Place of distancing measures in containing epidemics: a scoping review

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\textbf{ABSTRACT}

Distancing is one of the barrier measures in mitigating epidemics. We aimed to investigate the typology, effectiveness, and side effects of distancing rules during epidemics. Electronic searches were conducted on MEDLINE, PubMed in April 2020, using Mesh-Terms representing various forms of distancing (‘social isolation’, ‘social distancing’, ‘quarantine’) combining with ‘epidemics’. PRISMA-Scr statement was consulted to report this review. A total of 314 titles were identified and 93 were finally included. 2009 influenza A and SARS-CoV-2 epidemics were the most studied. Distancing measures were mostly classified as case-based and community-based interventions. The combination of distancing rules, like school closure, home working, isolation and quarantine, has proven to be effective in reducing R\textsubscript{0} and flattening the epidemic curve, also when initiated early at a high rate and combined with other non-pharmaceutical interventions. Epidemiological and modeling studies showed that isolation and quarantine in the 2009 influenza pandemic were effective measures to decrease attack rate also with high level of compliance but there was an increased risk of household transmission. Lockdown was also effective to reduce R\textsubscript{0} from 2.6 to 0.6 and to increase doubling time from 2 to 4 days in the covid-19 pandemic. The evidence for school closure and workplace distancing was moderate as single intervention. Psychological disorder, unhealthy behaviors, disruption of economic activities, social discrimination, and stigmatization were the main side effects of distancing measures. Earlier implementation of combined distancing measures leads to greater effectiveness in containing outbreaks. Their indication must be relevant and based on evidence to avoid adverse effects on the community. These results would help decision-makers to develop response plans based on the required experience and strengthen the capacity of countries to fight against future epidemics. \textit{Mesh words:} Physical Distancing, Quarantine, Epidemics, Public Health, Scoping Review.

1. Introduction

Social distancing is one of the main non-pharmaceutical measures that may be recommended worldwide to reduce virus transmission from infected persons to susceptible individuals by increasing physical distance between people or reducing frequency of congregation in socially dense community settings, such as schools or workplaces [1]. It is one of the barrier measures, in the historical continuity of the quarantine, the oldest and probably one of the most effective methods for controlling infectious disease outbreaks [2]. Today, social distancing is part of the triad of means of protection (distancing, wearing masks and frequent handwashing) against epidemics and pandemics, recommended by international bodies [3–5]. This social distancing response can be particularly useful early in an epidemic when other interventions such as antiviral drugs and vaccinations might not yet be readily available [6]. Indeed, a variety of studies have shown that human behavioral changes, such as reducing physical contacts during outbreaks, can have a significant effect [7–9].

Since the emergence of Coronavirus disease 2019 (COVID-19) pandemic, many countries have also adopted unprecedented social distancing policies, and applied severe restrictive public measures [10–13]. In fact, confining the entire population to an almost complete lockdown for several weeks; first initiative in the history of public health; can be considered controversial when excessively prolonged over time, due to many possible economic, psychological [14] and social consequences with a remarkable impact on the population, especially in low-income countries where e-commerce is not common [15]. Governments worldwide have implemented various forms of physical distancing measures with varied
stringency level and timeliness, ranging from general confinement for a period of several weeks to simply maintaining a minimum distance of 1 m during activities of daily living, to slowdown transmission and reduce mortality associated with COVID-19 [16]. Since then, there have been controversial debates among experts about the efficacy of distancing measures for controlling infectious disease outbreaks [2]. The evidence for their effectiveness is just slowly accruing [17]. Considering the continuous spread of COVID-19 throughout majority of countries, health policymakers need compelling evidence of the previously implemented policies on this similar occasion. Therefore, the effectiveness of these policies should be evaluated to standardize, rationalize the use of a basic barrier control technique in an epidemic context, to maximize profits, to reduce side effects, to promote uptake by the community and to motivate health professionals.

**Objective:** This review aims to study the typology, effectiveness, and side effects of physical distancing measures in the control of epidemics through international experience, via a scoping review of the bibliography cumulated up to May 2020.

### 2. Methods

It is a scoping review of biomedical literature to provide analysis on the role of physical distancing measures in the control of epidemics. A documentary search was conducted on 28 April 2020, on Medline via its PubMed interface, through the following documentary request: ‘epidemics’[Majr] AND (‘social distance’ [MeSH Terms] OR ‘social isolation’[MeSH Terms] OR ‘social distancing’ [All Fields] OR ‘quarantine’[MeSH Terms]). Any studies describing the types, effectiveness, and side effects of physical distancing measures in the context of epidemics were included. Texts in languages other than French or English, manuscripts with no abstract available, duplicates, commentaries, and editorials, were excluded. Eligible articles were identified, by screening titles and abstracts and reviewing full-text articles if they were available. Data extraction was done by two reviewers: a university hospital assistant and a preventive and community medicine resident, independently. In case of divergent opinions in the assessment, the opinion of a well-qualified senior in the discipline was considered decisive. Selected publications were analyzed and synthesized to extract the typology of distancing measures and their indications, Arguments of effectiveness through the international experience of the fight against epidemics, and side effects on the psychological, economic and health levels. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis Extension for Scoping Reviews (PRISMA-ScR) statement was consulted to report this review [18].

### 3. Results

A total of 314 studies were identified and 93 [1,6,8,10–12, 2, 19–98,99–105] were included in this review. The selection of eligible studies is shown in the flow diagram (Figure 1).

Among 93 articles included, 50.5% (n = 47) were published in 2020, and 11.8% in 2011. The United States of America and England were countries that published 53.8% (n = 50) of articles, mainly in public health journals. BMC public health was the journal that published 7.5% (n = 7) of papers followed by the international journal of environmental research and public health with 4.3% (n = 4) of articles. Table 1 summarizes the main bibliometric characteristics of the 93 articles included in this scoping review.

Social distancing measures were classified into two main classes. First, as individual measures also called case-based distancing such as voluntary physical distancing, isolation, and quarantine. Second, community measures called community-based distancing including school and workplace-based distancing, restriction of mobility and mass gathering, travel restriction, and total lockdown (Figure 2).

The 2009 influenza A (H1N1) outbreak and SARS-CoV-2 epidemic were the most studied epidemics. Among studies on the effectiveness of social distancing measures, 20 were modeling studies, particularly on the impact of school closures on epidemics control. School closures appear to be moderately effective and acceptable in reducing the transmission of influenza (range 1–50%). School closure alone may not be able to delay the peak until vaccine is ready to be deployed. Modeling study suggests that workplace closure lessens the attack rate to less than 5% and delays the peak by 1 week. Home working is moderately effective in reducing transmission of influenza by about 20% to 30%. Internal mobility restriction is effective only if prohibitively high (50% of travel) restrictions are applied and mass gatherings occurring within 10 days before the epidemic peak are likely to increase the risk of transmission of influenza. Voluntary home isolation and quarantine are also effective and acceptable measures but there is an increased risk of intra-household transmission from index cases to contacts. The household reproduction number would be reduced to less than one when enough symptomatic individuals comply with home confinement at symptom onset. After imposing the lockdown in China in the COVID-19 pandemic, the R0 decreased from 2.6 to 0.62. A decline in the number of infected growth rate and a significant increase in its doubling time from 2 days to 4 days was also
observed. Social distancing measures must be combined and implemented in the early stage of outbreaks to be effective. Efficiency arguments through international experience are described in Table 2.

Psychological disorder, unhealthy behavior, disruption of economic activities, social discrimination and stigmatization were the main side effects of containment measures. Health services utilization has also declined considerably in low- and middle-income countries, especially after the SARS-CoV-2 epidemic, following the suspension of non-emergency services of health facilities, and massive mobility restrictions. Side effects are summarized in Table 3.

4. Discussion

Research on the impact of social distancing on the dynamics of disease transmission has grown in relevance and importance in recent years, especially in the light of the Swine Flu in 2009 and the COVID-19 pandemics [11,78]. The global experience is teaching that distancing, containment measures and aggressive contact tracing are mandatory to keep the infection under control until an approved treatment or a vaccine is available to the global community. Over the past months, there has been an intensive and unanimous recourse to distancing measures recommended by international organizations [4] and applied by the various countries of the world [78]. In this study, we review what is currently known regarding the typology, effectiveness, and side effects of physical distancing measures, and offer an evidence-based review of current practice.

Our study has some limitations. First, terms related to distancing practices are used inconsistently in the literature and, as such, our search strategy based on four Mesh Terms; describing the main form of distancing; may have inadvertently excluded relevant articles. Second, we only reviewed publications available on the PubMed. It is possible that literature not indexed on Medline have relevant articles that are not captured and, as such, were not included in this review. Furthermore, there is an expansion of the literature since the emergence of the COVID-19, every day new relevant papers are published. Most of the included studies were based on modelling and few were in actual settings. Mathematical modeling plays an important role in better understanding the disease dynamics and in designing strategies to control the rapidly spreading infectious disease in lack of vaccine or antivirals [106,107]. Models can fill gaps when decisions must be made when there is a paucity of information. However, more epidemiological studies are needed on social distancing in actual settings.

Despite certain limitations, Medline remains the reference database in health science. We have used as keywords most of the terms used in recent years
Table 1. Bibliometric characteristics of the 93 articles included in the scoping review on the role of physical distancing measures in the control of epidemics [PubMed 2020].

| Characteristics       | Effective (n) | Percentage (%) | Cumulative percentage (%) |
|-----------------------|---------------|----------------|---------------------------|
| **Year of publication** |               |                |                          |
| 2010                  | 3             | 3.2            | 3.2                       |
| 2011                  | 11            | 11.8           | 15.0                      |
| 2012                  | 7             | 7.5            | 22.5                      |
| 2013                  | 8             | 8.6            | 31.1                      |
| 2014                  | 1             | 1.1            | 32.2                      |
| 2015                  | 6             | 6.5            | 38.7                      |
| 2016                  | 3             | 3.2            | 41.9                      |
| 2017                  | 2             | 2.2            | 44.1                      |
| 2018                  | 5             | 5.4            | 49.5                      |
| 2020 (first four months) | 47            | 50.5           | 100.0                     |
| **Country**           |               |                |                          |
| USA                   | 28            | 30.1           | 30.1                      |
| England               | 22            | 23.7           | 53.8                      |
| Netherlands           | 4             | 4.3            | 58.1                      |
| Switzerland           | 4             | 4.3            | 62.4                      |
| Australia             | 3             | 3.2            | 65.6                      |
| India                 | 3             | 3.2            | 68.8                      |
| Others                | 29            | 31.2           | 100                       |
| **Review**            |               |                |                          |
| BMC public health     | 7             | 7.5            | 7.5                       |
| International journal of environmental research and public Health | 4 | 4.3 | 11.8 |
| The Lancet. Public health | 3 | 3.2 | 15.0 |
| Mathematical biosciences and engineering: MBE | 3 | 3.2 | 18.2 |
| Indian journal of medical ethics | 3 | 3.2 | 21.4 |
| Journal of travel medicine | 3 | 3.2 | 24.6 |
| Turkish journal of medical sciences | 3 | 3.2 | 27.8 |
| PLoS One | 3 | 3.2 | 31.0 |
| Epidemiology and infection | 2 | 2.2 | 33.2 |
| Public health | 2 | 2.2 | 35.4 |
| JMI public health and surveillance | 2 | 2.2 | 37.6 |
| International medical journal of experimental and clinical research | 2 | 2.2 | 39.8 |
| Science | 2 | 2.2 | 42.0 |
| Others | 34 | 38.0 | 100 |

during several epidemics and especially which are not specific to COVID-19.

Keywords that we had used for our study on 27 April 2020, are no longer recognized as mesh terms on Pub Med. A recent change in Medline nomenclature has been made, ‘physical distancing’ has been introduced in 2021 as a new keyword. Following this, we recommend the use of a new query (Box 1) adapted to the study subject.

Additionally, a rapid review of some relevant papers [106,108,109] that were not included in our work showed results consistent with our findings.

The findings of this scoping review of 93 studies were: a conceptual diversity of social distancing measures, a concordance concerning the proven effectiveness of social distancing measures in the fight against covid-19 and 2009 influenza A (H1N1) epidemics, and several and serious side effects.

(1) **Typology of social distancing measures: Conceptual diversity**

Various distancing measures have been implemented globally to combat COVID-19 and other contagious diseases like the Swine Flu in 2009. Measures were mostly classified as Case-based and community-based distancing interventions. At the individual level, case-based distancing includes voluntary physical distancing called self-quarantine or self-isolation and mandatory measures including isolation and quarantine. At the community level, community-based distancing may be partial (by sector), it involves closure of settings in which people gather, like school or workplace closure, or total containment of population called lockdown or Mass quarantine. In the literature and publications, we reviewed terms related to distancing that were used inconsistently and were not clearly defined. ‘Social distancing’ is a term that was used earlier in the pandemic as many people stayed home to help prevent spread of the COVID-19 [5]. Now as communities are reopening and people are in public

**Box1. The new documentary request on the subject adapted to the new nomenclature of pubmed.**

\((\text{‘physical distancing’[MeSH Terms]} \text{ OR } \text{‘quarantine’[MeSH Terms]} \text{ OR } \text{‘social distancing’[All Fields]}) \text{ AND (epidemics [MeSH Terms])})\)
more often, ‘physical distancing’ is used to stress the importance of maintaining physical space when in public areas. Physical distancing is the practice of staying at least 1 meter (6 feet) away from others to avoid catching a disease such as COVID-19 [4,110].

In psychological terms, loneliness is construed as the subjective state that one is not experiencing enough social connection, whereas isolation is an objective lack of social interactions. This means one can be isolated but not lonely, or lonely in a crowd. Thus, the term ‘social distancing’ might imply that one needs to cut off meaningful interactions. A useful alternative term might be ‘physical distancing’, to help highlight the fact that social connection is possible even when people are physically separated [111]. The World Health Organization (WHO) has started using the phrase ‘physical distancing’ instead of ‘social distancing’ as a way to prevent the spread of the novel coronavirus from people to people, a move widely welcomed by experts as a step in the ‘right direction’ [112].

Diverse terminology has been used to describe distancing measures. Abdullahi L & al have clarified this diversity in a systematic review [113]. Quarantine and isolation are often used interchangeably and equivocally nowadays. As is the difference between screening and diagnosis, which is often poorly understood and causes a lot of confusion. In public health, a ‘diagnostic’ examination is performed on a subject exhibiting symptom that may suggest the existence of the disease, while a screening examination is performed on a subject not showing symptoms [114]. Our results show that there is a need for sequencing in a conceptual model clarifying the target audience and indication. The conceptualization helps to better use the barrier measures to fight against epidemics, hence the interest of our conceptual model, making it possible to better lay down the indications and avoid confusion. Therefore, the term isolation should be reserved for symptomatic patients and the term quarantine for suspected or exposed subjects who do not yet have symptoms of the disease (Figure 3).

(2) A concordance regarding the proven effectiveness of distancing measures

Multiple surveys have been instigated on the uptake of different distancing measures during various epidemics [1,6,10,11,19,20,24,27–30,34,35,38,40–42,44–46,52,53,55,57,59,78,94,105–107]. There is a concordance between epidemiological and modeling studies on the effectiveness of distancing measures studied. Based on the above, studies confirmed the positive effect of physical distancing, implementing mass quarantine and movement limitations during the COVID-19, and the H1N1 pandemics. A systematic review of 172 studies on COVID-19, SARS, and MERS showed that current policies of at least 1-m physical distancing are associated with a large reduction in infection, and distances of 2 meter could be more effective [115]. The strict
Table 2. Efficiency arguments through international experience in fighting epidemics, scoping review, 28 April 2020.

| Author, year | Measures | Epidemic | Results |
|--------------|----------|----------|---------|
| **Epidemiological studies** | | | |
| Jarvis CL, 2020 [10] | Lockdown | COVID-19 | A 74% reduction in the average daily number of contacts observed per participant (from 10.8 to 2.8) would be sufficient to reduce $R_0$ from 2.6 to below 1.0. This is based on all types of contact and 0.37 (95% CI 0.12–0.53) for physical contacts only. |
| Huang Y, 2020 [54] | Social distancing | COVID-19 | With social distancing and a range of accompanying epidemic control measures such as lockdown, the number of daily new cases decreased continually after February 12. |
| Liu H, 2020 [59] | Lockdown | COVID-19 | A significant increase in doubling time from 2 days (95% CI: 1.9–2.6) to 4 days (95% CI: 3.5–4.3), after imposing lockdown. |
| Zhang Y, 2012 [99] | Quarantine | Influenza A (H1N1), 2009 | Quarantine of close contacts allowed high-risk subjects to be monitored closely over a longer period. This has significant implications in reducing the risk of disease transmission due to timely detection of disease in those who had onset of illness several days after arriving in Beijing. |
| Miyaki K, 2011 [100] | Staying home | Influenza A (H1N1), 2009 | The policy of staying at home on full pay reduced the overall risk of Influenza A H1N1 infection in the workplace by about 20% in one flu season. |
| Paynter S, 2011 [27] | Social distancing | Influenza A | Lower mortality in rural civilians was due to the rural environment, probably due to the relative social isolation in rural areas. |
| Chu CY, 2010 [20] | Quarantine | Influenza A (H1N1), 2009 | Results support the effectiveness of quarantine in preventing a secondary outbreak of pandemic (H1N1) 2009 among contacts of confirmed cases. |
| Khanna RC, 2020 [78] | Lockdown | COVID-19 | A decline in the number of infected growth rate and an increase in its doubling time (from 2 to 4 days) was eventually achieved. The Wuhan shutdown slowed the dispersal of infection to other cities by 2.91 days. The Wukan shutdown, delays epidemic growth elsewhere in China. Other Chinese cities that early implemented preventive control measures reported 33.3% fewer cases in the first week of their outbreaks compared with cities that started control later. |
| Ahmed F, 2018 [1] | Workplace distancing | Influenza H1N1, 2009 | Workplace social distancing measures alone produced a median reduction of 23% in the cumulative influenza attack rate in the general population. It also delayed and reduced the peak influenza attack rate. The reduction in the cumulative attack rate was more pronounced when workplace distancing was combined with other nonpharmaceutical or pharmaceutical interventions. |
| Pasquini D H, 2017 [52] | Social distancing | Influenza H1N1, 2009 | Limited school closure in combination with antiviral treatments and other social-distancing policies has often been regarded as an optimum strategy in multi-intervention studies. Adult and child social distancing (meaning voluntarily staying home) is more cost-effective than closing schools, with increased cost-effectiveness if a high percentage of the population complies. |
| Rashid H, 2015 [11] | Social distancing | Influenza H1N1, 2009 | School closure appears to be moderately effective and acceptable in reducing the transmission of influenza (range 1–50%) and in delaying the peak of an epidemic by a week or two, depending on the timing of the closure. Voluntary home isolation and quarantine are also effective and acceptable. In the United Kingdom, a 30% reduction in the number of influenza cases was achieved. |
| **Modeling studies** | | | |
| Rocklov J, 2020 [57] | Isolation and quarantine | COVID-19 | Isolation and quarantine, on the Diamond Princess cruise ship, therefore prevented 2307 cases and lowered the R0 to 1.78. |
| Leung KY, 2018 [55] | Social distancing | Epidemic network models | If social distancing occurs at a high rate at the beginning of an epidemic, this can prevent an outbreak from occurring, in the sense that it lowers R0. However, moderate social distancing can worsen the disease outcome, both in the initial phase of an outbreak and the final epidemic size. |
| Esquivel-G JJ, 2018 [53] | Quarantine | Infectious disease outbreaks | The efficiency of quarantine is improved if it is jointly implemented with a self-protection process driving the number of infected individuals significantly lower. Americans voluntarily reduced their time spent in public places during the2009 A/H1N1 swine flu, and that these behavioral shifts were of a magnitude capable of reducing the total number of cases. |
| Bayham J, 2015 [46] | Voluntarily social distancing | Influenza H1N1, 2009 | Americans voluntarily reduced their time spent in public places during the2009 A/H1N1 swine flu, and that these behavioral shifts were of a magnitude capable of reducing the total number of cases. |
| Kleczkowski A, 2015 [6] | Spontaneous social distancing | Infectious disease outbreaks | Policy makers may not be able to rely exclusively on spontaneous social distancing to control epidemics but should supplement this with other measures such as enforced social distancing (e.g. school closures, event cancellations) and similar strategies. Spontaneous social distancing leads to a substantial reduction in the peak attack rate. |
| Zhang Q, 2015 [45] | Self-isolation | Influenza H1N1, 2009 | The household reproduction number (RH) would be reduced to less than one when enough symptomatic individuals comply with home confinement at symptom onset. When the time to beginning voluntary self-isolation after symptom onset increases from zero to two days, this strategy has a limited effect on reducing the transmission of influenza; therefore, this strategy should be implemented as soon as possible. In addition, the effect of voluntary self-isolation decreases substantially with the proportion of asymptomatic infections increasing. |

(Continued)
Table 2. (Continued).

| Author, year | Measures | Epidemic | Results |
|--------------|----------|----------|---------|
| Fung IC, 2015[44] | school closure | Avian influenza A (H7N9), 2013 | For every week of school closure at day 5 of introduction and a 30% clinical attack rate scenario, epidemic peak would be delayed by approximately 5 days. For a 15% clinical attack rate scenario, 1-week closure would delay the peak by 9 days. Closing schools less than 84 days (12 weeks) would not, however, reduce the estimated total number of cases. Unless vaccine is available early, school closure alone may not be able to delay the peak until vaccine is ready to be deployed. |
| Chen SC, 2015[42] | school closure | Influenza H1N1, 2009 | The basic reproduction number (R0) was <1 during weekends in pandemic periods, implying that school closures or class suspensions are probably an effective social distancing policy to control pandemic influenza transmission. |
| Ali ST, 2013[41] | School closure | Influenza H1N1, 2009 | School holidays reduced the reproduction number by 14%–27% in different regions of India, relative to levels seen outside holiday periods. |
| Li X, 2013[40] | quarantine, | Influenza H1N1, 2009 | Mandatory quarantine served to postpone the spread of the 2009 H1N1 pandemic in Beijing by one and a half months. If mandatory quarantine was not enforced in Beijing, the infectious population could have reached 1,553 by 21 October, i.e. 5.6 times higher than the observed number. |
| Milne GJ, 2013[38] | Social distancing | Influenza H1N1, 2009 | Social distancing strategies may be rapidly activated once a pandemic strain appears in a community. The most effective such strategy involves the continuous application of the combination of all social distancing interventions, namely school closure and workforce and community contact reduction. For pandemics ranging from very low to high severity in categories 0 to 5, this intervention strategy results in from 23 to 1806 life years saved (per 10,000 population) with cost effectiveness ratio from $469,517 to $4,413 per life year saved respectively. Every social distancing policy will introduce a delay in pandemic dynamics, and a social distancing policy with the right level of contact reduction implemented for the right amount of time may drive the system close to the epidemiological optimum (EPO) of infecting exactly 1–1/R0 individuals without over shooting (the ‘soft landing’). The intermediate social distancing policy that guides the system to the EPO is more optimal than a stronger social distancing policy that extinguishes the epidemic in its early phases, as the strong strategy will leave too many susceptible in the population (R effective > 1), making the population vulnerable to a reintroduction of the virus and a delayed but full-sized epidemic wave. |
| Boni MF, 2013[35] | Social distancing | Influenza H5N1 | If timely performed, case isolation is sufficient to contain a MARV outbreak. Analysis reveals that even low daily isolation probabilities (around 20%), if combined with first isolation day no longer than 2–3 days after symptoms onset, can drastically reduce the impact of the epidemic: the cumulative number of MARV deaths drops from 42.3% to less than 0.55% of the population. |
| Ajelli M, 2012[34] | Case isolation | MARV, 2005 | The effect on pandemic progression strongly depends on the timing of the start of the school closure. School closures during a late spring wave of an epidemic can cause a pandemic to become up to 20% larger but have the advantage that the average time of the peak is shifted by up to two months, possibly allowing enough time for development of vaccines to mitigate the larger size of the epidemic. |
| Towers S, 2012[30] | School closure | Influenza A, H1N1, 2009 | For every week of school closure at day 5 of introduction and a 30% clinical attack rate scenario, epidemic peak would be delayed by approximately 5 days. For a 15% clinical attack rate scenario, 1-week closure would delay the peak by 9 days. Closing schools less than 84 days (12 weeks) would not, however, reduce the estimated total number of cases. Unless vaccine is available early, school closure alone may not be able to delay the peak until vaccine is ready to be deployed. |
| Bolton Kl, 2012[29] | social distancing | Influenza A, H1N1, 2009 | In a moderate pandemic scenario, early social distancing measures decreased the mean attack rate from around 10% to 7–8%. Similarly, in a severe pandemic scenario such measures cut the mean attack rate from approximately 23% to 21%. In low-income regions, social distancing may be more effective than the large-scale use of antivirals. |
| Earn DJ, 2012[28] | School closure | Influenza A, H1N1, 2009 | Mathematical models suggested that school closure reduced transmission among school-age children by more than 50% and that this was a key factor in interrupting transmission. |
| Yang Y, 2011[101] | Quarantine | influenza outbreak | Household quarantine decrease the peak number of cases from more than 300 to around 158 for a 100% compliance level, a decrease of about 48.7%. The delay in the outbreak peak was about 3 to 17 days. The total number of cases decreased to a range of 3,635–5,463, that is, 63.7%-94.7% of the baseline value. When coupling contact in groups, household quarantine together with school closure was the most effective strategy. Earlier implementation of control measures leads to greater efficacy. |
| Chowell G, 2011[102] | school closure | Influenza A (H1N1), 2009 | The 18-day period of mandatory school closures and other social distancing measures implemented in the greater Mexico City area was associated with a 29%-37% reduction in influenza transmission in spring 2009. In addition, an increase in RF was observed in the southeast states, after mandatory school suspension resumed and before summer vacation started. State-specific fall pandemic waves began 2–5 weeks after school reopened for the fall term, coinciding with an age shift in influenza cases. |
| Prosper O, 2011[24] | Social distancing | Influenza A (H1N1), 2009 | Optimal social distancing policies alone can be as effective as the combination of multiple policies, reducing the total number of influenza cases by more than 99% during the 100-day control period, within a single outbreak, an unrealistic but theoretically possible outcome for isolated populations with limited resources. |
| Halder N, 2010[19] | School closure | Influenza A (H1N1), 2009 | The results of different school closure interventions and final attack rate show that 1 week of school closure has minimal effect on reducing the epidemic size. A 2.5% cumulative attack rate reduction (from a baseline attack rate of 32.5% to an attack rate 30%) can be achieved by the Individual School Closure strategy. However previous work suggests that school closure for longer durations may have a significant impact on reducing epidemic severities in terms of both the cumulative attack rate and the peak daily incidence rate. |
quarantine strategies, such as home quarantine, traffic restrictions and travel bans, significantly decreased the transmission of infection in the community and were highly successful in controlling the initial stages of epidemic spreading. Rashid et al., 2015 review reported local mobility restriction to have a peak delay effect, especially if implemented early into the pandemic, while a different study reveals that weak travel restrictions would lead to increased spread of the influenza virus [11]. Isolation and quarantine reduced the total number of cases and lowered the basic reproduction number ($R_0$), but there is an increased risk of intra-household transmission from index cases to contacts [11,20]. The efficiency of quarantine is improved if it is jointly implemented with a self-protection process driving the number of infected individuals significantly lower [1]. Moreover, these measures would be more effective if associated with strict hygiene measures. If the environment is disinfected by sanitation, the number of infected people cannot increase drastically [116]. Closure of schools during the H1N1 pandemic was the most studied measure. School closures or class suspensions are probably moderately effective social distancing policy in reducing pandemic influenza transmission and delaying the peak of an epidemic. Postponing the peak of cases would be potentially beneficial so health managers are better prepared, and so researchers can find more effective treatments. Therefore, if social distancing can reduce the peak of infected people, at the same time postponing its occurrence, many lives can be saved [11,41,42,44]. Workplace-related interventions like work closure and home working are also modestly effective and are acceptable. The effectiveness was estimated to decline with higher basic reproduction number values. The lower effectiveness could be because social distancing may be less likely to reduce the effective reproduction number to below one if $R_0$ is higher. Earlier implementation of distancing measures and combination with others non-pharmaceutical or pharmaceutical interventions leads to greater efficacy. According to a recent study, although the advantage is clear, most countries face difficulties with the coordination and implementation of social distancing, as to when, in the pandemic, is the best time to implement the measure [113]. Fong et al. suggested that rapid implementation of social distancing measures and high compliance in the community would determine the success of the intervention [117]. In a recent study, Rai

Table 3. Side effects of social distancing measures. Scoping review, 28 April 2020.

| Mechanism                  | Summary of effects                                           | References                                |
|----------------------------|---------------------------------------------------------------|-------------------------------------------|
| Psychosocial impact        | Greater incidence of panic disorder, stress, anxiety, depression, and other psychosocial issues. | [78,80,83,87,103]                         |
| Stigmatization            | Escalation of psychological alert of the population, afraid and confused. | [12]                                      |
|                            | Social discrimination: healthcare workers are increasingly looked at as someone who can spread the virus in the community | [78]                                      |
|                            | Violence and hate                                            |                                           |
| Social disorder            | Stigmatization of patients and family members placed in isolation and quarantine | [25,49]                                   |
|                            | Deprivation of liberty and the interruption of the normal life. Some even viewed these measures as human rights violations. | [25,49,49]                               |
| Economic effects           | Increase of domestic violence.                               | [12]                                      |
|                            | Disruption of the usual activities and essential services     | [103]                                     |
|                            | Supplies of foods, essential medicines, car parts and innumerable other products are affected globally. | [37]                                      |
| Health effects             | Economic hardship and escalation of job losses.              | [11,47,78]                                |
|                            | Lost working days of parents and loss of education account for a substantial portion of the costs. | [52]                                      |
|                            | Decreased business productivity through loss of workdays and income. | [11]                                      |
|                            | Disrupted supply chain and declining stock markets, thus hitting the global economy. | [78]                                      |
|                            | Recession: restrictions compelling 70% of economic activities to temporarily shut down. | [12]                                      |
|                            | Restrictions on travelling will halt trade and business and may indirectly impair supply of essential commodities and disrupt economic activities. | [11]                                      |
|                            | Productivity losses. The use of resources involved in the implementation of placing close contacts under quarantine was very high. | [105]                                     |
|                            | A greater effect at the international scale, where case export was reduced by nearly 80%. | [7]                                       |
|                            | Dramatic drop in the number of cardiovascular admissions.    | [84]                                      |
|                            | Lack of attention for all acute situations beyond the cardiovascular disease setting |                                           |
|                            | Loneliness and social isolation worsen the burden of stress and often produce deleterious effects on mental, cardiovascular, and immune health | [83,89]                                   |
|                            | Excessive physical inactivity.                               | [90]                                      |
|                            | Elderly who are not moving much can lose a significant amount of muscle strength, flexibility, and aerobic capacity. It can accelerate the frailty and dependency of the seniors, and subsequently, claiming of care and health services. |                                           |
|                            | Impact on waits for elective operations, with tens of thousands of scheduled surgeries being cancelled or postponed. | [79,91]                                   |
|                            | Decline in vaccination.                                      | [97,98]                                   |
|                            | Worsening of psychiatric diseases.                           | [12]                                      |
|                            | Behavioral addiction disorders: increase in drugs, cigarettes and alcohol consumption. |                                           |
|                            | Insufficient sunlight exposure.                               | [12,67]                                   |
|                            | Overweight, due to lack of physical exercise vs unmodified diet |                                           |
|                            | Isolated geography of some rural areas and the lack of healthcare workers and security officials | [49]                                      |
RK et al. showed that continuous propagation of awareness through the internet and social media platforms should be regularly circulated by the health authorities/government officials for hospitalization of symptomatic individuals and quarantine of asymptomatic individuals to improve compliance and to control the prevalence of disease [118].

We underline the lack of specific, robust data regarding efficacy of school closure and lockdown measures vs an appropriate use of physical distancing and correct hygienic interventions, also in the COVID-19 pandemic, supporting the need of more epidemiological on social distancing in actual settings. Cross-sectional epidemiological studies can be used to assess the prevalence of social distancing measures, but this design is not optimal to assess effectiveness because of inherent biases. Because randomizing may not be feasible in this case for ethical reasons, prospective cohort studies may provide the best available evidence on effectiveness. These results are important and should be valued although they are not from randomized studies. In public health, the precautionary principle allows decision-makers to apply distancing measures in epidemics, even in the absence of solid evidence, for public protection considerations.

(3) Several and serious side effects:

The health benefits of social distancing measures are obvious, with a slower spread of infection reducing the risk that health services will be overwhelmed. But they may also prolong the pandemic and the restrictions adopted to mitigate it. Several sectors are seeing steep reductions in business. Social, economic, and health consequences are inevitable and directly linked to distancing measures or indirectly because of misuse. Collateral damages from restrictions could induce more deaths than the virus itself. According to data collected by the World Health Organization, UNICEF, Gavi and the Sabin Vaccine Institute, provision of routine immunization services is substantially hindered in at least 68 countries. Putting 80 million of children under one at risk of diseases like diphtheria, measles, and poliomyelitis [119]. A study examined the effects of COVID-19 on the South African health system and society. It has shown that the prolonged lockdown has been associated with increases in acute panic, fear, depression, obsessive behaviors, social disorders, stigma, anxiety, depression, increased incidence of violence, gender bias, and discrimination in the distribution of relief food aid [120].

Policy makers need to balance these considerations while paying attention to broader effects on health and health equity. Application of distancing measures must be accompanied by recommendations of good practice. Decision-making must be collegial, reasoned, and well thought out. Social distancing policies are an important public health tool for controlling epidemics, with proven effectiveness particularly during the early stages. However, the social and economic costs of social distancing policies imply that public health officials must weigh the costs and benefits of such measures to determine when to employ the
social distancing policy. The success and failure of such policies should be evaluated to find the evidence-based action for the local and international communities.

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