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School closure during novel influenza: A systematic review

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ABSTRACT

Background: School closure as a non-pharmaceutical measure appeared as an efficient strategy in previous epidemics. We investigated the impact of school closure on the epidemic peak whether implemented before or after the epidemic reaches its peak. We also investigated the optimal duration of closure.
Methods: Data sources included Medline-PubMed, ProQuest and Cochrane databases. The inclusion criteria were all articles that reported a quantified effect on school closure on an influenza epidemic. Exclusion criteria were non-English articles that have no translation and articles that only reported school closure effect as a combination with another measure. Out of 668 articles, we included 31 articles.
Results: The mean reduction of the peak of the epidemic was M = 29.65%. Implementing school closure before or after the epidemic reaches its peak reduced the overall influenza epidemic. School closure reduced and delayed the epidemic peak especially if implemented earlier. The longer the duration of closure the more the epidemic peak delayed. Additionally, closure containment effect also correlated with organisms having high attack rate and longer infectiveness duration.
Conclusion: We conclude with several implications for school closure taking into consideration the feasibility and the cost.

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Introduction

The frequent emergence of novel influenza mandates an immediate action towards containment. However, such urgency may not be possible early in the epidemic given the scarcity of the information around the organism and its unknown sequelae. This urge for an implementation of a social distancing measures [1] to ameliorate the behavior of the community toward such organism and the behavior of the organism within the community.

School closure emerged as one of the non-pharmaceutical strategies during influenza pandemic [2]. This in part due to its high contact context with high number of students in one place within a close proximity and with less than acceptable hygiene practices [3,4]. On the other end closure has a positive mitigating effect noted in several previous epidemics [3,5]. Despite that, still there are controversies around when to initiate closure and for how long.

Community Strategy for Pandemic Influenza Mitigation [6] advocated a need to study how to delay the growth of the epidemic, how to affect its peak in addition to how to affect the total number of cases within such epidemic. In this study, we investigated the impact of school closure on the epidemic peak whether implemented before or after the epidemic reaches its peak. We also investigated the optimal duration of school closure. Finally, we explored other features that may influence school closure during emerging influenza epidemic.

Methods

We used an electronic search in Medline-PubMed, ProQuest and Cochrane databases with keywords of: School Closure and Infection; School Closure and Influenza. The search ended in March 2017. The inclusion criteria were all articles that reported a quantified effect on school closure on an influenza epidemic whether as a primary outcome or secondary and whether in an established epidemic or mathematical models.

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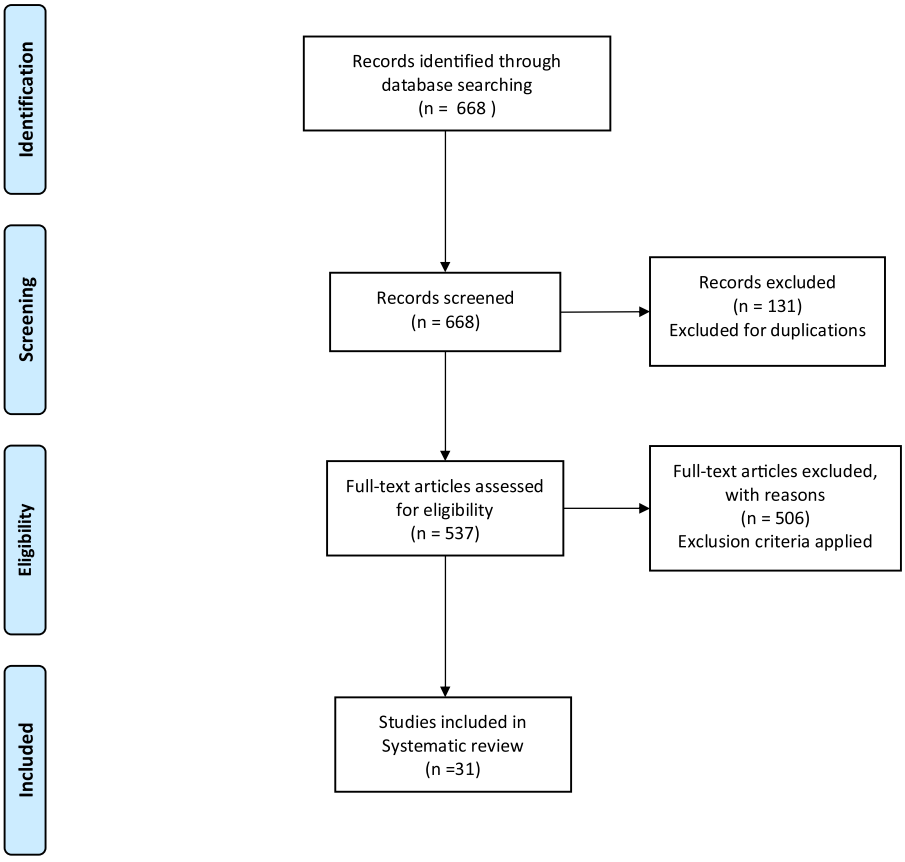

Fig. 1. Flow chart for systematic review.

Exclusion criteria were non-English articles that have no translation and articles that only reported school closure effect as a combination with another measure. Each article was reviewed by three independent investigators for eligibility through reviewing the title and the abstracts preliminary in addition to full articles before analysis. From total of 668 articles, we included 31 articles in our analysis.

In our analysis we included an independent entry for each predictions in the mathematical model that used a specific Ro (basic reproduction number) to predict an effect of school closure. This also applied to models that studied specific periods in relation to epidemic peak or size. The total entry used for analysis was 85. A flow chart for such methods adapted from www.prisma-statement.org [7] as illustrated in Fig. 1. We included the effect of school closure on the first epidemic peak in those with multiple peaks. The reason is to avoid the confounder of herd immunity and increasing public awareness after the first peak in addition to the confounder of other public health measures that are not captured in their analyses.

Results

Description of the studies included

Our analysis included studies from twelve different countries. Fig. 2 illustrates the contribution percentages of each of the countries. We included studies from 1957 to 2015. Fig. 3 demonstrates the epidemics' organism studied in our analysis in which 7 events comprises seasonal flu (8.3%) and 46 events for pandemic flu (91.7%) with H1N1 studied in the majority.

The median period of school closure was 14 days (Mdn = 14 days, range 1–140 days).

The mean attack rate was 31% [M = 31.86% (SD = 21.30)]. This include a mean attack rate of 32.79% in the community and 18.19% among school children.

The median duration of infectiveness of the various influenza pathogens was 4 days (Mdn = 4 days)

The mean reduction of the peak of the epidemic was M = 29.65% (SD = 23.63)

Four events associated with H1N1 had two peaks. The second peak was excluded to control for confounding.

The timing of closure

The timing of school closure in relation to the start of an epidemic is inversely correlated with reduction in the peak of the epidemic $r = -0.57$, $p < 0.05$. The results of the Hierarchical multiple regression indicated those two predictors explained 36.2% of the variance ($R2 = 0.39$, $F(6,69) = 7.35$, $p < 0.05$). We found that the early closure of school in relation to the start of an epidemic significantly predicted more reduction in the epidemic peak ($\beta = -0.501$, $p < 0.05$)

The correlation was augmented further to an $r = -0.671$ ($p < 0.05$) when we controlled for the position of the epidemic peak through partial correlation. That is the faster the epidemic reaches its peak; the more likely early school closure would have an effect on the reduction of its peak.

The delay of the epidemic peak

The median time for school closure to delay the epidemic peak was Mdn = 11 days. Yet, delaying the epidemic peak did not correlate with the reduction of its peak ($p > 0.05$). However, a reduction

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