

Assessing HPV vaccine coverage in Australia by geography and socioeconomic status: are we protecting those most at risk?

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Two prophylactic human papillomavirus (HPV) vaccines have been developed that can prevent infection and disease due to HPV types 16 and 18, the most oncogenic types, which are responsible for 70% of cervical cancers.¹

In 2007, the Australian Government funded the quadrivalent HPV vaccine through its National Immunisation Program. The quadrivalent vaccine also provides protection against HPV types 6 and 11, which cause genital warts. Australia was the first country to introduce a fully funded, population-based HPV vaccination program, which is an ongoing school-based program for 12 and 13 year old females, and – from 2013 on the basis of acceptable cost effectiveness – males. The immunisation program is not mandated through legislative arrangements but rather occurs in schools on a 'good will' basis, with the administration and organisation negotiated at the school level by individual State Health and Education Departments.² There were 9,468 schools in Australia in 2010, 71% of which were government, 18% Catholic and 11% part of the independent sector.³ Although the program is not compulsory, the majority of schools participate; however, individual schools may have different levels of resourcing allocated to support the operations of the program.⁴ The National HPV Vaccination Program Register (NHVPR) was established to measure HPV vaccination coverage and support the management and evaluation of the program.² Coverage achieved during the initial catch-up program

Abstract

Objective: To determine whether HPV vaccine coverage in 12–13-year-olds varies by geographical area, remoteness and ecological level indicators of socioeconomic status (SES).

Method: Data from the National HPV Vaccination Program Register (NHVPR) were analysed at Statistical Local Area (SLA) level, by the Index of Relative Disadvantage (IRSD) and the Australian Standard Geographical Classification Remoteness Structure.

Results: Nationally, 73% of females aged 12–13 years in 2007 were fully vaccinated against HPV. Coverage in low SES areas (71.5%) was 4.1 percentage points lower than coverage in high SES areas (75.6%). Uptake of the first two doses was higher in the very remote parts of Australia (dose 1 – 88.5%, dose 2 – 81.8%) than in major cities (dose 1 – 83.4%, dose 2 – 80.2%), but not for dose 3 where coverage in major cities was 3% higher (73.6% versus 71.4%).

Conclusion: Notifications of HPV vaccine doses delivered to females aged 12–13 through schools suggest a high and relatively equal uptake across socioeconomic groups. Females in remote regions have the highest uptake of dose 1 but are least likely to complete the course. This may be due to particular challenges in vaccine delivery to residents of remote areas.

Key words: Human papillomavirus (HPV), vaccine, health inequality, socioeconomic status, remoteness

(2007–2009) for all women 12–26 years was substantial (around 50% of the total female population in the age group received all three doses) and substantial declines have already been observed in HPV prevalence⁵ and genital warts.⁶

Women of lower socioeconomic status (SES) are at higher risk of cervical cancer in Australia,⁷ as elsewhere,⁸ with an 18% lower two- year screening participation rate among women residing in the least (52.1%) affluent compared to the most (63.2%) affluent areas of Australia in 2009–2010.⁹ An important concern raised about the HPV vaccination program is whether it will predominantly

capture the same women who would have participated in screening, thus possibly widening existing inequities related to SES. The current study is the first to examine participation in the HPV vaccination program in Australia by SES and remoteness areas, to determine whether it provides an equitable basis for HPV prevention and, ultimately, cervical cancer prevention. If females in lower SES groups participate in the HPV vaccination program at a lower rate, then existing inequities in cervical cancer incidence and mortality could widen.¹⁰

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Methods

HPV vaccine coverage

Data for vaccinated females aged 12 and 13 years in 2007 (the first year of the program) were extracted from the National HPV Vaccination Register (NHVPR) as at December 2011 as de-identified data at the Statistical Local Area level (SLA). SLAs are a base spatial unit used to collect and disseminate statistics within the Australian Bureau of Statistics (ABS). There were 1,426 SLAs in Australia at 2006, with resident populations ranging from 15 people up to around 134,000.¹¹

Details of data collection and processing by the Register are available elsewhere.⁴ In brief, vaccination providers submit notifications of vaccine doses administered as a record of each individual. With the exception of a small number of individuals who may opt off inclusion on the Register, data from school programs should be completely notified. Where individuals were vaccinated by general practitioners (e.g. for those not at school or who missed a dose at school), notification may be incomplete as notification was not compulsory, although attracting a payment of \$6 per dose notified. Australian Bureau of Statistics 2007 mid-year population estimates were used as the denominator. HPV vaccine coverage is calculated as females aged 12 and 13 years who received either one, two or three doses as a proportion of the female estimated resident population also aged 12 and 13 years.

Socioeconomic status and the IRSD

The ABS 2006 SEIFA Index of Relative Socioeconomic Disadvantage (IRSD) is derived from 2006 Census variables related to disadvantage such as low income, low educational attainment, unemployment and dwellings without motor vehicles. It represents an average of the socioeconomic conditions of people living in an area; as such, it does not represent the individual situation of each person living in the area.¹² SLAs were ranked by their IRSD score and then allocated into quintiles, each with approximately 20% of the population.

Remoteness

Remoteness is measured by the Remoteness Structure published by the ABS in the Australian Standard Geographical Classification (ASGC).¹³ This classifies Australia into large regions that share common remoteness characteristics based on the

physical distance of a location from the nearest Urban Centre (access to goods and services) based on population size. SLAs were allocated in whole or in part to one of five remoteness classes: Major Cities of Australia, Outer Regional, Inner Regional, Remote and Very Remote, as illustrated in Figure 2.

Correlation

The correlation coefficient was used to measure the strength of the association

between HPV vaccination and selected SES indicators. Pearson correlation coefficients range from +1 (complete positive correlation) through 0 (complete lack of correlation) to -1 (complete negative correlation).

Analyses were performed using Microsoft Excel and IBM SPSS Statistics 19 software. Spatial analyses were performed using the ESRI ArcMap version 10 software.

Figure 1: HPV vaccine coverage in 12-13 year old females (age as at 2007), Australian States and Territories (Data as at Dec 2011).

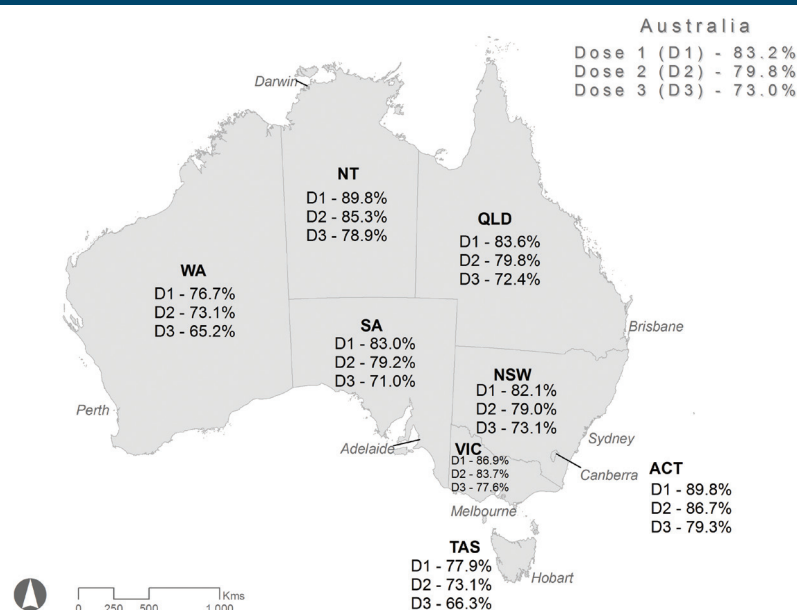
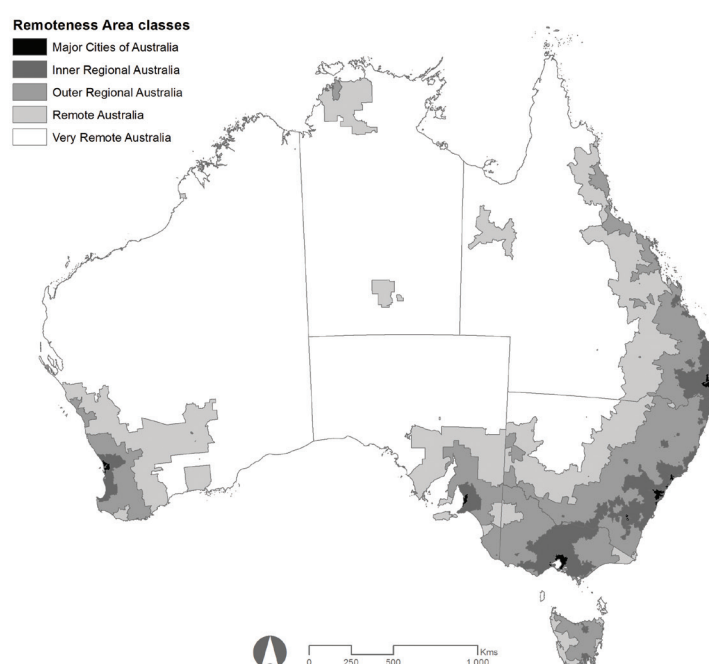


Figure 2: Remoteness Areas, Australia, 2006.



Results

HPV vaccine coverage by States and Territories

Nationally, 73% of females aged 12–13 years were fully vaccinated against HPV (Figure 1). Full vaccination coverage ranged from 65.2% in Western Australia to 79.3% in the Australian Capital Territory. A larger proportion received at least one dose, at 83.2%, while almost 80% received at least two doses. The Northern Territory and Australian Capital Territory reported the highest HPV coverage estimates for delivery of one, two or three doses.

HPV vaccine coverage by capital cities

In the capital cities of Australia, 73.8% of females aged 12 and 13 years were fully vaccinated with three doses of HPV vaccine (Table 1). Full vaccination status varied between the capital cities, from 63.7% in Perth to 80.8% in Darwin. The proportion of females receiving at least one dose in capital cities was 83.5%, 9.7 percentage points higher than the proportion fully vaccinated, while 80.2% received at least two doses.

HPV vaccine coverage by SES

When stratified by SES, HPV vaccine coverage was relatively uniform. Nationally, 83.9% received the first dose of the vaccine in high SES areas, compared to 83.1% in low SES areas, ($p < 0.001$) (Table 2). The difference in coverage by SES was slightly greater for two doses, although still relatively small with 81.2% coverage in high SES areas compared to 79.1% in low SES areas ($p < 0.001$). The SES gradient was most pronounced when observing completed vaccination, with the rate in the low SES areas 4.1 percentage points lower than that in high SES areas (71.5% and 75.6% respectively, $p < 0.001$) (Table 2).

Remoteness

Coverage of the HPV vaccine for each dose received was relatively uniformly spread across Australia's major cities, and regional and remote areas, although rates for three doses dropped off more markedly in the remote areas (Table 3). The rate for dose one coverage was highest in the Very Remote areas of Australia (88.5%), an increase of 5.1 percentage points from the rate in Major Cities ($p < 0.001$). The Outer Regional class had the lowest uptake rate for dose one at 82.4%. Similarly for Dose 2 the highest rate was in the Very Remote class (81.8%), while the other

four remoteness classes were similar (78.2% to 80.2%).

The proportion fully vaccinated was highest in the Major Cities (73.6%) but it declined by just 3% across the remoteness classes to 71.4% in the Very Remote class ($p = 0.01$). The Remote class recorded the lowest rate for both Dose 2 and Dose 3 vaccine coverage.

Correlation analysis

The correlation analysis showed there to be either a very weak association or lack of correlation between HPV vaccine coverage and several indicators of SES at the SLA level (Table 4). Although the correlations are weak, a positive association exists between high vaccine coverage and socioeconomic advantage, with 'young people learning or earning' showing the greatest degree of correlation across all doses at 0.20 for Dose 1,

increasing slightly to 0.24 for Dose 2 and 0.27 for Dose 3. 'Children in welfare-dependent and low income families', on the other hand, illustrated a weak but negative correlation.

When observing the results by dose number, slightly stronger correlations were recorded for the third dose, representing females who were fully vaccinated, than for females receiving at least one dose, for almost all of the SES indicators.

Conclusions

Nationally, HPV vaccination coverage shows a high and relatively equal uptake across areas of advantage and disadvantage, with only a 4.1 percentage point difference in full vaccination coverage in the lowest and highest SES areas of Australia. Relatively equal access was also observed in the uptake

Table 1: HPV vaccine coverage amongst 12-13 year old females in 2007, by capital city (Data as at Dec 2011).

	Dose 1 % (95% CI)	Dose 2 % (95% CI)	Dose 3 % (95% CI)
Sydney	82.2 (81.9–82.5)	79.4 (79.0–79.7)	73.7 (73.3–74.1)
Melbourne	86.2 (85.9–86.5)	83.1 (82.8–83.4)	77.2 (76.8–77.5)
Brisbane	86.6 (86.2–87.0)	82.6 (82.1–83.0)	75.8 (75.3–76.3)
Adelaide	86.2 (85.7–86.8)	82.5 (81.8–83.1)	73.3 (72.6–74.0)
Perth	74.0 (73.4–74.6)	70.9 (70.2–71.5)	63.7 (63.0–64.3)
Hobart	75.1 (73.5–76.8)	70.2 (68.5–71.9)	63.8 (62.0–65.7)
Darwin	93.0 (91.7–94.2)	87.7 (86.1–89.4)	80.8 (78.9–82.8)
Canberra	89.8 (88.9–90.7)	86.7 (85.6–87.7)	79.3 (78.1–80.5)
Total capital cities	83.5 (83.3–83.7)	80.2 (80.0–80.4)	73.8 (73.5–74.0)

Table 2: HPV vaccine coverage among 12-13 year old females in 2007, by socioeconomic status, Australia (Data as at Dec 2011).

	Dose 1 % (95%CI)	Dose 2 % (95%CI)	Dose 3 % (95%CI)
Quintile 1: High SES	83.9 (83.6–84.3)	81.2 (80.9–81.5)	75.6 (75.2–75.9)
Quintile 2	82.6 (82.3–82.9)	79.4 (79.1–79.8)	72.9 (72.6–73.3)
Quintile 3	83.3 (83.0–83.6)	79.9 (79.6–80.3)	73.0 (72.6–73.3)
Quintile 4	83.0 (82.7–83.3)	79.4 (79.1–79.7)	72.6 (72.2–72.9)
Quintile 5: Low SES	83.1 (82.8–83.5)	79.1 (78.8–79.4)	71.5 (71.2–71.9)

Table 3: HPV vaccine coverage amongst 12-13 year old females in 2007, by remoteness, Australia (Data as at Dec 2011).

	Dose 1 % (95%CI)	Dose 2 % (95%CI)	Dose 3 % (95%CI)
Major Cities	83.4 (83.3–83.6)	80.2 (80.0–80.4)	73.6 (73.4–73.8)
Inner Regional	82.6 (82.3–83.0)	79.1 (78.7–79.4)	72.1 (71.8–72.5)
Outer Regional	82.4 (82.0–82.8)	78.8 (78.3–79.3)	72.0 (71.5–72.5)
Remote	83.0 (82.0–84.1)	78.2 (77.0–79.3)	70.1 (68.8–71.4)
Very Remote	88.5 (87.2–89.8)	81.8 (80.2–83.3)	71.4 (69.5–73.2)

Table 4: Correlation coefficients between selected indicators of socioeconomic status and HPV vaccine coverage, Australia, 2007–2011.

Indicator	Dose 1	Dose 2	Dose 3
Index of Relative Socioeconomic Disadvantage	0.12	0.14	0.17
Young people learning or earning ^a	0.20	0.24	0.27
Attending secondary school full-time ^b	0.16	0.19	0.22
Jobless families ^c	-0.11	-0.14	-0.17
Single parent families with children ^d	-0.05	-0.09	-0.12
Dwellings rented from housing authority	0.04	0.00	-0.04
Children in welfare-dependent, low income families	-0.16	-0.19	-0.23
Dwellings with no Internet connection	-0.09	-0.10	-0.11
Born in NES countries and resident less than 5 years	0.00	0.00	-0.01
Born in NES countries with poor proficiency in English	0.03	0.03	0.04

a Includes people at ages 15 to 19 who were engaged in school, work or further education/training

b Includes students age 16 attending secondary school full-time

c Families with children under 15 years in which no parent is employed

d Children under 15 years

Source: All data from the ABS 2006 Census other than for children in welfare-dependent, low income families, which is sourced from Centrelink, 2009

of the school-based vaccine across major cities, regional and remote areas. Although no strong correlations between various indices of SES and HPV vaccine coverage were identified, the strongest correlation was found between the measure of 'young people learning and earning' and vaccination, which is congruent with the fact that the program is delivered through schools.

Interestingly, females in the most remote areas had the highest coverage for the first two doses, yet were least likely to complete the course, which suggests some challenges still exist for populations in the more isolated parts of Australia. In relation to vaccination services, these may relate to the difficulty in providing outreach vaccination services on multiple occasions if designated provider visits are missed by vaccinees. Those in more remote areas are more likely to be Indigenous,¹⁴ so high HPV vaccine uptake in these areas is promising; however, questions remain of the equity of access to the vaccine among urban Indigenous and non-English speaking communities, including recently arrived refugees. Indigenous women are known to have a significantly higher incidence rate of cervical cancer than non-Indigenous women.⁹

Notifications of doses delivered as part of the school program are expected to be relatively complete, with a low opt-off rate.¹⁵ Delivery of the program including information given to parents and adolescents, collection of forms and provision of data to the register, varied between jurisdictions. Some of the variability in vaccine coverage between states is likely to be affected by these processes.¹⁵

The weak associations we observed between uptake of the HPV vaccine and selected indicators of SES reaffirms, at an ecological level at least, that participation in the HPV vaccination program for 12–13 year olds has to date been fairly equitable across socioeconomic groups. This is reassuring given the association between lower screening participation and low SES apparent within the Australian National Cervical Screening Program, and inequities in cervical cancer incidence documented both nationally and internationally.^{7,16,17} Poverty is a root cause of inequity in cervical cancer burden, mediated through higher risk of HPV exposure and reduced detection, follow-up and treatment of abnormalities.¹⁸

Recent findings from Malagón et al. suggest that different distributions of vaccine uptake by sexual behaviour risk groups can produce very different population-level reductions in HPV prevalence, with the risk of reduced vaccine effectiveness even at high coverage, and an increase in existing inequalities.¹⁹ Crowcroft et al. found in a simulation study that, in the majority of hypothetical scenarios, even the worst-off groups are better off when vaccination is implemented but that achieving coverage in all groups of more than 60% should reduce the potential for substantial inequality. Critically, they highlight that school-based programs are most likely to achieve this and that it is vital that systems can identify any groups at risk with both low vaccine uptake and screening participation so that mitigation steps can be taken.¹⁸

Underlying explanations for the socioeconomic disparity between attendance for a

Pap test and HPV vaccine course completion are likely due to a number of social and demographic factors. Socioeconomically disadvantaged people are less likely to engage in preventive health behaviours.²⁰ Furthermore, the out-of-pocket cost of seeing a GP has risen in Australia over the past 10 years,²¹ which provides a potential barrier to women attending a GP for a Pap test. A UK study found material deprivation influential in explaining a considerably lower uptake rate for the HPV vaccine among the catch-up cohort of females aged 17–18 years than the females aged 12–13 years receiving vaccinations at their schools.²² The study suggested the mode of delivery as the probable root cause for the disparity. In contrast, an organised vaccination program conducted during normal school hours reduces the need for personal effort.²²

Similar to our findings, a UK study found minimal disparity between socioeconomic groups based on similar ecological data in the uptake of the HPV vaccine among adolescents when delivered through a school based program,²³ although an individual level study in two primary care trusts did find evidence of disparity at the local level.²⁴ Studies in other international settings where delivery of the program differs from Australia have reported a wider gap in uptake across socioeconomic areas. In the US, where no school programs exist and vaccination is not fully government funded, ecological analysis shows a significant maldistribution of the vaccine, with coverage in the wealthiest states that have the lowest cervical cancer rates around three times higher than in states with the highest cervical cancer rates.²⁵ Another study from the US found geographic disparity by region of residence among young women.²⁶ A study of HPV vaccine uptake through a catch-up campaign for females aged 12–16 years in the Netherlands also found lower uptake in areas of lower SES, which was consistent with the pattern of participation in cervical screening by SES in the Netherlands.²⁷ Although vaccination was free of charge to all females, the immunisation program was not school-based – with the exception of one region – suggesting this could be a factor in the lower uptake in lower SES areas.²⁷

Some prior evidence of an association between SES and vaccination completion with childhood vaccines exists in Australia, despite provision of vaccines being funded for all children by the National Immunisation Program. A study of

predictors of immunisation in Victorian children found an association between SES and incomplete immunisation with the lowest quintiles having the highest rate of incomplete immunisation.²⁸ In comparison to our findings, a WA study of HPV vaccine uptake among Year 7 female students found independent and consistently negative associations between HPV vaccine uptake and schools located in remote areas, as well as schools in socioeconomically disadvantaged areas. The study also reported higher HPV vaccine uptake in Catholic schools than in government schools.²⁹ Hull et al. found single parenthood a strong predictor of non-compliance for childhood immunisation at 12 months of age.³⁰ This may be due to time constraints or financial pressures, barriers that are reduced when vaccination is provided freely and in a school setting.

The higher disparity in coverage of the third dose may reflect that this dose is administered six months after the first, meaning that females who miss this dose at school due to absence will generally not have the opportunity provided within the school year to complete the course at school. They will instead need to access a catch-up dose often through attending a general practice, which requires knowledge, access and sometimes out-of-pocket costs. This may be a contributing factor to lower follow-up doses in the most remote parts of Australia.

The most important limitation to this research is that this is an ecological study. Socioeconomic data is collected from the Census and represents the average of the characteristics for the population in that area, which can conceal the differences that exist between populations within each area. In addition, the observed associations may be confounded by other factors such as country of birth, which could not be examined in this study. Although generalisations would still apply for data averaged at the SLA level, it is the smallest area for which most health status and use of health services information is available, and was the unit used in this study. Individual level data about SES (e.g. income, employment or education) are not available in the HPV register. Future analysis on HPV vaccine uptake could benefit by analysing HPV vaccine uptake by school type. Although this information is not routinely available on the Register, a study could be undertaken to determine this using school name. Thus, while it is important that these findings are confirmed by individual level data on

vaccination coverage, population level data can provide useful insight, particularly where individual level data is not available.

Implications

Research in Australia and overseas has highlighted existing disparities in access to cervical screening prevention. This is the first study in Australia to evaluate the relationship between geographic disparity and SES by HPV vaccine uptake. The government-funded HPV vaccine program, delivered through schools, has contributed to a high and – to date – fairly equitable uptake across socioeconomic groups and between geographical areas in Australia.

Nonetheless, continued monitoring of cervical cancer screening participation among vaccinated and unvaccinated women is paramount to ensure existing inequalities in cervical cancer incidence and mortality do not widen.

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