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The uptake of adolescent vaccinations through the School Immunisation Program in specialist schools in Victoria, Australia

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ABSTRACT

Background: As part of the National Immunisation Program (NIP) students in Australia receive adolescent immunisations through the School Immunisation Program at 12 to 13 years. For children with disabilities attending specialist schools, no vaccine uptake data is collected at this time point. We aimed to determine uptake of diphtheria-tetanus-pertussis (dTpa) and Human Papillomavirus (HPV) immunisations amongst young people with disabilities in specialist schools in Victoria.
Methods: A prospective cohort study was conducted in Victoria, Australia. Data was collected on immunisation days in the 2017 school year from specialist schools in Victoria. The school immunisation coordinator entered data online for eligible students for receipt of dTpa and HPV on each school immunisation day. Demographic data, motor and intellectual function of students and reasons for non-receipt of dTpa and HPV vaccine were recorded. Data were analysed using descriptive statistics.
Results: Of 73 eligible specialist schools in Victoria, 28 (38%) participated. dTpa was received by 63% (237/374) of participating students and HPV dose 1 (HPV1) was received by 66% (76/114) females and 67% (174/260) male students respectively. Three doses of HPV were received by only 41% (100/241) of students. The main reasons for missed immunisation were absence from school, lack of consent and inability to immunise due to the student's behaviour and/or anxiety.
Conclusion: This is the first study in Australia to report that uptake of adolescent immunisations in specialist schools for young people with a disability is significantly lower than in mainstream settings. Comparative data during the same time period for students in mainstream schools demonstrated higher uptake, at 89% for dTpa and 75% for three doses of HPV. These data highlight the inequity of receipt of school-based immunisations for this group of adolescents, the barriers to which could be more thoroughly explored through qualitative inquiry from a socio-ecological perspective.

1. Introduction

As part of the National Immunisation Program (NIP) in Australia, all young people aged 12 and 13 years are eligible to receive adolescent immunisations through the School Immunisation Program. In 2017, a booster dose of diphtheria-tetanus-pertussis (dTpa) vaccine, three doses of Human Papillomavirus (HPV) vaccine, and a catch-up dose of varicella vaccine (for young people who did not receive a dose in childhood and had no clinical history of infection) were offered in the school-based program. Signed parental consent is required for these immunisations to be given in the school setting by the Local Government Area immunisation nurses who visit the school [1]. For ease of administration, these vaccines are typically offered in the first year of high-school (Year 7) in Victoria. Vaccine

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uptake is determined by the number of doses given divided by the number of enrolled eligible students in Year 7. In 2016, 89% of eligible students attending mainstream schools received dTpa vaccine and 79% of females and 75% of males received three doses of HPV vaccine [2–4].

Mainstream schools in Victoria must accommodate students with any level of disability [5]. However parents of students with disabilities, who meet the criteria of an Intelligence Quotient (IQ) below 70, or high-level physical or behavioral support needs, can choose instead for them to attend specialist schools [6]. The decision to enroll a child in a specialist school is made by parents, often with specialist and educational advice, but is not mandated. The differences in the population of children attending mainstream schools with disabilities and those in specialist schools with disabilities, are not well described, with no statewide data collection of the demographics of these cohorts.

The specialist school settings are broadly divided into Special Schools, which enroll students with mild to moderate disability, and Special Development Schools, which enroll students with moderate to severe intellectual disability or high-level needs. In addition there are Multi-mode schools enrolling students with any level of intellectual disability or high-level needs (which are often also referred to as Special Development Schools), schools specifically for students with a diagnosis of Autism Spectrum Disorder (ASD), and schools for students with significant physical disability needing paramedical support.

Students in specialist school settings are typically grouped in classes according to ability and educational needs, but are not graded into individual year cohorts as seen in mainstream schools. As the majority of specialist schools have no Year 7 enrollment cohort, and therefore no figure to provide a denominator to calculate uptake of the school-based immunisations given at 12–13 years. As a result, data for adolescents with disabilities in specialist schools are not included in Victorian immunisation figures documented by the Department of Health and Human Services (DHHS) Victoria, nor is it possible to determine HPV uptake for these students from the HPV register.

The limited available evidence suggests that children with disabilities are at risk for under or non-immunisation. Lower rates of immunisation are recorded for children with disabilities for early childhood immunisations [7–9] and for the seasonal influenza vaccine [10,11]. Two studies from the USA and Canada on adolescent immunisation found that only 17% of children with special health care needs were immunised against HPV, and that having Trisomy 21 or ASD was significantly associated with missing HPV immunisation [12,13]. In a cohort of 72 Australian young people aged 14 with a range of disabilities, only 44.1% of females and 39.5% of males had received 3 doses HPV [14]. One unpublished audit in the United Kingdom, found that although parental consent for HPV vaccine was high at 77%, it was well below the 93% recorded in mainstream schools [15,16] and immunisation receipt was not recorded.

The potential for the population of young people with disabilities to be under-immunised is not only an equity issue, but has significant health implications. The consequence of vaccine-preventable diseases, in those with disabilities is likely to be more severe. This is particularly the case for people with significant physical disability, or disability related to prematurity, which can result in chronically impaired respiratory and neurological health [7,17,18]. In addition, the importance of HPV immunisation for young people with disabilities cannot be underestimated. Young people with disabilities are not only sexually active, but have a younger age of sexual debut and are more likely to experience unwanted sexual activity than their typically developing peers [19–21].

In this study we aimed to measure the uptake of school-based immunisations for young people with disabilities in the specialist school setting in Victoria, Australia. We also aimed to collect information on motor and intellectual function and reasons for non or under-vaccination to try and ascertain whether the type of disability influences immunisation receipt, and to identify the barriers and enablers to immunisation delivery. We hypothesised that the uptake of adolescent immunisations would be lower for students in specialist schools compared to mainstream school settings and would be predominantly due to lack of parental consent and behavioural factors and/or anxiety amongst students with disabilities.

2. Materials and Methods

2.1. Study population, recruitment and sampling

This prospective cohort study collected immunisation information on each of the three immunisation days in the 2017 school year for each consenting specialist school identified in Victoria. The principals of all eligible schools (n = 73) were sent an introductory letter and information statement in mid-December 2016 or late January 2017 outlining the study. If they consented to participation, they were asked to identify the school immunisation coordinator as the primary contact. A maximum of two follow up calls were made to schools that did not respond to the initial invitation.

On each immunisation day in 2017, the school immunisation coordinator was requested to enter data online for eligible students. Students were identified as eligible if they were aged 12 or 13 on the first immunisation day of the year. Data requested included: receipt of HPV and/or dTpa; age; gender; Aboriginal and Torres Strait Islander (ATSI) status; level of motor and intellectual function and reasons for non-receipt of dTpa and HPV vaccine. As not all adolescents were eligible for the varicella vaccine, uptake data for this vaccine was not recorded. Study data were collected and managed using REDCap™ electronic data capture tools hosted at the Murdoch Children's Research Institute, Melbourne [22].

2.2. Inclusion and exclusion criteria for schools

Eligible specialist schools were identified through the DHHS Immunisation Section, Victoria. This included all Special Schools, Special Development Schools, Multi-mode Schools, Physical Disability Schools and Autism Specific Schools. The principal investigator checked the enrolment criteria of each school to ensure that the specialist schools enrolled adolescent students with physical and/or intellectual disabilities. Young people attending mainstream schools were excluded. Satellite units for young people with special needs attached to mainstream schools; schools for hearing impaired students and specialist schools for students with primary mental health or behavioral needs were also excluded.

2.3. Ethics

Ethics approval was obtained from The Royal Children's Hospital, Melbourne, Human Research and Ethics Committee (HREC 36326B) and the research was approved by the Department of Education and Training Victoria. Consent of the individuals were not required, as individual, school and Local Government Areas were not named, and only aggregate data was reported.

2.4. Data analysis

Statistical analysis of uptake rates was undertaken using Stata [23]. Analysis of the difference in proportions between specialist school uptake and mainstream immunisation uptake was undertaken using Chi-Square. The association between demographic

variables and uptake rates was calculated using logistic regression, adjusted for age and clustering by school. Reasons for non-immunisation are presented as proportions of missed doses.

3. Results

3.1. Demographics

The demographics of consenting and non-consenting schools (28 [38%] vs 45 [62%]) are compared in Table 1. The schools that consented to participate were largely representative of specialist schools in Victoria although there were fewer medium size schools (32 vs 58%; p = 0.013) and schools from the South-Eastern region of Victoria (18 vs 38%; p = 0.026). There was no clear explanation for these differences.

3.2. Participant flow

Data was entered for 400 individual students, with 24/28 (86%) of participating schools completing data for all three immunisation days. Twenty-six records were excluded from students who received the third dose of HPV only, as a catch up dose from the 2016 school year. Complete data for the dTpa and first HPV immunisation dose (HPV1) was obtained for 374 students, with some attrition for the second and third HPV doses (HPV2 and HPV3) (Fig. 1). Hence there were 314 individual records entered for HPV2 and 241 entered for HPV3.

3.3. Immunisation uptake

The uptake rate for dTpa was 63% (237/374), and for HPV1 was 66% (76/114) for females and 67% (175/26) for males respectively. HPV3 completion was recorded for only 40% (28/72) of females, and 43% (72/169) of males from specialist schools (Tables 2 and 3). Uptake figures varied considerably by school, with schools reporting medians of 66% (IQR 38–85) for dTPa, 69% (IQR 43–80) for HPV1, 58% (IQR 33–75) for HPV2 and 43% (IQR 33–66%) for HPV3 (see Fig. 2). After clustering for schools, there was no significant difference in uptake of dTpa and HPV1 by gender, type of specialist school and degree of physical and intellectual impairment (Table 4). Students whose ATSI status was documented as "unclear" were statistically less likely to receive dTPa and HPV1 than those students who were not ATSI. However there was no significant difference in uptake for students who were confirmed ATSI.

3.4. Reasons for non-immunisation

The most common reason for missed doses of dTpa or HPV was absence from school with 38% (47/124) of missed dTpa doses and 117/391 (30%) of missed HPV doses attributable to absence on immunisation day (Table 5). Lack of consent card returned (31/124 [25%] for dTPa and 97/391 [25%] for HPV), and lack of consent given on a returned card (9/124 [7%] for dTPa and 52/391 [13%] for HPV) were also reasons for significant numbers of missed immunisation doses. Less common was inability to vaccinate the

Table 1
School demographics: consenting and non-consenting schools.

Demographic	Consenting schools (n = 28) n (%) Total students: 4,976	Non-consenting schools (n = 45) n (%) Total students: 6,298	p value
Type of School			
Special School	6 (22)	8 (18)	0.648
Special Development School	7 (25)	13 (29)	0.357
Multi-Mode School	11 (39)	18 (40)	0.476
Physical Disability	2 (7)	4 (9)	0.393
Autism Specific School	2 (7)	2 (4)	0.680
Student enrolment numbers			
<50 students	4 (14)	5 (11)	0.652
50–99 students	5 (18)	7 (16)	0.601
100–199 students	**9 (32)**	**26 (58)**	**0.013**
200–299 students	6 (22)	5 (11)	0.873
>299 students	4 (14)	2 (4)	0.911
Region of Victoria			
Metropolitan Melbourne	17 (61)	26 (58)	0.598
North Eastern	7 (25)	8 (18)	0.766
North Western	6 (21)	11 (24)	0.382
South Eastern	**5 (18)**	**17 (38)**	**0.026**
South Western	10 (36)	9 (20)	0.926
Student population			
Socio-economic index*^			
Low	14 (50)	23 (51)	0.463
Low-mid	7 (25)	11 (25)	0.521
Mid	2 (7)	5 (11)	0.278
Mid-High	2 (7)	6 (13)	0.189
High	2 (7)	0 (0)	0.929
Missing data	1 (4)	0 (0)	0.846
English as a second language home*			
<10%	22 (79)	37 (82)	0.352
10–19%	6 (21)	8 (18)	0.648
ATSI student*			
<10%	25 (89)	37 (82)	0.807
10–19%	3 (11)	7 (16)	0.272
>19%	0 (0)	1 (2)	0.156

* 2015 data obtained from school annual reporting, available for 72/73 schools.
^ As determined by family occupation.

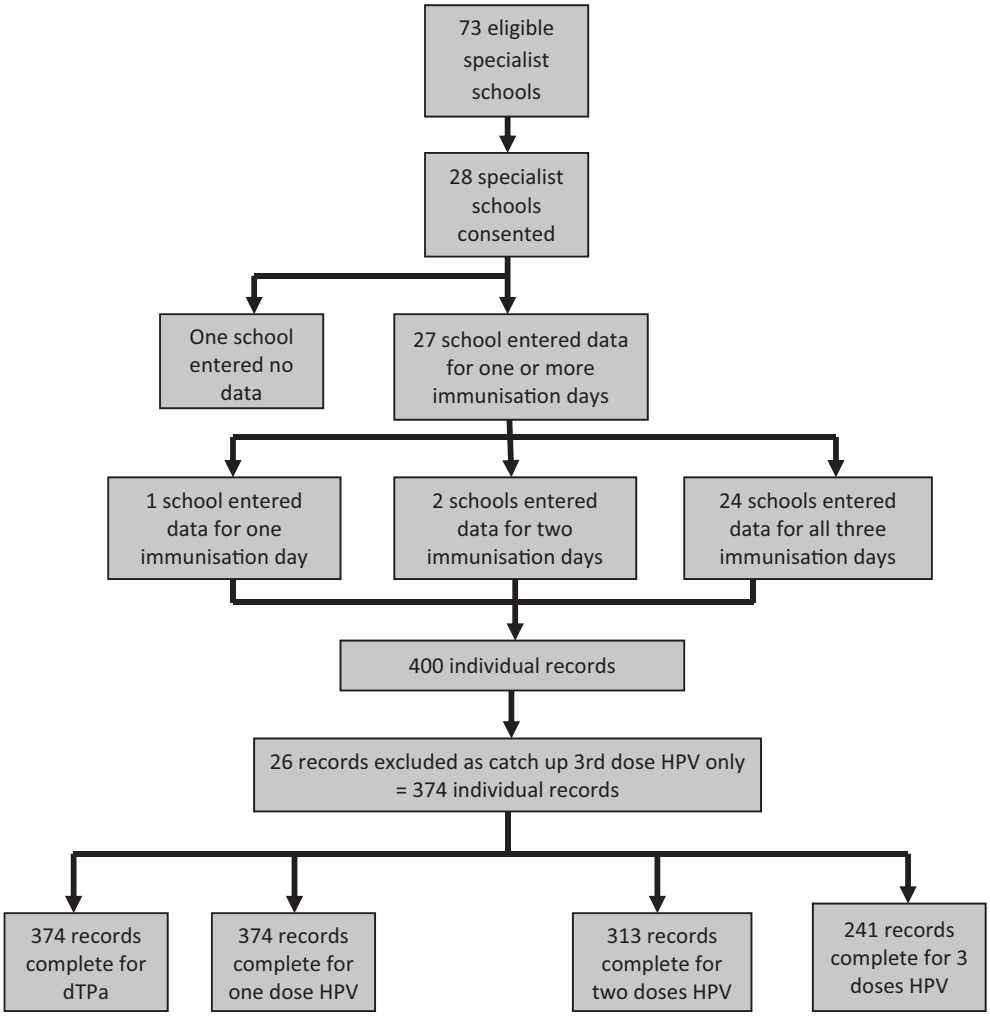

Fig. 1. Flow chart of participants.

Table 2
Uptake of dTPa vaccine as compared to Victorian data.

	Total number	dTPa Number (%)	OR (95% CI)
Victorian 2016 Year 7*	69,186	60,944 (89)	0.23 (0.19–0.29)
Specialist schools	374	237 (63)*,**	

* From data provided by DHHS Immunisation Victoria and DET.
** Includes those who received the dTPa immunisation on an immunisation day in 2017 and those who were up to date with dTPa.

student due to the student's degree of anxiety or distressed behaviour (91/124 [9%] for dTPa and 35/391 [9%] for HPV), however 49 of the 251 students who did receive their immunisation (19.5%) had a notation in this section that they were "very challenging" or "required extra support" or "became very distressed".

Reasons given in the "other" category for missed doses included, students who were enrolled also at a mainstream school so were attending there on immunisation day, were on excursions, or were at school but were unwell. There was no statistically

Table 3
Uptake of HPV vaccine as compared to Victorian data.

	Total Number	HPV 1 dose Number (%)	OR (95% CI)	Total Number	HPV 2 doses Number (%)	OR (95% CI)	Total Number	HPV 3 doses Number (%)	OR (95% CI)
Female									
Victorian Year 7*	33,675	29,545 (88)	0.28 (0.19–0.41)	33,675	28,566 (85)	0.19 (0.13–0.29)	33,675	26,640 (79)	0.17 (0.10–0.27)
Specialist Schools	114	76 (66)		96**	58 (52)		72***	28 (40)	
Male									
Victorian Year 7*	35,511	28,672 (84)	0.49 (0.37–0.63)	35,511	28,582 (81)	0.31 (0.24–0.41)	35,511	26,531 (75)	0.26 (0.19–0.35)
Specialist Schools	260	174 (67)		217**	123 (57)		169***	72 (43)	

* 2016, from the HPV Register.
** Missing dose 2 data includes: schools not submitting any individual data for that immunisation day (n=19, 5%), and individual student not having had any data reported for that day, although the school did submit other data that day (n=50, 13%).
*** Missing dose 3 data includes: schools not submitting any individual data for that immunisation day (n=38, 10%), and individual student not having had any data reported for that day, although the school did submit other data that day (n=102 ,27%).

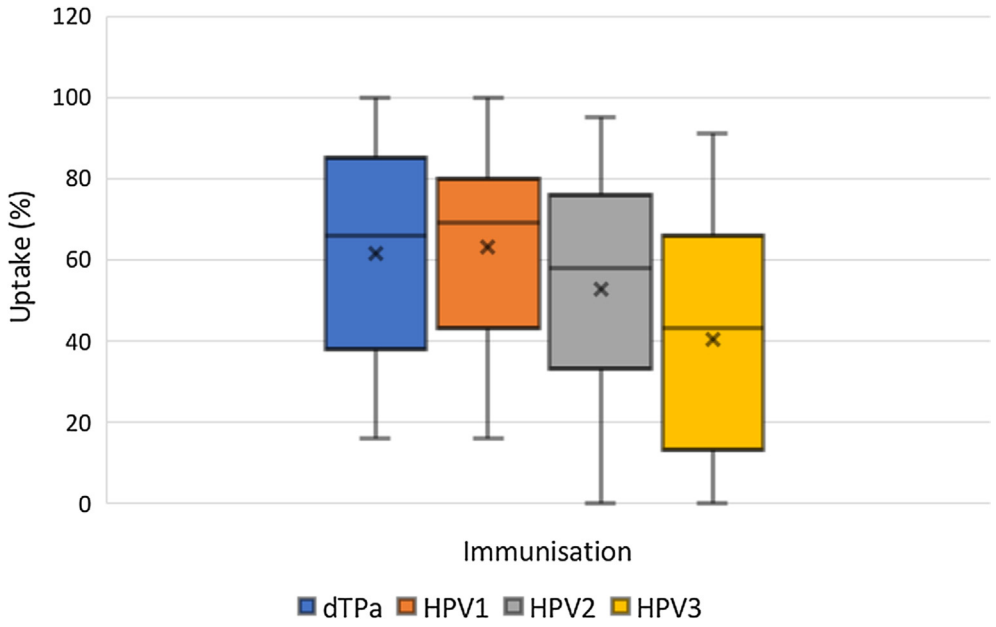

Fig. 2. Range of immunisation uptake across schools.

Table 4
Phase 1 Demographic association with uptake of dTPa and HPV.

Demographic	Total Number	Uptake dTpa n (%)*	OR	95% CI	Uptake HPV1 n (%)	OR	95% CI
Gender							
Female	114	68 (60)	Ref		76 (67)	Ref	
Male	260	169 (65)	1.26	0.69–2.28	174 (67)	1.01	0.54–1.88
ATSI status							
Not ATSI	352	227 (65)	Ref		239 (68)	Ref	
Unsure of ATSI status	12	3 (25)	0.18**	0.05–0.61**	4 (33)	0.24**	0.07–0.84**
ATSI	10	7 (70)	1.28	0.35–4.71	7 (70)	1.10	0.31–3.97
Type of School							
Special School	73	54 (74)	Ref		53 (73)	Ref	
Special Development School	82	42 (51)	0.37	0.12–1.18	43 (52)	0.41	0.14–1.24
Multi-Mode School	160	102 (64)	0.62	0.28–1.35	113 (71)	0.91	0.46–1.78
Physical Disability School	33	19 (58)	0.48	0.16–1.44	21 (64)	0.66	0.12–3.54
Autism Specific School	26	20 (77)	1.17	0.59–2.32	20 (77)	1.26	0.71–2.21
Physical impairment							
Ambulant without aides	330	210 (64)	Ref		222 (67)	Ref	
Ambulant with aides	18	10 (56)	0.71	0.28–1.80	11 (61)	0.76	0.32–1.82
Non-ambulant	26	17 (65)	1.08	0.25–4.64	17 (65)	0.92	0.11–7.69
Intellectual impairment							
No intellectual impairment	5	3 (60)	Ref		3 (60)	Ref	
Mild intellectual impairment	173	110 (64)	1.16	0.21–6.60	117 (68)	1.39	0.26–7.49
Moderate intellectual impairment	155	95 (61)	1.06	0.19–5.89	104 (67)	1.36	0.25–7.03
Severe intellectual impairment	41	29 (71)	1.61	0.28–9.21	26 (63)	1.16	0.22–6.10

* Includes those who received the dTpa 17immunisation on an immunisation day in 2017 and those who were up to date with dTPa.
** Statistically significant association $p<0.05$.

significant difference in reasons for missed immunisations for dTPa, as compared to HPV immunisation doses.

4. Discussion

This is the first study to describe immunisation uptake for young people administered vaccines through the school-based immunisation program delivered in specialist school settings in Victoria, Australia. We found dTpa and HPV uptake to be considerably lower in young people with disabilities in specialist schools compared to mainstream schools in Victoria. However, we did not find any association between vaccine uptake and gender, type of school or broad description of disability. The association between unclear ATSI status and lower uptake of dTPa and HPV1 in specialist schools, may reflect students that are less well known and at greater risk of under-vaccination, although the numbers were small. The most common reason for missed vaccination was absence from school, followed by lack of parental consent and inability to immunise due to the behavioural manifestations of anxiety.

The difference between specialist and mainstream school uptake data highlights how mainstream population data can mask poor immunisation rates in minority subpopulations. Although there is very little published research analysing dTpa uptake in adolescence, there is much published about HPV. It is well recognised globally that a government-funded school immunisation

Table 5
Reasons for non-immunisation.

Reason	dTPa n = 124 students not immunised number (%)	HPV n = 391 doses not given number (%)	OR (95% CI)
Not at school	47 (38)	117 (30)	0.70 (0.46–1.07)
No consent form returned	31 (25)	97 (25)	0.79 (0.49–1.27)
Consent form returned but no consent given	9 (7)	52 (13)	1.96 (0.93–4.10)
Behaviour/refusal	11 (9)	35 (9)	1.01 (0.50–2.05)
Parents indicate they will take to a community provider/ GP	9 (7)	35 (9)	1.26 (0.59–2.70)
Other	17 (14)	55 (14)	1.03 (0.57–1.85)

program yields the highest uptake of HPV immunisation [24–26]. Australia has become a world leader in the provision and completion of HPV vaccination, initiating the program in 2007 for girls and in 2013 for boys [24]. The uptake rate for students in specialist schools is far below mainstream school uptake and HPV vaccine uptake in all 40 countries where government-funded HPV vaccines are provided through a School Immunisation Program, with the exception of Colombia [27]. Systems delivery and policies for school-based delivery of adolescent vaccines to specialist schools in Victoria, and more broadly in Australia need to be carefully evaluated.

Absence from school has been recognised as a barrier to delivery of immunisations through school-based programs in low to middle income countries where school attendance is poor [28,29]. However, it has not to date been described as a barrier in high-income countries where school attendance is generally high. Specialist schools in Victoria have twice the rate of student absenteeism as mainstream schools (12% vs 6% respectively) [30] on any given day, which provides challenges for the School Immunisation Program, especially for the HPV vaccine, which required three doses in 6 months. The change to a two-dose schedule, which occurred in Australia in 2018, may help to reduce missed vaccinations, especially if more catch up immunisation days are provided. However, the rate of missed immunisations due to absence in this setting is more than double the average rate (30% vs 12%) and the reason for the high absentee rate on immunisation days is not clear.

Lack of consent from parents for immunisation, including both failure to return consent cards and specific non-consent to the vaccination, was also a major reason for missed immunisation. Parent refusal of adolescent vaccinations, particularly HPV, is well documented with parents citing concerns about safety, low perceived likelihood of their child contracting HPV, and concern that the immunisation will encourage sexual activity [31,32]. It is unclear whether these concerns were held by parents of young people with disabilities in this study. Interestingly, there was no statistical difference in consent for dTpa compared to HPV, suggesting determinants of parental consent to adolescent immunisation in this population were not related to vaccination type. Reasons for non-immunisation in specialist schools may therefore be less about parental concern about specific vaccines and more about logistics, the process associated with vaccination and/or the behavioural concerns during immunisation.

Just under 10% of dTpa and HPV doses missed were reported to be due to anxiety and behavioural concerns. In addition 19.5% of students who received an immunisation were noted to require extra support or were upset at the time of vaccination. Distress of students on vaccination day, linked to anticipatory anxiety and needle phobia, is not unique to the specialist school setting [33]. Indeed a case of mass psychogenic illness triggered by anxiety at the prospect of receiving the HPV vaccination when it was first introduced at a mainstream school in Melbourne has been described [34–36]. A Canadian study found that 8% (79/1024) of children aged 6 to 17 were non-compliant with immunisation due to needle phobia, and 5% (45/883) of parents delayed or missed their child's immunisation due to the child's level of anxiety [37].

There is an absence of literature exploring the anxiety of young people with disabilities during immunisation. The behavioural manifestations of anxiety in children with intellectual disability and autism are more likely to be externalised than children without disabilities [38], and this may be a safety consideration for both students and staff when immunising in the school environment. The large number of students who are successfully immunised in specialist schools, but require extra support for distress is not captured in uptake figures. How this is managed by the immunisation teams, and the intensity of resources required, as well as the emotional impact on staff and students, requires further exploration.

For students who are not able to be immunised at school due to their anxiety or behaviour, the standard advice given is to attend their general practitioner (GP) for these immunisations. However GPs do not generally have more resources or experience administering immunisations to anxious young people who may have significant cognitive impairment than school immunisation nurses, and often refer onto specialist immunisation clinics in their state, if available. Assessment and immunisation under sedation can be arranged by specialist tertiary immunisation clinics, with high degrees of success [39]. However, many GPs and families may be unaware of this option or it may be logistically difficult to organise Clear referral pathways for students with disabilities who may need to attend such services to minimise distress and the potential for physical harm to both students and staff would be optimal.

Further research, incorporating qualitative inquiry, of the uptake of adolescent vaccinations in specialist schools in Victoria, Australia, is needed to understand the issues and barriers to implementation, provision and acceptance of immunisations in the specialist school setting. Qualitative inquiry could explore the multifactorial and complex determinants of under-vaccination, as well as the experience of vaccination for young people with disabilities in specialist schools [40,41] The strengths of qualitative research in understanding barriers to immunisation in defined, minority populations who are vulnerable to under-immunisation have been emphasised in a recent review of the Tailoring Immunisation Program (TIP), a program run in the World Health Organisation (WHO) European Region. The TIP program outlines a supported process to explore barriers and motivations to immunisations in populations with low immunisation coverage [42] and illustrates the growing recognition of the need for specific analysis and targeted interventions for some populations in order to provide equitable access to immunisation. A socio-ecological framework would enable exploration of the social, cultural and political constructs as well as individual and familial values and behaviours that may be barriers to vaccination in under-immunised minority groups.

There are some limitations to this study. Accurate data collection was reliant on the school immunisation coordinators to

identify all eligible students. There was a wide variety of staff who undertook this role, including school nurses, teachers, administration staff, wellbeing coordinators and vice-principals, with variable knowledge about immunisation and motivation to undertake this role. Not all of the school coordinators in this study were present on the immunisation days, and while clear inclusion instructions were provided, it is possible some students who were eligible for adolescent immunisation were overlooked in data collection.

The uptake rates reported in this study may be an overestimate of true uptake rates for specialist schools. The School Immunisation Program operates in schools in Victoria on a good-will basis with no financial reimbursement, and therefore a participation rate of just over a third of specialist schools was not unexpected. The schools that participated were more likely to have the time and resources, or a dedicated school nurse whose primary focus was health rather than education, than those who declined. This may have translated into increased promotion and uptake of immunisation amongst participating schools.

Overestimation of uptake rates may be particularly evident in the figures for HPV2 and HPV3 where there was a significant decrease in numbers of individual entries, compared to dTPa and HPV1. This attrition included schools who did not submit any individual data for that immunisation day (HPV2: n = 19/375 [5%]; HPV3 n = 38/375 [10%]), therefore their immunisation status was unknown. It also included schools who only submitted data for immunised students (n = 50 [13%] HPV2: 50/374 [13%]; HPV3: 102/374 [27%]), therefore students with missing data were unlikely to have received an immunisation on this day but this was not explicitly stated.

5. Conclusion

This is the first study of immunisation uptake in specialist schools in Australia and is one of only a few studies globally examining adolescent immunisation in young people with disability. Young people with disabilities are at risk for under-immunisation with a significant disparity in uptake of dTpa and HPV in specialist schools compared to mainstream schools. Absence from school, lack of consent and behavioural issues were the main reasons for missed vaccination and warrant deeper exploration through qualitative inquiry. Such data can inform policy and new interventions to improve vaccine uptake for children with disabilities in congruence with the principles of equity in health care and the rights of persons with disabilities.

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Conflicts of interest

None.

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References

[1] Ward K, Quinn H, Bachelor M, Bryant V, Campbell-lloyd S, Newbound A, et al. Adolescent school-based vaccination in australia. Commun Dis Intell 2013;37(2):156–67.
[2] Department of Health and Human Services Immunisation Section Victoria. School immunisation overall encounter by LGA. Unpublished data. 2016.
[3] Brotherton JM, Winch KL, Bicknell L, Chappell G, Saville M. HPV vaccine coverage is increasing in Australia. Med J Aust. 2017;206:262.
[4] HPV Register. Coverage Data - National HPV Vaccination Program Register. 2017. Available from: http://www.hpvregister.org.au/research/coverage-data
[5] Department of Education and Training Victoria. Students with a Disability school policy. 2018. Available from: https://www.education.vic.gov.au/school/principals/spag/participation/Pages/studentswithdisability.aspx
[6] Association for Children with a Disability. Government specialist schools and units. 2015. Available from: https://www.acd.org.au/government-specialist-schools-units/
[7] Greenwood VJ, Crawford NW, Walstab JE, Reddihough DS. Immunisation coverage in children with cerebral palsy compared with the general population. J Paediatr Child Heal. 2013 Feb;49(2):E137–41. , http://doi.wiley.com/10.1111/jpc.12097.
[8] Raddish M. The immunization status of children with spina bifida. Arch Pediatr Adolesc Med 1993;147(8):849.
[9] Tillmann BU, Tillmann HC, Heininger U, Lütschg J, Weber P. Acceptance and timeliness of standard vaccination in children with chronic neurological deficits in north-western Switzerland. Eur J Pediatr 2005;164(5):320–5.
[10] Pandolfi E, Carloni E, Marino MG, Ciofi Degli Atti ML, Gesualdo F, Romano M, et al. Immunization coverage and timeliness of vaccination in Italian children with chronic diseases. Vaccine 2012;30:5172–8.
[11] Yen C-F, Hsu S-W, Loh C-H, Fang W-H, Wu C-L, Chu CM, et al. Analysis of seasonal influenza vaccine uptake among children and adolescents with an intellectual disability. Vol. 33. Res Dev Disabil 2012:704–10.
[12] Cody PJ, Lerand SJ. HPV vaccination in female children with special health care needs. J Pediatr Adolesc Gynecol 2013;26:219–23.
[13] Remes O, Smith LM, Alvarado-Llano BE, Colley L, Lévesque LE. Individual- and regional-level determinants of human papillomavirus (HPV) vaccine refusal: the Ontario Grade 8 HPV vaccine cohort study. BMC Public Health 2014;14(1):1047.
[14] O'Neill J, Elia S, Perrett K. Human Papillomavirus vaccine uptake in adolescents with developmental disabilities. J Intellect Dev Disabil 2017:1–5.
[15] Tuffrey C, Le Provost N, MacLeod R. Audit of the local rates of parental consent given for the HPV vaccine amongst girls with moderate and severe learning difficulties in accordance with the national immunisaiton programme. Unpublished data. 2013.
[16] MacLeod R, Tuffrey C. Immunisation against HPV in girls with intellectual disabilities. Arch Dis Child Educ Pract Ed 2013;99(12):1068–70. , http://adc.bmj.com/cgi/doi/10.1136/archdischild-2013-305919.
[17] Cameron JC, Allan G, Johnston F, Finn A, Heath PT, Booy R. Severe complications of chickenpox in hospitalised children in the UK and Ireland. Arch Dis Child 2007 Dec;92(12):1062–6. , http://www.ncbi.nlm.nih.gov/pubmed/17991685.
[18] Sachedina N, Donaldson LJ. Paediatric mortality related to pandemic influenza A H1N1 infection in England: an observational population-based study. Lancet 2010;376(9755):1846–52.
[19] Wienholz S, Seidel A, Michel M, Haeussler-Sczepan M, Riedel-Heller S. Sexual experiences of adolescents with and without disabilities: results from a cross-sectional study. Sex Disabil 2016;34:171–82.
[20] Jones L, Bellis MA, Wood S, Hughes K, Mccoy E, Eckley L, et al. Prevalence and risk of violence against children with disabilities: a systematic review and meta-analysis of observational studies. Lancet 2012;380:899–907.
[21] McCabe MP. Sexual knowledge, experience and feelings among people with disability. Sex Disabil 1999;17(2):157–70.
[22] Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—A metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009;42(2):377–81.
[23] Stata. Statacorp. Stata statistical software. College Station TX: StataCorpLLC; 2017.
[24] The Garland SM. Australian experience with the human papillomavirus vaccine. Clin Ther 2014;36:17–23.
[25] Paul P, Fabio A. Literature review of HPV vaccine delivery strategies: considerations for school- and non-school based immunization program. . Vaccine 2014;32:320–6.
[26] National Centre for Immunisation Research and Surveillance. Evaluation of the National Human Papillomavirus Vaccination Program. 2014;(August), 20.
[27] Brotherton JML, Bloem PN. Population-based HPV vaccination programmes are safe and effective: 2017 update and the impetus for achieving better global coverage. Best Pract Res Clin Obstetrics Gynaecol 2018;47:42–58.
[28] Mackroth MS, Irwin K, Vandelaer J, Hombach J, Eckert LO. Immunizing school-age children and adolescents: Experience from low-and middle-income countries. Vaccine 2010;28:1138–47.
[29] Vandelaer J, Olaniran M. Using a school-based approach to deliver immunization-Global update.. Vaccine 2015;33(5):719–25.

[30] Department of Education and Training Victoria. Government school student attendance rates by sex, indigenous status and year level, 2015. 2016. Available from: https://www.data.vic.gov.au/data/dataset/government-school-student-attendance-rates-by-sex-indigenous-status-and-year-level-2015/resource/feeb83a0-792c-4828-9b7e-a4f593020ec4
[31] Thavarajah N, Chow E, Arocha J. Factors influencing parental decision making for the human papillomavirus (HPV) vaccine: a literature review. Int J Child Adolesc health. 2015;8(3):265–76.
[32] Tung ILY, Machalek DA, Garland SM. Attitudes, knowledge and factors associated with human papillomavirus (HPV) vaccine uptake in adolescent girls and young women in Victoria, Australia. PloS one 2016;11(8):e0161846.
[33] Bernard DM, Robbins SCC, Mccaffery KJ, Scott CM, Skinner SR. The domino effect: adolescent girls' response to human papillomavirus vaccination. Med J Aust 2011;194(6):294–300.
[34] Buttery JP, Madin S, Crawford NW, Elia S, La Vincente S, Hanieh S, et al. Mass psychogenic response to human papillomavirus vaccination. Med J Aust. 2008;189(5):261–2.
[35] Clements C. Gardasil and mass psychogenic illness. Aust NZ J Public Healt 2007;31(4):387.
[36] Taddio A, Chambers CT, Halperin SA, Ipp M, Lockett D, Rieder MJ, et al. Inadequate pain management during routine childhood immunizations: the nerve of it. Clin Ther Suppl B 2009;31.
[37] Taddio A, Ipp M, Thivakaran S, Jamal A, Parikh C, Smart S, et al. Survey of the prevalence of immunization non-compliance due to needle fears in children and adults. Vaccine 2012;30:4807–12.
[38] Evans DW, Canavera K, Kleinpeter FL, Maccubbin E, Taga K. The fears, phobias and anxieties of children with autism spectrum disorders and down syndrome: comparisons with developmentally and chronologically age matched children. Child Psychiatry Hum Dev 2005;36(1).
[39] Cheng DR, Elia S, Perrett KP. Immunizations under sedation at a paediatric hospital in Melbourne, Australia from 2012–2016. Vaccine 2018;36(25):3681–5.
[40] Batista Ferrer H, Audrey S, Trotter C, Hickman M. An appraisal of theoretical approaches to examining behaviours in relation to Human Papillomavirus (HPV) vaccination of young women. Prev Med 2015;81:122–31.
[41] Larson HJ, Jarrett C, Eckersberger E, Smith DMD, Paterson P. Understanding vaccine hesitancy around vaccines and vaccination from a global perspective: a systematic review of published literature, 2007–2012. Vaccine 2014:2150–9.
[42] Dubé E, Leask J, Wolff B, Hickler B, Balaban V, Hosein E, et al. The WHO Tailoring Immunization Programmes (TIP) approach: Review of implementation to date. Vaccine 2018;17(36):1509–15.