delay can range from 1 week to 8 weeks or more, depending on the jurisdiction, age, and cause of death.
[3] Influenza death counts include deaths with pneumonia or COVID-19 also listed as a cause of death.
[4] Population is based on 2018 postcensal estimates from the U.S. Census Bureau [9].
[a] Deaths with confirmed or presumed COVID-19, coded to ICD–10 code U07.1.

3. Role of natural forces, like seasonal change

Pandemics can fizzle out. We hope this will happen with COVID-19. This is not a public health intervention and not in Table 1. In the Spanish flu epidemic there was a respite before the virus returned more virulently [11]. Summers might bring respite even if lockdowns are relaxed but the virus seems to survive and be contagious in most climates. Infection in summer may be less common and less severe than in winter because other respiratory infections are less common and being outdoors presents lower risk of acquiring infection than indoors. In very hot climates, however, people go indoors to escape the heat.

4. Lockdowns

Lockdowns are important in primary, secondary and tertiary prevention (Table 1, column 3). Most nations are applying strict lockdowns for 6–8 weeks, but as the WHO emphasises, this merely provides time to reduce the reproduction rate of infection (R) from about three to less than one [3]. The lockdown in Wuhan, China was severe and strict from 23 January-8 April, about 12 weeks. However, life there is not normal even now and the infection has recurred. Hubei province, where Wuhan is, has about 60 million people in China i.e. less than 5% of the population. The province, unlike countries, had access to the resources of the nation to survive.

Some economies cannot sustain even 6–8 week lockdowns and they are being lifted or breaking down within weeks e.g. after three weeks in Ghana, and some places are resisting them e.g. Brazil [12]. Prolonged lockdowns may cause more morbidity and mortality than COVID-19, especially in the poorest countries, where the populations are relatively young on average and at little risk of death. We must evaluate the health consequences of lockdowns, assessing the benefits and costs 2. Lockdowns are likely to become variable and local, depending on circumstances. Mixing amongst local populations is already occurring and widespread international travel is returning.

A UK-based strategy has suggested easing lockdowns when widespread testing is in place and when the number of daily deaths is below 500 (182,500 deaths annually), and relaxing most measures when deaths are fewer than 100 (36,500 deaths annually) [13]. The UK Government seems to be following this approach in England, with more cautious approaches in Scotland, Wales and Northern Ireland. During lockdowns population immunity is being acquired slowly, and those at highest risk of severe morbidity and death are being shielded. Population immunity will be accelerated as lockdowns are eased.

5. Testing: surveillance, research, isolation and contact tracing

Testing is vital for both primary, secondary and tertiary prevention, and helps identify places where the disease has not yet occurred (Table 1, column 2). WHO has emphasised testing as key until a vaccine or a cure are discovered(3) but the reasoning is seldom explicit to the public.

Testing in selected populations is essential for public health surveillance and medical research to establish the incidence, prevalence and outcomes of the disease (Table 1, column 3) [14,15]. Such data help adjust our plans through feedback including indicating the proportion of the population that has acquired the infection and is potentially immune.

The benefit of detecting the virus or the viral antigen in suspected cases is accurate diagnosis for clinical management (including protection of frontline staff) and to permit isolation/quarantine of proven cases.

Tracing of contacts becomes possible so they can be isolated to minimise spread. This is better than asking everyone with respiratory symptoms to isolate without doing tests but it requires extensive public health infrastructures (in addition to apps) and access to laboratories and testing kits (column 3, Table 1). To work, both testing and feedback of results must be prompt. Testing helps control the acquisition of population immunity.

Testing for virus and antigen is also useful to check whether people recovering from COVID-19 can return to normal without infecting others or harming themselves by premature activity (tertiary prevention) (column 2, Table 1). People who have recovered will need to be careful as their immunity may be partial and some may continue to shed the virus [16]. Some recovered people, especially in essential services who have already returned to work, may be shedding virus but whether these people are contagious needs research.

5.1. *Antibody testing*

Immunity to respiratory viruses is complex but cellular responses by macrophages and lymphocytes, including T-cells, are critical [17]. Antibody, whether IgM or IgG, is a marker of potential immunity but its absence does not necessarily imply lack of immunity. People who have recovered from proven COVID-19 must be partially immune [18]. Adults with mild or even asymptomatic illnesses may not mount a strong antibody response but like children probably have a strong, innate defence system [17,18].

We need an accurate antibody test to identify, retrospectively, people who have been infected and several are available. When the population prevalence is about 5% as is the case in many countries, even at 99% sensitivity and specificity only about 82% of positive tests are correct (predictive power of a positive test) [14]. Higher accuracy could be achieved by using more than one kind of test. People who have self-isolated because of typical COVID-19 symptoms and have antibody have probably had COVID-19 and are partially immune. Some false positives and false negatives are still inevitable [14,15]. Nonetheless, antibody tests are invaluable for measuring the prevalence of population immunity (Table 1, column 3). Surprisingly, the accuracy of a test required to measure prevalence is usually different from the accuracy required for clinical practice [14].

6. Mobilising people who have recovered

We need to normalise recovered people, especially those delivering essential services. The concept of immunity passports has been discussed. Immunity passport implies a guarantee that cannot be given but a certificate indicating that a person has had the infection, has recovered clinically and is likely to be partially or wholly immune is more accurate [19].

The number of eligible people globally could soon be in the hundreds of millions so the clinical, ethical, legal, and practical issues arising need urgent consideration [20–22]. I have called for public debate including a citizen's jury [19].

7. Treatment for COVID-19 in relation to public health

The ideal treatment would be preventative i.e. it would stop the infection occurring (Column 1, Table 1). Such treatment would, however, need to be extremely safe, especially in young people without underlying disorders where COVID-19 is rarely fatal (Table 2) [9]. It would probably be unaffordable for low-and middle-income countries. More likely, treatments may attenuate the illness, reducing the duration and fatality of the infection [23,24]. They could be valuable in public health in reducing the transmission of disease, especially to healthcare workers (column 2, Table 1). This will slightly slow the acquisition of population immunity.

8. Immunity in those at high risk because of comorbidities

People with comorbidities, who are usually in the older age groups, are most severely affected by COVID-19, and especially if they have cardiovascular disorders, type 2 diabetes, hypertension, and chronic respiratory disorders [25,26]. Clearly, public health interventions should promote control of risk factors that lead to these diseases e.g. smoking, physical inactivity, high levels of alcohol consumption, high levels of salt and exposure to air pollution (column 2, Table 1). People in these groups could minimise their risk of exposure to COVID-19, await effective vaccination and benefit indirectly as population immunity through natural infection increases (Column 2, Table 1) [27,28].

9. Involving the entire population especially those most vulnerable

As the WHO has emphasised the strategy for controlling COVID-19 needs to be global, and reach out to everyone (Column 1, Table 1). TheWHO has emphasised the needs of populations in crowded circumstances, including asylum seekers, refugees and migrants, where the infection can spread readily [3,29]. Regulations and laws making it illegal or difficult to house, employ or provide health and other services to vulnerable people (e.g. undocumented migrants, who cannot access public funds), need to be reviewed, especially as international travel is problematic [30]. The pandemic hits minorities and migrants hard, given their greater overcrowding in homes and workplaces, relative poverty, the difficulties of understanding and acting upon social distancing guidelines, and the propensity to cardiovascular diseases and type 2 diabetes [31–33]. Large numbers of such populations are being infected but being relatively young, comparatively fewer will die from COVID-19, thereby contributing disproportionately to population immunity.

10. Population (herd) immunity via vaccination

Vaccination is the acceptable way of gaining population immunity, and our main hope for controlling the pandemic (columns 1 and 2, Table 1) [6,34,35]. Numerous trials to develop a vaccine are underway and the WHO has set up a vaccine task force [3]. We cannot, unfortunately, pin all hopes on vaccines as they may only work for a short time especially if the virus evolves new strains. A vaccine that is effective, proven to be safe, manufacturable in billions of doses and available globally is unlikely this year, and may take years, even decades. Proven safety is essential especially in children or young people [9]. Serious illnesses or deaths in young people following immunisation, whether coincidental or causal, could impede vaccination. In people over 70-years of age, or the immunosuppressed, where the vaccine is needed most, a strong immune response is unlikely. Efficacy of vaccines needs to be demonstrated in older groups and in those with underlying disorders.

11. Population immunity through natural infection

The technical phrase is herd immunity, with connotations of animals, rather than humans. Herd immunity provokes hostility and controversy as it is usually interpreted as allowing the pandemic to unfold without interventions. The concept needs revisiting. If safe and effective vaccines and life-saving preventative and therapeutic medications are not found, lengthy lockdowns prove impossible, and the pandemic does not disappear spontaneously, population immunity *is the only, long-term solution* (column 2, Table 1).

Everyone infected and achieving any degree of immunity contributes to population immunity [6], and this is likely to be through a combination of cellular and antibody-based (humoral) responses. The duration of such immunity is unknown although it is reasonable to assume it will last this season with some long-term benefits given exposure to the same or similar strains of the virus.

Through social distancing and lockdown measures most societies

have brought the reproduction number from about three[36] to about one or less. The proportion of the population required to be immune to control an infection is called the herd (population) immunity threshold. It is difficult to calculate this number exactly in real world circumstances. To control an infection with an R of about 1 and even somewhat higher we need about 50% of the population to have immunity (unlike measles where over 90% is needed) [5,6]. Currently, the prevalence of COVID-19 infection is variably estimated from 1 to 20% according to locality and work settings. However, if COVID-19 becomes endemic, the proportion of the population with immunity will rise fast, especially where lockdowns have been lifted [12]. This immunity will be helpful, though not fully protective, as new strains of COVID-19 will probably emerge, so people will be re-infected but probably less severely so, as is the case for influenza.

Opening up the economy, schools, colleges and social life is accepting that many people will become infected even with test, track and isolate strategies. Most young people will probably acquire the infection, often without a diagnosis as they will be asymptomatic or mildly affected. Given this, we need to minimise the already low risks of adverse effects in young people (Table 2), especially by identifying the reasons why a few become seriously ill [37,38]. Hygiene and some social distancing measures will continue to be required in homes as children and young people return to nurseries/school/colleges [4,7,8]. Some young people with immunity related disorders could be advised not to return to school or university presently, while awaiting the rise of population immunity in their classmates, which will protect them indirectly.

Young people present risks of transmitting COVID-19 to people in their household, especially parents and grandparents who have underlying disorders or are in the oldest age groups. Home school may be needed for children in these exceptional circumstances. Teachers and others in close contact with children and young people, especially those in older age groups and with chronic disorders, need shielding and/or personal protection equipment.

We need excellent facilities for diagnosis, isolation, quarantine, and treatment for these young people and their contacts as they return to normal life. The public will need to be informed frankly about the risks by comparing those of COVID-19 with infections they are familiar with e.g. influenza (Table 1) [9].

The idea of COVID-19 'parties' by young people has been met with shock. Intermingling is inevitable as workplaces, schools, colleges and universities are reopened. Young people will make decisions that are logical for them given their risks and life circumstances. Could we consider allowing young people *without underlying disorders* to get COVID-19 naturally while shielding those most at risk through continued social distancing and isolation? [13,27,28] Young people might prefer this route rather than remaining in lockdown or acquiring the infection in riskier circumstances e.g. while travelling abroad. Such people could be given advice and lightly monitored to minimise adverse effects. This is not unprecedented. Chickenpox parties were occurring even in the 1980s even though such infections posed risk to pregnant women and the ethics have been considered [39].

The acquisition of COVID-19 naturally by the young and healthy is, arguably, the safest way towards the goal of about 50% population immunity while protecting those most at risk and maximising benefits for society, whether in terms of the economy or achieving the full potential of future generations [27,28]. This question poses ethical, legal, logistical and clinical challenges similar to those arising in the proposal to test COVID-19 vaccines in healthy volunteers [40].

12. Conclusions

Allowing the COVID-19 pandemic to run its course uncontrolled must not be permitted. None of the responses of countries internationally are optimal as partly reflected in their variability [41,42]. COVID-19 has placed us in zugzwang so we need precise and detailed plans and well-calculated series of moves that minimise the harms, tailored for each country and region according to their context and resources. The pandemic needs to be prevented from returning year-on-year, potentially more severely, especially in young people and children, and mandating repeated lockdowns [3]. We urgently need to consider all reasonable public health actions and plans (Table 1).

Hope in natural forces, effective and safe vaccines and curative treatments is important but, given uncertainty, we need to consider other, admittedly difficult, paths. Adults should now reflect on and debate, together with their elected policymakers and scientific advisers, the balance of risks they accept for themselves, versus the risks imposed to wider society, and thus directly inform potential strategies. Covid-19 is having a major impact on children and their voice needs to be heard [43]. Ageism must be avoided whether through shielding or workplace policies that might inadvertently cause harm. Everyone has the right to balance risks and benefits in relation to their own quality of life. This pandemic is complex while the messages being given to the public are overly simplistic. We need global and national leadership, imagination, courage and honest public discussion to shape and influence our future [1,13].

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