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Improved population coverage of the human papillomavirus vaccine after implementation of a school-based vaccination programme: the Singapore experience

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ABSTRACT

Introduction: Cervical cancer has a high disease burden in Singapore, and it is strongly associated with human papillomavirus (HPV) infections. Despite constant efforts to encourage vaccination, local HPV vaccine uptake remains low. Universal mass vaccination is a proven cost-effective method to reduce the cervical cancer disease burden. This paper reviews the newly implemented school-based HPV vaccination programme in Singapore and the factors that led to its success.

Methods: Fully subsidised HPV vaccinations were offered to all Secondary 1 female students on an opt-in basis, starting as a rollout dose in 2019. One-time catchup vaccination was also offered to female students in Secondary 2–5. Eligible recipients were identified using enrolment data provided by Ministry of Education schools. A total of 19,144 students across 139 schools were offered the rollout dose, and 20,854 students across 140 schools were offered the catchup doses.

Results: High vaccine uptake rates of 80.6%–87.3% were noted with the introduction of the school-based programme, translating to high vaccine coverage of 90.3%–93.4%. Only a small proportion of students (1.5%–1.9% per cohort) opted out. The rate of reported side effects, which were commonly known effects, was low at one in 1000. Among the students who reported side effects, those who received the second vaccine dose did so uneventfully.

Conclusion: High HPV vaccine coverage was achieved after implementation of the school-based immunisation programme. Timely assessment of knowledge lapses and targeted intervention, strong partnerships with stakeholders, constant on-site adaptation and positive social influence contributed to its success. This model can be applied to future school health programmes.

Keywords: cervical cancer, HPV, immunisation, school-based, Singapore

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INTRODUCTION

Cervical cancer is the fourth most common cancer among women and the fourth leading cause of cancer-related death among women worldwide. In a 2018 worldwide analysis, approximately 570,000 women developed cervical cancer and 311,000 women died from it, with a corresponding age-standardised incidence rate (ASIR) of 13.1 per 100,000 women-years and age-standardised mortality rate (ASMR) of 6.9 per 100,000 women-years.[1]

In Singapore, cervical cancer is the tenth most common cancer among women and eighth most common cause of cancer-related death.[2] In a study conducted from 2013 to 2017, cervical cancer had an ASIR of 7.1 and an ASMR of 2.1. Notably, of the 1,077 cases of cervical cancer diagnosed, 64.8% of patients were younger than 65 years of age.[3] Additionally, the treatment of cervical cancer locally constitutes a significant economic burden, with an estimated total cost of SGD 57.6 million over a period of 25 years, starting from 2008.[4]

Human papillomavirus (HPV) infection has a strong association with cervical cancer. Carcinogenic types of HPV, such as HPV 16 and 18, are proven causes of invasive cervical cancer,[5,6] associated with around 70% of cervical cancer cases.[7] Thus, vaccination against HPV is an effective measure to reduce cervical cancer rates.

Acknowledging the rising incidence of cervical cancer and capacity for screening, the Cervical Cancer Screening (CCS) Programme Advisory Committee in Singapore recommends that all women who have ever had sexual intercourse should be screened for cervical cancer through a Pap smear every three years from age 25 to 29 years and through HPV testing every five years from age 30 to 69 years. In spite of the low cost and subsidies available, cervical cancer screening rates have remained low at 42%–50%,[8] short of the target of 80% set by the Ministry of Health.[8-10]

In addition, the HPV vaccine has been part of Singapore's National Childhood Immunisation Programme (NCIP) since November 2010 and the National Adult Immunisation

Schedule since November 2017. Despite efforts to involve industry partners, widespread campaigns and the ability to use MediSave – a national medical savings scheme – to fund the vaccinations, the uptake rate for the vaccine remains low. Only 13.6% of women aged 18–26 years have been immunised,[11] compared to countries which have a school-based immunisation programme, such as Australia and Malaysia, where between 70% and 99% of women have been immunised.[12,13]

Some reasons accounting for the low uptake include inconvenience, misconceptions regarding the safety profile of the HPV vaccine, and low awareness of the HPV and its vaccine.[9,14] An additional factor could be the cost of the vaccine – at SGD 120 per dose or SGD 240–360 for a complete course at polyclinics, the HPV vaccine is the costliest vaccine in the NCIP after the pneumococcal vaccine.

The World Health Organization (WHO) recommends to first establish whether a new vaccine is cost-effective before it is introduced into a national immunisation schedule.[15] HPV vaccines currently available in Singapore include the bivalent Cervarix vaccine (GlaxoSmithKline, covers HPV serotypes 16 and 18), quadrivalent Gardasil vaccine (Merck & Co; covers serotypes 6, 11, 16, 18) and the nonavalent Gardasil vaccine (Merck & Co; covers serotypes 6, 11, 16, 18, 31, 33, 45, 52, 58). In a study analysing the cost-effectiveness of the bivalent vaccine using the lifetime Markov cohort model, the introduction of the bivalent AS04-HPV-16/18v, in addition to the current cervical screening programme, compared with screening alone, resulted in a gain of 1,314 Quality Adjusted Life Years (QALYs). Significantly, the introduction of the vaccine would result in a further 137 prevented cervical cancer cases and 48 cervical cancer deaths. Factoring in the important cost savings associated with cervical intraepithelial neoplasia and cervical cancer treatment, it was found that the incremental cost-effectiveness ratio of introducing the bivalent vaccine in addition to screening, compared with screening alone, was SGD 12,645 per QALY gained. As per the WHO

threshold, the bivalent vaccine AS04-HPV-16/18v is considered highly cost-effective (< 1 × gross domestic product/capita).[16]

When comparing the effectiveness of the bivalent and quadrivalent vaccines, the bivalent AS04-HPV-16/18v was found to be more effective for avoiding cervical intraepithelial neoplasia, cervical cancer cases and cervical cancer-related deaths. Both before and after discounting, when compared with the quadrivalent vaccine, AS04-HPV-16/18v generated 174 and 28 additional QALYs respectively, at a lower cost.[16]

The above made the bivalent vaccine AS04-HPV-16/18v the dominant choice for the introduction of universal mass vaccination into the school-based immunisation programme in Singapore, as it proved more effective in reducing rates of cervical cancer and at a lower cost. This paper is an initial look at the newly introduced school-based HPV vaccination programme in Singapore and, consequently, its effects on vaccine uptake and coverage in the local population.

METHODS

The WHO recommends a two-dose immunisation schedule at least six months apart (0 and 6–12 months) for females aged 15 years and below and a three-dose schedule (0, 1 and 6 months apart) for those aged above 15 years.[17] Studies have proven that the two-dose schedule has comparable efficacy and immunogenicity with the three-dose one.[18-20] The Secondary 1 female students, who are of the 12–13-year age group, were the chosen target age group for the following reasons: (a) there is proven value in vaccinating early, prior to the onset of sexual activity; (b) they can adopt the two-dose immunisation schedule, which is less disruptive to the curriculum and allows resources to be more effectively utilised by carrying out vaccinations to two student cohorts at each visit; and (c) they do not sit for major national examinations, which could affect uptake rates and scheduling arrangements.

The Health Promotion Board (HPB), a statutory board under the Ministry of Health, Singapore, that manages the School Health Services, was the main provider of the school-based HPV immunisation programme. The HPV vaccination was incorporated as a free-of-charge opt-in programme, with the cost borne by the government. Private vendors were contracted to facilitate the vaccination process for the roll-out and catchup groups. These vendors were also engaged for follow-up vaccination of students who were not medically fit for immunisation on the day of the school field visit and students from the catchup group, who were graduating prior to completion of the three doses. We used the School-based Health and Immunisation Programme (SHIP), a government-secured intranet programme that has been in use by the School Health Services for current immunisation programmes in the primary schools and for school-based health screening.

The HPB provided the schools under the Ministry of Education with close updates on the HPV immunisation schedule, coverage and progress of implementation, including the various consenting processes and measures to uphold confidentiality. The Secondary 1 students' enrolment data was made available to the HPB.

Briefings were given to the director and superintendents of the schools that were involved to familiarise the schools with the workflow. Detailed letters were also sent to the school principals concerning the vaccinations.

Since the goal of HPV vaccination was to reduce rates of cervical cancer and the costs incurred in its treatment, the HPB also partnered with the Singapore Cancer Society to promote the joint message that the HPV vaccination provides good protection against cervical cancer, presenting a united public health front.

In-depth communication with the Islamic Religious Council of Singapore helped to ascertain that there were no contraindications to receiving HPV vaccination from a religious viewpoint.

A preliminary field survey was conducted in August 2018, prior to the planned implementation of the HPV vaccination programme. A total of 2,098 parents across eight primary and eight secondary schools were surveyed. Responses were generally supportive – 63.3% of those surveyed supported vaccination, with only 4.4% being against the introduction of the HPV vaccination. 32.3% were neutral. A large majority (69.2%) were willing to consent to their children receiving the vaccine. The survey revealed a need for widespread publicity and campaign – only 44.0% had heard of the vaccine, of which only 14.8% had a family member who had been vaccinated. Having insufficient information about the vaccine was cited as the top reason among parents who were unwilling to consent.

In partnership with the Singapore Cancer Society, a widespread digital campaign was held specifically targeting parents with children aged 13–17 years from July to September 2019. Sustained digital media in the form of advertisements and posters continued till December 2019. Its aim was to build trust regarding the HPV vaccination and the value in reducing the risk of cervical cancer. Widespread publicity of the HPV vaccination, its benefits and good safety profile was carried out via several media outlets including newspapers in multiple languages, broadcast news as well as social media. The then-Senior Minister of State for Health also highlighted it in her speech, and it was raised and included in the budget for healthcare.

Prior to the introduction of the HPV vaccinations, multiple meetings were held with vendors to brief them on the immunisation process, as well as training sessions including mock-up scenarios that are commonly faced during immunisation and how to handle them. This was to better equip vendors with the relevant skill sets during the field visits. Vendors were also trained to use the SHIP system.

The vaccine was delivered to the HPB warehouse two to three weeks prior to the scheduled vaccination period. Strict adherence to the cold chain and storage protocol was ensured.

An HPV control room was set up at the HPB to monitor the pan-island field visits and vaccine uptake. Daily After Action Review (AAR) meetings were held involving the various team nursing managers after the field visits. Updates on figures for vaccination, which had been tallied onsite previously, as well as troubleshooting of problems faced, were performed. The supervising committee also visited various fields to monitor the immunisation workflow and identify possible lapses.

An online Child Consent Portal (CCP) was made available to parents on the government-secure HPB website. Parents were given instructions to log on and fill in their child's medical information, current medications, known allergies as well as to provide consent to the HPV vaccinations. The consent would be valid through all doses of the vaccine until completion. If parents were not agreeable, they were given fields to indicate their reasons for objecting to the vaccination. A week prior to the school visit, students whose online forms were not filled received hard copy consent forms containing the same information fields, to take home to their parents. The online CCP forms were secured via the selective government-based network, and hardcopy consent forms were sealed and locked, transferred to the HPB centre via courier, and kept for two years in a facility with secure access.

On the day of the vaccination, the field team nurses educated the students on HPV infection and its relation to cervical cancer, and explained the indications for the HPV vaccine. Possible side effects and mitigating factors were mentioned. The students were then reviewed by a medical practitioner to evaluate for contraindications to vaccination. Physical and online consent forms were reviewed. If the parents still had not completed either form, the nurses in the field teams would contact them via phone calls to request for consent. This allowed queries and concerns of parents to be answered in real time and misconceptions to be addressed. If agreeable, the parent would then provide written consent via the online portal or visit the school to sign a hard copy. The vaccination would then be administered. After vaccination, it was

mandatory for the student to sit in the rest area for 15 minutes under direct observation by the nursing team, to watch for adverse reactions or side effects. Thereafter, if there were no observed side effects, students were allowed to return to class and advised on when to seek medical attention.

The free-of-charge, opt-in HPV vaccination was offered to all female students studying in Secondary 1 grades or the equivalent in the year 2019, who were aged between 12 and 13 years in the index year.

The same vaccination was offered as a one-time catchup programme to all female students who were enrolled in Secondary 2 to Secondary 5 in the year 2019. In the index year, the Secondary 4 and 5 cohorts, which were leaving school, were vaccinated. The Secondary 2 and 3 cohorts would be given the catchup dose in the subsequent two years, up to 2021.

Vaccine uptake and vaccine coverage were monitored as measures for success. They were defined as follows:

$$\textit{Vaccine uptake for the rollout dose (\%)} = \frac{\textit{Number of students who opted in and received vaccination onsite}}{\textit{Total number of female students enrolled in Secondary 1 in 2019}} \times 100\%$$

$$\textit{Vaccine uptake for the catchup dose (\%)} = \frac{\textit{Number of students who opted in and received vaccination onsite}}{\textit{Total number of female students enrolled in Secondary 4 and 5 in 2019}} \times 100\%$$

$$\textit{Vaccine coverage for the rollout dose (\%)} = \frac{\textit{Number of students who opted in and received vaccination (onsite or elsewhere)}}{\textit{Total number of female students enrolled in Secondary 4 and 5 in 2019}} \times 100\%$$

$$\textit{Vaccine coverage for the catchup dose (\%)} = \frac{\textit{Number of students who opted in and received vaccination (onsite or elsewhere)}}{\textit{Total number of female students enrolled in Secondary 4 and 5 in 2019}} \times 100\%$$

Opt-in was synonymous with having received parental consent. The secondary school cohort is a comparable surrogate for the total population of the corresponding age group, since

99.8% of females in that age group are enrolled in school.[21] Reasons for opting out were also studied. Adverse events were recorded by the nursing team. Vaccine completion was not studied, as the index batch of students involved in both rollout and catchup doses were in the midst of completing their doses according to schedule at the time of writing this study.

RESULTS

Through the use of school enrolment data from secondary schools and the Ministry of Education, a total of 139 mainstream schools were identified, comprising 19,144 students eligible for the rollout dose. They would receive their second dose in the following year. For the catchup dose, a total of 140 mainstream schools comprising 20,854 students were identified.

For the rollout dose, total vaccine uptake onsite in the schools was 16,717 (87.3%). For the catchup doses, vaccine uptake onsite was 17,163 (82.3%) for catchup dose 1 and 16,815 (80.6%) for catchup dose 2.

Total vaccine coverage for the Secondary 1 population, which corresponded to the rollout dose cohort, was 17,885 (93.4%). This was contributed by an additional 575 (3.0%) students who had been vaccinated by their own family physicians and 593 (3.1%) students who had their vaccinations at vendor clinics. Only 361 (1.9%) students truly opted out. Including those who opted in after field visits and those who opted to go to their own doctors to receive vaccinations, vaccine coverage in the mainstream schools was 96.7% (18,514 students; Table I).

Table I. Breakdown of decisions for the rollout dose of the HPV vaccine (n = 19,144).

Decision on rollout dose	No. of students (%)
Vaccine coverage	18,514 (96.7)
Vaccinated (i.e. vaccine uptake)	17,885 (93.4)
In school	16,717 (87.3)
By family physician	575 (3.0)
At vendor clinic	593 (3.1)

Opted-in later and referred to vendor clinic	77 (0.4)
Opted out of vaccination in school/opted to go to family physician	552 (2.9)
Opted out of vaccination in school due to various reasons	361 (1.9)
No consent form	269 (1.4)

Table II. Breakdown of reasons for opting out of the HPV vaccine (rollout dose) (n = 361).

Reason for opting out	No. of students (%)
No reason	161 (44.6)
Not comfortable with side effects	52 (14.4)
Considering giving at a later time	51 (14.1)
Do not think vaccine is necessary	25 (6.9)
Not keen/not comfortable	24 (6.6)
Need more information before deciding/do not think it prevents cervical CA	11 (3.0)
Do not trust vaccine/do not think it is safe	10 (2.8)
Others (overseas/leaving Singapore/medical condition)	9 (2.5)
Prefer other type of HPV vaccine	9 (2.5)
Child is acutely unwell/already received too many vaccines	6 (1.7)
Not compulsory/child not sexually active	3 (0.8)

CA: cancer; HPV: human papillomavirus

While the majority of the parents (44.6%) did not share reasons for opting out, common reasons were being uncomfortable with listed side effects of the vaccine (14.4%) and considering vaccination at a later date (14.1%). 3.0% felt they required more information or thought the vaccine did not prevent cervical cancer. 2.8% were doubtful in trusting the vaccine or had concerns regarding vaccine safety (Table II).

Total vaccine coverage for the Secondary 4 and 5 population, which corresponded to the index catchup dose cohort, was 19,187 (92.0%) for the first dose and 18,825 (90.3%) for the second dose.

Of the 140 mainstream schools and 20,854 students, an additional 1.3% opted in and were referred on to vendor clinics, 2.7% did not have valid consent forms and 3.9% opted out. Of these 3.9%, 2.4% opted to go to their family physician for vaccinations. Only a very small minority of 318 students, or 1.5%, truly opted out. Including those who opted in after field

visits and those planning to go to their family doctors for vaccinations, catchup dose vaccine coverage in mainstream schools would be 95.8%, or 19,978 students. Reasons for not consenting were similar to those mentioned earlier – a majority (50.6%) did not state a reason, 10.4% were considering whether to take the vaccine or to do so at a later time, and 9.1% were not comfortable with the possible listed side effects. None cited concerns regarding vaccine safety or having too many vaccines as a reason (Table III).

Table III. Breakdown of reasons for opting out of HPV vaccine (catchup dose) (n = 318).

Reason for opt-out	No. of students (%)
No reason	161 (50.6)
Considering whether to give/giving at a later time	33 (10.4)
Not comfortable with possible side effects	29 (9.1)
Others (overseas/leaving Singapore/medical condition)	24 (7.5)
Do not think vaccine is necessary	18 (5.7)
Child is acutely unwell	15 (4.7)
Not keen/not comfortable with vaccine	14 (4.4)
Need more information before deciding/do not think it prevents cervical CA	13 (4.1)
Do not trust vaccine	5 (1.6)
Prefer other type of HPV vaccine	4 (1.3)
Not compulsory/child not sexually active	2 (0.6)

CA: cancer; HPV: human papillomavirus

At the completion of the index year, for the 50,695 HPV vaccinations administered in school, including the rollout dose 1, and catchup dose 1 and 2, only 51 (0.1%) students reported side effects. These were all known side effects of the vaccination and were largely mild, including giddiness (26 students), malaise (25 students) and headache (16 students). Only three students had syncope, all of whom received further medical evaluation; one was reported as secondary to an extreme fear of needles, and the other two were deemed not vaccine-related. 37 of these students, including two of those who had syncope, have received their second dose uneventfully; 13 students had yet to get their second dose at the time of writing and would be

monitored for recurrence of side effects. One student who had pain and oedema of the injection site and lightheadedness opted out of the second dose.

Table IV. Side-effect profile of HPV vaccinations administered in school in 2019.

Side effect	No. of students (%)
Giddiness	26 (51.0)
Malaise	25 (49.0)
Headache	16 (31.4)
Syncope	3 (5.9)
Pain and swelling of the injected limb	2 (3.9)
Rash	1 (2.0)

Percentages do not add up to 100.0% as some students experienced multiple side effects.

DISCUSSION

High vaccine coverage (90.3%–93.4%) across the rollout and catchup doses was noted. This could be attributed to the high vaccine uptake onsite (80.6%–87.3%) across the doses during the school field visits. Prior to the school-based HPV immunisation programme, studies suggested that only 13.6% of women aged 18 to 26 years had been vaccinated,[11] and from our field data, only 3.0% of the Secondary 1 cohort and 6.2% of the Secondary 4 and 5 cohorts had been vaccinated before the field visit. The marked improvement in HPV vaccine coverage after introduction of the school-based programme could be attributed to various factors (Fig. 1).

We aimed to assess knowledge lapses and provided targeted solutions. Parents and children were involved early on using surveys to assess sentiment, understand knowledge, attitudes and practices towards the vaccine and towards health-related information. Choice of location for vaccination was also surveyed (Appendix, Supplementary Figs. 1–4). Using the survey results, several solutions were then put into place, including a media blitz to raise awareness on the vaccine, widespread publicity, the information sheet and a Frequently Asked Questions fact sheet for parents.

Involvement of key stakeholders and forging strong partnerships was key to smooth implementation of the programme. Partnerships with the Ministry of Education ensured that

the vaccination schedule would fit well into the school curriculum while being mindful of national examinations or major examinations. Partnerships with the Singapore Cancer Society supported the unified message on the vaccination's importance, and partnerships with religious groups such as the Islamic Religious Council of Singapore ascertained that there were no contraindications to religious requirements. On the ground, partnership with the school and its operations manager ensured smooth setup and immunisation flow. Open communication with parents and children was emphasised. Partnerships with healthcare vendors ensured that students who were unfit for vaccination during the field visit could receive their vaccinations conveniently at clinics located island wide, and in many neighbourhood enclaves. These clinics were open on Saturday mornings as well, and some provided services in the evenings or on Sunday mornings. This significantly lowered barriers to access.

Constant visits to the field, evaluation, supervision of cold chain management to maintain vaccine storage standards, and AAR meetings to evaluate the day's events contributed to continuous evaluation and improvements to the existing system. Some of these improvements included: (a) improving timeliness of delivery of vaccines to avoid extending the time that students spent in school and (b) reviewing success factors of schools that had achieved high uptake rates of 95%–100% and implementing these in other schools. The implementation process involved: (a) sending reminder letters to parents a week before vaccination, to reduce the rate of incomplete forms, (b) systematic follow-up with absentees by calling them up for vaccination on other days and (c) working with the school parent support group. The team optimised their time at the field by collating consent forms prior to vaccination day and contacting parents who had not filled in the forms during vaccinations, which allowed voicing and addressing of concerns, and real-time consent.

Students also exerted a positive influence on one another in terms of receptivity towards vaccination. Peers have a pivotal say in the decision-making processes of adolescents.

Empirical studies suggest that when an individual is confronted with uncertainty towards what to do, observing others can help with making a decision.[22] While not studied quantitatively, observations onsite during vaccination affirmed this. Several students who were initially afraid and apprehensive towards the vaccination were more accepting once the first few students in their class had been vaccinated. Some negotiated for their peers to be vaccinated first, and after being reassured by their peers' experiences, agreed to the vaccination. The majority opinion often affects an individual's opinions and behaviours, and may change them to follow social norms.[23-27] Students who are undecided about vaccination tend to follow the majority to receive their vaccination in school. This factor is absent in routine immunisation in private clinics. Moral support was also observed during field visits, as students were able to watch one another receive vaccinations. This, too, is unique to school-based immunisation.

Incorporation of HPV vaccination into the school-based programme is not a novel practice. Countries such as Malaysia and Canada have done so as early as 2007.[13,28] Most countries offer it to 13-year-old girls (Grade 7 or Grade 8), while Canada and the United Kingdom include vaccination for their male counterparts as well.[28,29] While this was considered in our local context, females were chosen as the group, because the aim of vaccination was to reduce the cervical cancer disease burden instead of reducing sexually transmitted infections.[16] Vaccine uptake rates, when calculated based on the definitions used in this paper, were generally comparable to those in other countries in the index year of the vaccination programme, with Australia achieving school-based uptake rates of 64%–85% for the first dose across different states[12] and Malaysia achieving school-based uptake of 95.9%.[13] Unlike in Malaysia and Singapore, there was no apparent period of publicity before introducing the immunisation in Australia. Malaysia also appeared to have standardised publicity and dosing schedules across the country, with a common government body managing the operations. On the contrary, different regions in Australia were granted independent

jurisdiction over immunisation and dosing schedules.[12] Singapore's immunisation programme, which had some similarities to Malaysia's programme, was standardised across the country and included a media blitz beforehand. This could account for the higher uptake rates we noted compared to those in Australia. Vaccine coverage was largely based on completed doses and ranged from 83% to 91% in Malaysia, owing to a higher rate of children not enrolled in school.[13]

Our study has several limitations. First, vaccine completion was not studied, as the index batch of students in both the rollout and catchup dose cohorts had not received their last dose at the time of the study. Vaccine completion should be studied in the future, as this would affect vaccine efficacy. Second, we were unable to completely follow up on whether the students who had opted for vaccination at their family practitioner did indeed receive the vaccination. Only the family physicians who registered the vaccinations in the National Immunisation Records were able to be tracked.

Lack of valid consent forms led to 1.4%–2.7% of the population not being vaccinated. Improved publicity of the online portal could reduce the need for on-paper consent and allow parents to provide consent in real time while their child is in school, while the vaccination process is ongoing. This would reduce the number of students who are unvaccinated owing to lack of consent. Further, this number is likely to reduce with future batches of students, as the initial consent form would be valid through all doses of the vaccine.

Further studies can be conducted to explore ideas and concerns regarding the HPV vaccine, and efforts to raise awareness and correct misconceptions regarding the vaccine should be expanded. Small or focus group discussions may be considered to facilitate open sharing. As the HPV vaccine takes root in the school-based immunisation programme, teenagers and their parents are likely to become more acquainted with it, and increased familiarity and acceptance can be expected. Additionally, some (1.7%) students took the first

but not the second catchup dose. This number, albeit small, suggests the need to explore why some students choose not to complete the vaccination. While not studied extensively, the upcoming major exams in the catchup dose group (those in Secondary 4 and 5) was a commonly cited reason for deterrence. Since the vaccination programme will eventually be rolled out to only those in the Secondary 1 cohort, major exams should not interfere with the schedule. As the programme continues to take shape, vaccine completion should be studied. Should this be low, further evaluation and in-depth study of the reasons should be performed to improve vaccine completion.

The high vaccine uptake rate and coverage is encouraging as it will have a long-term positive impact in reducing rates of HPV infection and, correspondingly, cervical cancer rates. While specific coverage to generate herd immunity is not known, studies have found that in countries with female vaccination coverage of at least 50%, HPV type 16 and 18 infections decreased significantly between the pre-vaccination and post-vaccination periods, by 68%.[30] Vaccine completion is important to ensure this positive effect and should be studied in the years to come.

In conclusion, high vaccine uptake and coverage of the HPV vaccine after the implementation of the school-based immunisation programme is encouraging and can be considered a success. This could be more holistically evaluated with further studies after the completion of all doses, and following several years of programme implementation. An accurate assessment of parental knowledge, attitude and practices, coupled with targeted solutions, can significantly improve uptake rates. Strong partnerships with stakeholders and constant groundwork evaluation and adaptation are key factors for success, while peer influence may have had some positive impacts on uptake rates and should be studied in greater detail. This implementation model can be applied to future health prevention programmes in the school-going age group.

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FIGURES

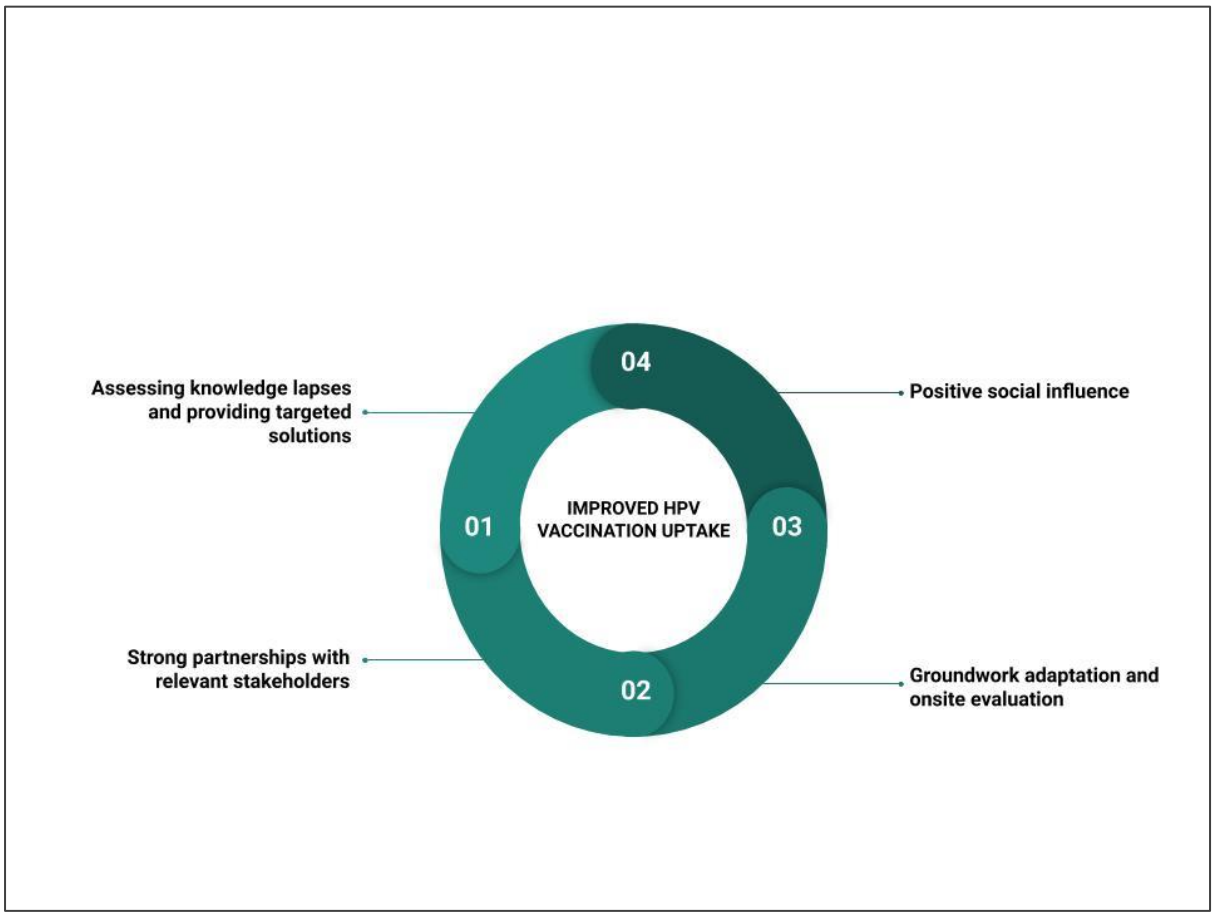
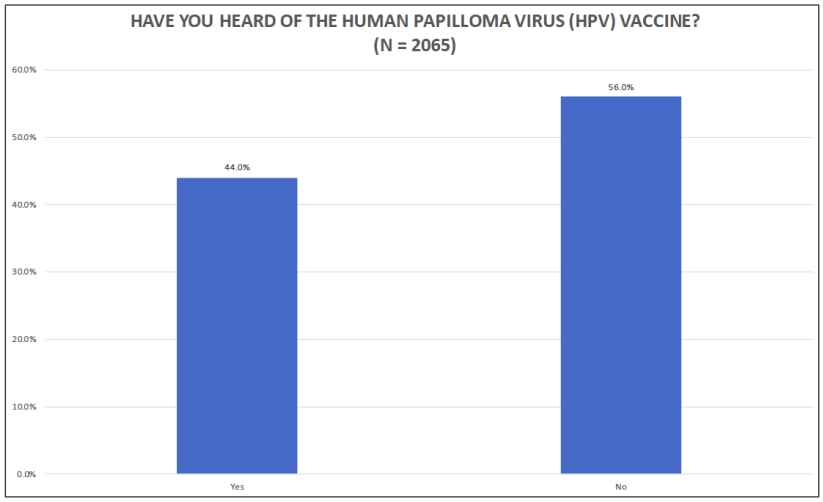
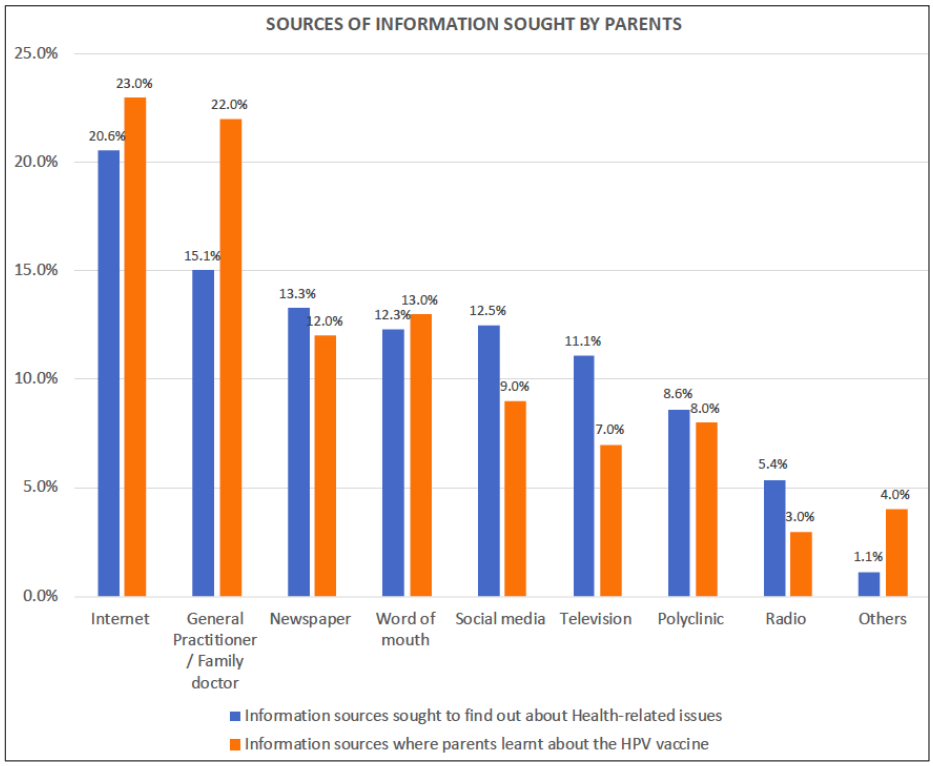


Fig. 1 Factors contributing to the success of the programme, as seen in improved HPV vaccine uptake rates. HPV: human papillomavirus

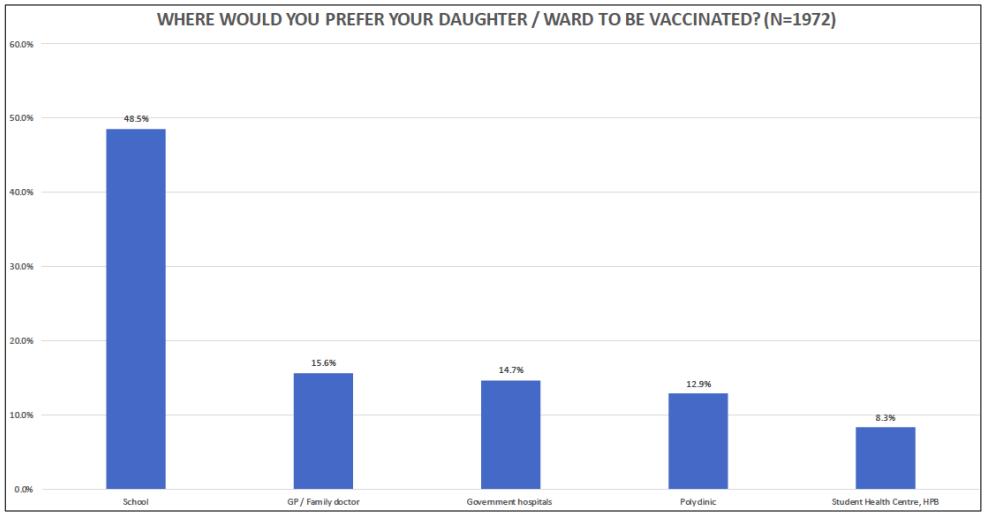
APPENDIX



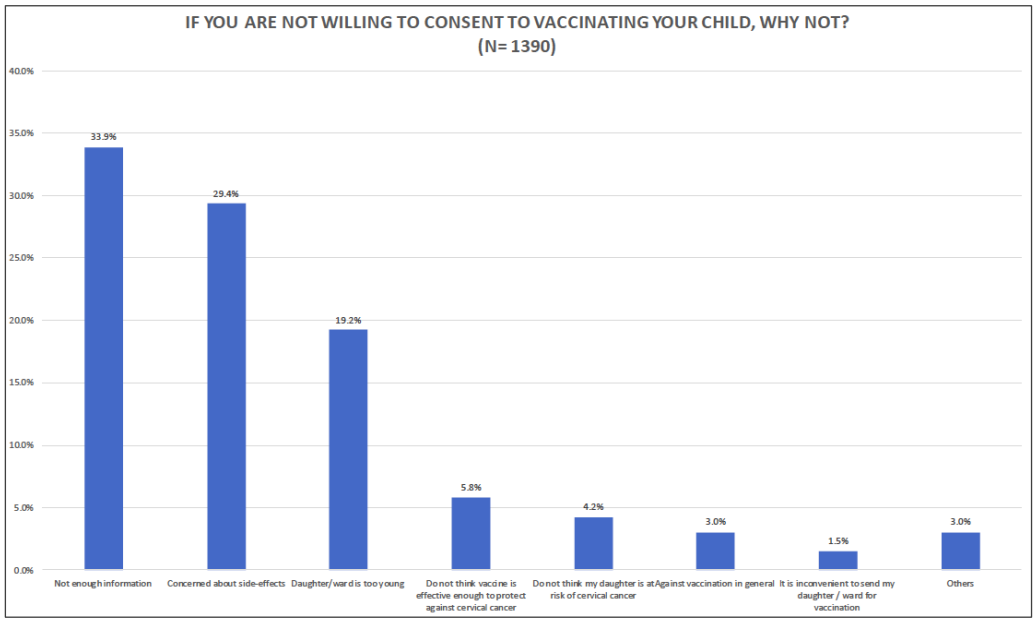
Supplementary Fig. 1 Chart shows that a majority of the parents surveyed had not heard of the HPV vaccine.



Supplementary Fig. 2 Chart shows that parents sought health-related information from various different sources, and parents who had heard about the HPV vaccine received information from various sources.



Supplementary Fig. 3 Chart shows preferred locations for taking the HPV vaccine, as cited by parents. HPV: human papillomavirus



Supplementary Fig. 4 Chart shows the reasons parents gave to explain why they were unwilling to consent to their child receiving the HPV vaccine. HPV: human papillomavirus