

SHORT REPORT



## Evaluating impact of school outreach vaccination programme in Hong Kong influenza season 2018 – 2019

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### ABSTRACT

School-based vaccination, as a means to mitigate seasonal influenza outbreak, depends on attaining adequate coverage rate. We evaluated the potential of a fully subsidized school outreach vaccination (SOV) program to achieve epidemic prevention potential in Hong Kong. The purpose of this study was to evaluate the impact of SOV program 2018–2019 on influenza vaccination rates and influenza-like illness (ILI) in the primary school students and their household members during the influenza season. The vaccination rate was significantly higher in the schools offering SOV (intervention schools) (69.2% vs. 34.3%) than those not offering SOV (control schools) ( $p < .0001$ ). The ILI rate was significantly reduced from 14.1% among non-vaccinated to 7.7% among vaccinated students ( $p < .0001$ ). Influenza vaccine effectiveness against ILI was 45.3%. The vaccination rates of the household members were the same in both intervention and control schools except in the sub-group of preschool household members with the intervention significantly higher than the control group (43.8% vs. 32%,  $p < .0001$ ). SOV program significantly improved influenza vaccine coverage, and the vaccine reduced ILI incidence. Extension of SOV program to all primary schools as well as kindergartens in Hong Kong could achieve epidemic prevention potential and should be evaluated.

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### Introduction

Seasonal influenza attacks 20–30% of children and 5–10% of adults annually, causing significant disease burden.<sup>1</sup> In addition, socio-economic burden extends beyond medical services to reduced productivity and absenteeism from school.<sup>2</sup> Influenza outbreaks in Hong Kong occurred mainly in kindergartens and primary schools, with influenza-related hospital admission rate highest in children aged under 5 years old and senior citizens.<sup>3</sup>

Children are primary vehicles for influenza virus transmission as they have higher infection rates, shed virus in larger quantities for longer periods than other age groups.<sup>4</sup> Hence, children are a recommended target population for influenza vaccination to reduce incidence at community level.<sup>5</sup> Influenza vaccination has been shown to have epidemic prevention potential.<sup>5,6</sup> Administration of the recommended seasonal influenza vaccine within an optimum narrow time period before the influenza season is suggested to ensure maximal protection.<sup>7</sup>

In Hong Kong, seasonal influenza vaccine effectiveness in reducing child hospitalization rate during influenza season has been documented.<sup>8</sup> To support and encourage influenza vaccination, the Hong Kong Government introduced the Childhood Influenza Vaccination Subsidy Scheme in 2015, to subsidize vaccination in children aged under 5 years old and was later extended to children aged between 6 and 12 years. However, as per the 2015–2016 data, despite the availability of Childhood Influenza Vaccination Subsidy Scheme, influenza vaccination rate remained low at 21.1% in under 5

years old, 18% in 6–18 years old and overall 11.9% in general population.<sup>9</sup>

School-based vaccination schemes have been shown to have variable results in increasing vaccination rate and reducing influenza-like illness (ILI) in both vaccinated children,<sup>5,10,11</sup> and their pre-school household members.<sup>12</sup> The Hong Kong Government piloted the fully subsidized school outreach vaccination (SOV) program in 184 out of the 587 primary schools in 2018.<sup>13</sup>

In this study, we compared the vaccination rates in primary schools with or without the SOV program among the students and their household members during the 2018–19 influenza season. Secondary outcomes include comparing the rate of ILI among vaccinated and non-vaccinated students as well as the vaccine effectiveness in preventing ILI during the influenza season.

### Materials and methods

We contacted the 587 Hong Kong primary schools and identified 180 schools offering SOV (intervention schools), from which we recruited 10 schools offering SOV. Only three control schools not offering SOV were successfully recruited. The influenza season was defined utilizing the Department of Health data on the number of influenza-positive nasopharyngeal aspirates (NPA) samples per week which is publicly available in the following week.<sup>14</sup> The first week with  $\geq 1000$  positive NPA samples per week was defined as the onset of the influenza season. The influenza season would start from this first

week through subsequent weeks with increasing NPA samples to reach the peak which was defined as the week followed by 2 weeks with falling number of positive NPA samples. The influenza peak was therefore from 13th to 19th January 2019.<sup>14</sup> We developed a questionnaire, in both English and Chinese, asking if the child and their family members received influenza vaccine in the 2018 fall season. The questionnaire also collected the surveyed child's ILI information, doctor diagnosed influenza, and school day missed due to ILI. The ILI was defined as the presence of fever ( $> 38^{\circ}\text{C}$ ) and cough which has been recommended in WHO guidelines as being able to identify significant percentage of influenza infection.<sup>15</sup> The questionnaire was pre-tested with 20 subjects to further rectify any unclear wording. Questionnaires were sent to the parents 2 weeks after the peak.

The null hypothesis is there is no significant difference in the vaccination rates between the students in the intervention and control schools. Sample size estimation was based on the previous finding of vaccination rates in intervention and control schools in the USA.<sup>11</sup> For 80% power and 5% level of significance, there should be at least 643 students in both intervention and control schools. We compared the vaccination rates of the primary school students and their household members in the intervention schools with that in the control schools by the Chi-square test. The ILI rate between vaccinated and unvaccinated students was also compared with the Chi-square test. The calculation of influenza vaccine effectiveness was based on preventing ILI by comparing the risk of ILI between vaccinated and non-vaccinated students.<sup>16</sup> The unpaired t-test was used to compare the days of school missed due to ILI between vaccinated and unvaccinated students. The missing answers were treated as missing value in the analysis.

## Results

The total number of primary school students in intervention schools was 3522 while in the control schools was 1738. The questionnaire return rates were 65.3% (2300) and 63.0% (1095) in the intervention and control schools, respectively. The null hypothesis was rejected as the vaccination rate of primary school students in intervention schools (69.2%) was significantly higher than that in control schools (34.3%,  $p < .0001$ ). The odds ratio was 4.3 (95% CI 3.7 to 5.0). The vaccination rate of the preschool children living in the same household was increased by 37% in the families of the intervention schools compared to that of control schools (43.8% vs 32%,  $p < .0001$ ) while the vaccination rates for adult household members were the same in intervention and control schools (Table 1).

The ILI percentage in vaccinated students (7.7%) was significantly lower than that in non-vaccinated students (14.1%,  $p < .0001$ ). The influenza vaccine effectiveness in preventing ILI was 45.3% (Table 2). The percentage difference of doctor diagnosed influenza and the mean of school day missed was insignificant between vaccinated and non-vaccinated students.

## Discussion

The schools offering SOV program has significantly higher vaccination rate of 69.2% with an odds ratio of 4.3 as compared to a vaccination rate of 34.3% in the control schools. The overall 69.2% vaccination rate in the intervention schools in this study was significantly higher than that of previous studies (54% Effler et al., 42% Tran et al., 52.5%

**Table 1.** Influenza vaccination status of the primary school students and their household members between schools offering SOV and not offering SOV.

	Schools offering SOV		Schools not offering SOV		<i>p</i> -Value	Odds ratio	95% C. I.
	Vaccinated for influenza	Not vaccinated for influenza	Vaccinated for influenza	Non-vaccinated for influenza			
Surveyed primary school students	1572 (69.2%)	700 (30.8%)	370 (34.3%)	709 (65.7%)	< 0.0001	4.3	3.7–5.0
Preschool household members	522 (43.8%)	670 (56.2%)	164 (32.0%)	349 (68.0%)	< 0.0001	1.7	2.1–1.3
Not attending kindergarten	305 (45.3%)	368 (54.7%)	72 (25.7%)	208 (74.3%)	< 0.0001	2.4	1.8–3.3
Attending kindergarten	217 (41.8%)	302 (58.2%)	92 (39.5%)	141 (60.5%)	0.6035	1.1	0.8–1.5
Household members attending secondary schools	116 (24.3%)	361 (75.7%)	25 (21.2%)	93 (78.8%)	0.5515	1.2	1.9–0.7
Household members > 18 years old	695 (17.9%)	3198 (82.1%)	346 (17.4%)	1647 (82.6%)	0.6658	1.0	1.2–0.9
Adults	451 (13.5%)	2902 (86.5%)	261 (14.7%)	1520 (85.3%)	0.2519	0.9	1.1–0.8
Senior citizens	244 (45.2%)	296 (54.8%)	85 (40.1%)	127 (59.9%)	0.2362	1.2	1.7–0.9

\**p*-Value is for comparing the vaccination rate of subjects between schools offering SOV and not offering SOV.

**Table 2.** Influenza-like illness of the surveyed primary school students.

	Vaccinated students		Non-vaccinated students		<i>p</i> -Value	Odds ratio	95% C. I.
	Yes	No	Yes	No			
Influenza-like illness	147 (7.7%)	1762 (92.3%)	210 (14.1%)	1281 (85.9%)	< 0.0001	2	1.7–2.5
Doctor diagnosed influenza	19 (1.0%)	1890 (99.0%)	16 (1.1%)	1475 (98.9%)	N.S.		
Mean school missed day (SD)	1.1 (1.5)		1.3 (1.6)		N.S.		

Missing response will not be included in the analysis.

Peabody et al.),<sup>5,10,17</sup> This may be due to the operational experience of the Department of Health and the parental trust<sup>18</sup> in Hong Kong generated by the preexisting primary-school-based MMR vaccine program which was started since 1995. Moreover, the whole SOV program is fully funded and directly implemented by the Department of Health without incurring any parental payment or intermediate groups.

Comprehensive program enrolling institutions with child population from 2 to 16 years old for vaccination has been shown to reduce influenza outbreak significantly.<sup>19</sup> A school-located influenza vaccination program for 5–17 years old has been shown to reduce their risk of ILI, and also ILI rates in other age groups, especially the 0–4 years old.<sup>20</sup> Furthermore, targeted vaccination in school has been estimated to be most cost-effective with heterogeneous vaccination coverage of 48% in primary schools and 34% in secondary schools for reducing seasonal influenza epidemic.<sup>18</sup>

Since our study has demonstrated the vaccination rate of the SOV program in Hong Kong was 69.2%, we recommend to extend the program to all the 587 primary schools and evaluate its potential to reduce the seasonal influenza epidemic. Moreover, extending the SOV program to kindergartens may similarly improve the vaccination rate in kindergartens from the current 30% to ~70% as in the primary schools. This will directly reduce influenza outbreaks in the kindergartens as well as hospitalization of pre-school children. Overall this may reduce the winter surge of hospital admission of all age groups during influenza season in Hong Kong.

The limitations of our study include possible recall bias. The exact age of the various groups of household preschoolers, school children and adults was not defined. The Department of Health, Hong Kong used the quadrivalent inactivated influenza vaccine in the SOV program in 2018, while students in the control schools may have been vaccinated with influenza vaccine other than quadrivalent inactivated influenza vaccine.

In conclusion, a comprehensive SOV program for all kindergartens and primary schools in Hong Kong could be a cost-effective public health measure to control seasonal influenza epidemic and its impact on reduction of outbreaks in kindergartens and schools as well as hospitalization rate should be evaluated.

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## Disclosure of potential conflicts of interest

No potential conflicts of interest were disclosed.

## Human subjects approval statement

The study was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster.

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