

Effects of School Closure on Transmission of COVID-19. A Rapid Systematic Review

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Article Info

Special Issue on
Coronavirus (COVID-19)

DOI:
10.24017/covid.12

Article history:

Received: 29 May 2020
Accepted: 31 May 2020

Keywords:

School closure,
COVID-19,
Transmission

ABSTRACT

Globally school closure is one of the social distancing strategies used to mitigate transmission of pandemic novel corona virus (COVID-19) among school populations. However, there are uncertainties around when, how and for how long schools need to be closed. There is limited evidence for the impact of school closure on the number of cases and spread of COVID-19 to inform management of future outbreaks. Several databases were searched using an adapted search strategy to obtain studies that met the inclusion and exclusion criteria. A large number of studies were found and they were quality appraised. Eight good quality studies were identified and these were reviewed. The studies that contained the desired outcomes were three epidemiological studies, and five modelling studies using actual data that making assumptions about changes in transmission dynamics after school closure is applied. The results show that schools were closed for different timings related to the peak epidemics. School closure almost reduced the transmission of the COVID-19. Delay in closing schools and combinations with other control and management measures may affect the likelihood of drawing consistent conclusions about the effectiveness of school closure on COVID-19.

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1. INTRODUCTION

The pandemic novel coronavirus disease (COVID-19) which is caused by (SARS-CoV-2), emerged from Wuhan city, China in December 2019. Later spread worldwide to about 213 countries and report 5,488,825 cases and 349,095 deaths as in 27 May 2020[1]. Since then

national and international measures have been taken as response to the disease. During the pandemic although many countries had antiviral stockpiles to be used as treatment or chemoprophylaxis and several attempts to produce vaccines, non-pharmaceutical interventions were considered as significant control measures to mitigate the impact of the illness for most populations. Closing schools is one of the social distancing strategies which several epidemiological and modelling studies have been used to estimate the impact of the action in decreasing the transmission of the pandemics mainly among school populations in primary, secondary and high schools, and then in communities outside these settings. School closure is either proactively (when schools close almost locally just or before the outbreak occurred) or they closed reactively (when schools closed after confirming one or more cases in the setting). Generally the main rationale for applying school closure during the pandemic outbreaks is to delay the overall effects of the disease, permit the antivirals to be managed and proper vaccines to be developed. In addition, there are some other factors that may justify this intervention as a significant control measure. Firstly, school-age children are considered to be more vulnerable to pandemics possibly because of their low immunity to the virus. Secondly, there is frequent contact reported rated among this age group[2].

Pandemic COVID-19 as public health issue

Pandemic COVID-19 is an airborne communicable disease which spreads very quickly and easily and transmits to other countries through traveler-infected cases. The disease outbreak is unpredictable because if the (SARS-CoV-2), mutates, then a new pandemic would emerge, not just in winter, but at any time and can kill large number of people (as occurred in the earlier pandemics). For this reason, preparedness measures for the outbreak are necessary.

Reviewing and synthesizing evidence about the subject may be helpful to policy makers and public health professionals so that they are prepared for future pandemics. In addition, in the early stages of the diseases, vaccines and antiviral drugs are probably not available. Therefore, WHO recommends the use of non-pharmaceutical interventions to reduce the size of the outbreak and minimize the risk of the disease at least in the early stages. Obviously, the difficulties in the control of the disease are at the beginning of an outbreak when mortality and morbidity rates are significantly high. This is because of the short incubation period, and a short interval between becoming infected and the transmission of the disease from symptomatic and asymptomatic infectious individuals[3].

The rationale for doing systematic review about school closure

This project attempts to fill a gap in the knowledge, because still there are some uncertainties about using the school closure strategy to mitigate future pandemics. For this reason, more evidence may be required to justify school closure initiation and, how, when and for how long schools should remain closed.

For many years school closures have been used as a social distancing measure to control the transmission of infectious viruses among children [4]. Conducting experimental controlled studies almost impossible and decision makers require evidence to develop school closure strategies. It is clear that, when an outbreak of pandemic influenza occurs, public health and school officials face various management challenges and decisions regarding when and for how long schools need to be closed and the number of schools to be closed (individual or entire schools in the area) depending on the number cases in schools and in the community around them. Additionally, combining school closure with other interventions, for example, the use of antivirals is another challenge [5]. Hence, decision about the best choice depends on the potential effectiveness of the intervention strategy. For this purpose, first computerized modelling studies provide useful estimation to be used for future pandemics, especially if a model estimates several possible outcomes under different scenarios rather than focusing on a particular policy decisions [4]. Second, outbreak reports and surveys about the pandemic

features are another type of study which collect and analyse epidemiological data. Reviewing two types of studies (epidemiological and modelling) about school closure is significant work and may reduce any uncertainties for applying this containment measure during future pandemics. Modelling studies are used to assess the benefits of several recommended interventions applied during the outbreak of infectious diseases. The timing, duration of school closure and its combinations with other containment measures have been examined through modelling studies (based on actual epidemiological data or based on computerised simulations only). Transmission dynamics of the COVID-19 in school settings are estimated through modelling studies. The transmissibility and spread of pandemic COVID-19, just like other communicable diseases, is determined by the effective reproductive number (R); which is an average number of secondary cases produced initially by a single primary case in the actual population.

The aim of this systematic review is to review all epidemiological and modelling studies related to the control of COVID-19 through closing primary, secondary and high schools, in order to evaluate if this intervention has an impact on mitigating the outbreak in the world. Make a decision to close schools requires the evaluation of the effectiveness of the potential benefits and estimation several undesired economic, social and educational consequences which can be occurred subsequently.

2. METHODS AND MATERIALS

Effectiveness of school closure during pandemic COVID-19 outbreak is assessed through this review. Systematic review is a method of summarizing of all good quality available evidence that answers the research question or it is identifying, critically appraising and combining relevant studies to answer the predefined question [6]. Systematic review is considered as a reliable type of study to be used for evidence based practice. Epidemiological and modelling studies are included for this review. Several data bases were scanned which are recommended to be used for the purpose of this review, from 2019 to May 2020 such as PubMed, WHO Global Research Database on COVID-19, MEDLINE, BMJ, Cochrane, and SOCIAL CARE ONLINE.

In order to identify relevant papers in this study, I devoted search in the different databases. Development of a search strategy is time consuming process, which is attempted to use different search histories several times and refine the searches and changing the keywords to obtain more relevant and valid results. For this purpose broad spectrum search was conducted by using the name of the disease or the virus such as (COVID-19, SARS-CoV-2, and pandemic COVID). After that the search was tightened by using the intervention keywords. For example, school closure, institution closures. Here some techniques was used like putting “star mark” at the end of some keywords to obtain as much as results on the topic, in addition to combine the name of the disease or the virus with the intervention keywords by using AND, OR. Then some other keywords were added to the search such as epidemiological reports, mathematical modelling and some others in order the search be more specific relating to the type of studies. To make sure that I obtained all the studies available on this topic, I expanded the search to explore all control or containment measures which have been used for the pandemic COVID-19 control, by including the search terms like control, mitigate, and spread control. The process was continued till sensed saturated and the search had become both sensitive and specific to the review, that is, broad enough to obtain as many relevant articles as possible on the topic, and narrow enough to exclude irrelevant articles; in order to minimize the selection bias and increase the precision of the study as well. Language restriction is applied during the search strategy. I have searched for articles in English language only.

3. RESULTS AND DISCUSSION

For this review eight studies were included; three outbreak reports and five modeling studies. In all outbreak reports data collected through surveys which conducted for school populations after pandemic COVID-19 outbreak or after schools were reopened. They were conducted in

different countries and cities, namely; Wuhan [7], USA[8], South Korea [9], China [10] and Singapore [11]. One of the three epidemiological studies was conducted based on data from an outbreak at schools in Italy which is analysis of outbreak data [12]. Another study conducted on school closures in France [13].The third study is conducted in the UK [14]

Selection of studies

A total of 2135 studies describe school closure, during pandemic COVID-19 between December 2019 and May 2020, were retrieved. Of these, 1975 records from PubMed, 40 from BMJ, 19 from Social Care Online, and 101 from WHO website. I removed 1022 records from 2135 records as they identified as duplicated, and remaining 1113 studies. After that I excluded 1050 studies on the basis of title and. In this stage 63 studies remained which the full text read fully. In this stage I excluded 55 studies as they are not appropriate to be included in this review. For example, I removed [15], because focused on pandemic influenza beside to the COVID-19. As well as, I excluded [16]because it is about work place closure beside school closure. The same situation for other excluded studies.

At this stage 8 studies remained which met the inclusion criteria. Decision made to include all these studies in this review. However some of them not directly and specifically aimed to assess the effect of school closure on the transmission dynamic or incidence of cases, but still can answer the research question of this review.

This review was designed to obtain information from outbreak reports and modelling studies, on the effect of school closure intervention for primary, secondary and high schools during outbreak of pandemic COVID-19. However, several implications of school closure not studied here such as economic, legal and ethical aspects which are important to be considered in policy making. The aspects which considered are changes in transmission dynamics of the infectious disease, among school age children, when school closure was used as a containment measure. The identified epidemiological and modelling studies of this review provide evidence that school closures may reduce incidence and transmission dynamics of pandemic influenza COVID-19, among school aged children. However, the effects may depend on timely implementing in relation to the epidemic peak and duration of the school closure. Findings of this study might be useful to improve a current and future preparedness plan of controlling the disease.

During the outbreak of COVID-19 schools closed for different periods throughout different countries. Many studies examined the impacts of extending school closure on control of the disease. The results of identified studies of this review reported the school closure for various durations and all of them stated that more or less school closure reduced the number of cases. A group of researchers from Wuhan, China conducted a modelling study to assess the effect of non- pharmaceutical interventions on mitigation of outbreak of COVID-19, they found that extended school closure will postponed the peak of the disease and decrease the cumulative infection. However, the outcome of these control measures vary according to the age groups [7][10]. Furthermore, the finding showed that the measure effects differ according to infectiousness of the cases and timing of the school closure. Similarly a study from France reported that age 6 years had more contacts per day if compared with age group 10-11 years by using a radio frequency identification devices (RFID) technology[13]. In addition [9] [11]concluded that school closure and other control measures mitigate the spread of COVID-19 especially if extended for another 2 weeks. But it is difficult to compare one study to other to find out an optimum period for closing schools. Firstly, contact patterns vary among school children in schools and within community. Secondly, each pandemic waves or outbreaks are caused by different virus subgroups. For this reason the preferred period of school closure probably cannot be applied for the future pandemics. Furthermore, other consequences of school closure for longer periods should be considered such as economic, social, ethical and educational consequences.

On the other hand studies from Italy and china stated that school closure had no significant impact on the control of the disease because the novel coronavirus mostly affects the adults

and elder ages more than children. Moreover, school closure alone has not vital impact on the mitigation of the disease without closing the other work places. [12] [10].

In addition, school closure may increase the disease among elder people as they take care of their siblings when the parents at work. Similarly a modelling study from USA concluded that many health care staff obligated to stay home to look after their children during school closure. This leads to the shortage in health services in health settings[8].

Strengths and weaknesses of the identified studies

Epidemiological studies

The identified epidemiological studies almost reported the school closure as an effective intervention, in containment phase of controlling COVID-19. Most of the outbreak report outcome measures relied on laboratory tests to confirm the cases affected by the disease. However, these studies have several limitations. Firstly, the school closures were not studied as a single intervention, but with combination to others. Therefore, it is not clear if the change in transmission dynamics were because of the school closures or the other interventions. Secondly, timing of the closures was mostly after epidemic peak of the disease. Therefore, it is difficult to separate the effects of the intervention from the natural transmission dynamics of the disease. Thirdly, comparison between several factors of school closures can be difficult, such as duration of the closures, reactive school closure and scheduled holidays and timing of the school closures. The reason for that is the heterogeneity in these factors in the identified studies, hence reaching a conclusion about standardized guideline for school closure to be applied during the outbreak is challenging.

Modelling studies

Computerized simulation models are considered as a trustworthy tool to assess the effectiveness of interventions when applied to an epidemic disease. The results of the modelling studies can be used in formulating policy of control the infectious disease, especially at the beginning of the outbreak. To assess the influence of the school closure, various modelling studies identified in this review which is estimated from modelling studies based on epidemiological data and based on mathematical calculations. Despite the advantages of the models, their results are considered as suggestive rather than absolute prediction. Furthermore, the future pandemics might have completely different characteristics and possibly fixed quantitative predictions which are not compatible to it.

4. CONCLUSION

This review has evaluated the impact of school closure on mitigating the spread of pandemic COVID-19. Five modelling and three epidemiological studies reviewed in which impact of school closure were estimated for the intervention. The result of this systematic review indicated that school closure can be effective in reducing the transmission dynamics of the disease, among school populations. Hence it is estimated that the outbreak most probably slowed down by applying school closure. Duration of the school closures vary from a study to other but it seems to be the closure for longer times more reduce the effects of the disease. However, the effectiveness somewhat is not clear, because school closure applied in combination with other control measures not as a single intervention. Moreover, in most situations school closed after the peak epidemic, therefore, it is difficult to conclude that this control measure mitigated the outbreak because the epidemic curve normally fall down within a period of time. In addition, consequences of school closure for longer periods should be considered such as economic, social, ethical and educational consequences.

Despite these limitations these types of studies may be useful to provide basic knowledge for control of the future pandemics. Obviously, pharmaceutical interventions may be not available appropriately at the beginning of pandemic outbreaks, because of not enough stockpiles (antiviral treatments) and delay in productions (vaccines). Therefore school closure and several non-pharmaceutical interventions are necessary to control the disease especially in the

beginning of outbreaks. The main rationale for school closure are high incidence of COVID-19 among school age children, frequent contacts with each other, low immunity against the disease and high compliance for the intervention.

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