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Analysis of cervical cancer and abnormality outcomes in an era of cervical screening and HPV vaccination in Australia

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Analysis of cervical cancer and abnormality outcomes in an era of cervical screening and HPV vaccination in Australia

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Contents

Summary

This is the third report from an Australian-first project, combining screening, cancer, death, and HPV vaccination data to demonstrate the effects of screening and HPV vaccination on cervical cancer and precancerous abnormalities and to discern cervical screening behaviour.

Cervical cancers detected through cervical screening less likely to cause death

Cervical screening aims to detect and treat precancerous abnormalities that might otherwise progress to cervical cancer, and so cervical screening more frequently detects precancerous abnormalities than cervical cancer. This is reflected in the observation that most cervical cancers (more than 70%) occurred in women who had never screened or who were lapsed screeners (had not screened for some time).

Of the 6,897 cervical cancers diagnosed in women aged 20–69 in 2002–2012:

- 354 (5%) were detected through cervical screening
- 3,511 (51%) were diagnosed in women who had never screened.

The remaining 44% of cervical cancers were diagnosed in women who had screened prior to the cervical cancer diagnosis, but the cancer was not detected through cervical screening (25% were not detected through cervical screening but were diagnosed in women who had previously screened; 19% were interval cancers, diagnosed after a negative cervical screen).

Cervical cancers detected through cervical screening had a 77% lower risk of causing death before 31 December 2015 (the end of follow-up) than cervical cancers diagnosed in women who had never screened.

Greater survival benefits for women for whom the cancer was screen-detected is likely due to these cervical cancers being diagnosed at an earlier stage than cervical cancers diagnosed in women who had never screened.

Together these results indicate that it is beneficial to participate in cervical screening. Benefits are due to the detection of precancerous changes providing an opportunity for treatment prior to progression to cervical cancer, and to improved survival outcomes of cervical cancers that are detected through cervical screening due to these being diagnosed at an earlier stage.

HPV-vaccinated women less likely to have a high-grade abnormality

High-grade abnormalities, in particular precancerous abnormalities, are an important indicator of the effectiveness of HPV vaccination, since it is necessary for HPV vaccination to prevent these abnormalities if the long-term aim of preventing cervical cancer is to be realised.

Analyses showed that women vaccinated against HPV had a lower incidence of high-grade abnormalities than unvaccinated women.

- Incidence was 9 high-grade abnormalities per 1,000 HPV-vaccinated women compared with 13 high-grade abnormalities per 1,000 unvaccinated women.
- HPV-vaccinated women had a 41% lower risk of a high-grade abnormality than unvaccinated women.

Results were stronger when high-grade abnormalities were restricted to the precancerous abnormalities of cervical intraepithelial neoplasia (CIN) grade 3 and adenocarcinoma in situ (AIS).

- Incidence was 3 cases of CIN3 and/or AIS per 1,000 HPV-vaccinated women compared with 6 cases of CIN3 and/or AIS per 1,000 unvaccinated women.
- HPV-vaccinated women had a 57% lower risk of CIN3 and/or adenocarcinoma in situ than unvaccinated women.

As a final analysis, cervical cancer incidence rates were calculated for HPV-vaccinated and unvaccinated women. It was confirmed that sufficient time had not yet passed since the introduction of HPV vaccination in 2007 for cervical cancers diagnosed up to and including 2012 to show a clear effect of HPV vaccination on cervical cancer incidence.

HPV-vaccinated women more likely to participate in cervical screening

Women vaccinated against HPV had higher participation in cervical screening than unvaccinated women. Participation in 2013–2014 by HPV vaccination status showed that:

- for women aged 20–24, participation was 46% in HPV-vaccinated women and 33% in unvaccinated women
- for women aged 25–29, participation was 57% in HPV-vaccinated women and 44% in unvaccinated women
- participation in cervical screening increased with increasing number of vaccine doses received for both age groups 20–24 and 25–29.

1 Introduction

1.1 Cancer screening programs in Australia

Disease screening is the use of a test in an asymptomatic population to identify individuals who are more likely to have a given disease and therefore require further diagnostic testing to determine if they have the disease. Because the screening test is used on individuals without overt signs or symptoms of the disease, screening is able to detect disease at an earlier stage, which can lead to better outcomes than if the disease was detected at a later stage.

Screening for a given disease should progress only if it meets the World Health Organization (WHO) principles of screening (Wilson & Jungner 1968). These screening principles are:

- the condition should be an important health problem
- there should be a recognisable latent or early symptomatic stage
- the natural history of the condition, including development from latent to declared disease, should be adequately understood
- there should be an accepted treatment for patients with recognised disease
- there should be a suitable test or examination that has a high level of accuracy
- the test should be acceptable to the population
- there should be an agreed policy on whom to treat as patients
- facilities for diagnosis and treatment should be available
- the cost of screening (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole
- screening should be a continuing process and not a 'once and for all' project.

Australia has built upon these WHO criteria for population screening in developing the Australian Population Based Screening Framework that additionally takes into account:

- the need for a strong evidence base in making a decision about the introduction of a screening program including evidence of the safety, reproducibility and accuracy of the screening test and efficacy of treatment
- the requirement that a screening program offers more benefit than harm to the target population (APHDPC 2008).

Australia currently has three population-based cancer screening programs that meet both the WHO principles and the additional considerations under the Australian criteria for the assessment of population screening (APHDPC 2008). These are BreastScreen Australia for breast cancer, the National Cervical Screening Program for cervical cancer, and the National Bowel Cancer Screening Program for bowel cancer. These programs all aim to reduce mortality from their respective cancer. The National Cervical Screening Program and the National Bowel Cancer Screening Program also aim to reduce the incidence of cervical and bowel cancer, respectively, through identifying and treating their precursors.

This report focuses on the National Cervical Screening Program—results for BreastScreen Australia can be found in previous AIHW reports for this project (AIHW 2018a; AIHW 2018b), and results from the National Bowel Cancer Screening Program can be found in previous AIHW reports for this and other projects (AIHW 2014; AIHW 2018a; AIHW 2018c).

1.2 Cervical screening reduces incidence of and mortality from cervical cancer

The principles of screening include the requirement for evidence that a screening program is effective in reducing mortality from cancer (Cancer Council Australia 2017). This relates to the requirement that benefits of screening outweigh potential harms. Studies are required to determine if there are mortality benefits due to screening, since assessing mortality trend data alone does not distinguish between reductions in mortality due to screening and reductions due to treatment advancements that have occurred over the same time period.

In considering the available evidence of the benefits of cancer screening, several studies have looked specifically at the Australian setting when considering whether cervical screening reduces mortality from cervical cancer.

Cervical cancer mortality rates are much lower in more developed countries, including Australia, and this has been attributed to the reduction in cervical cancer incidence and earlier diagnosis of prevalent cancers (down-staging) due to organised cervical screening programs. It has been recognised internationally for some time that screening for precancerous lesions can greatly reduce both the incidence of, and mortality due to, cervical cancer (Bray et al. 2018), making cervical screening a public health success story.

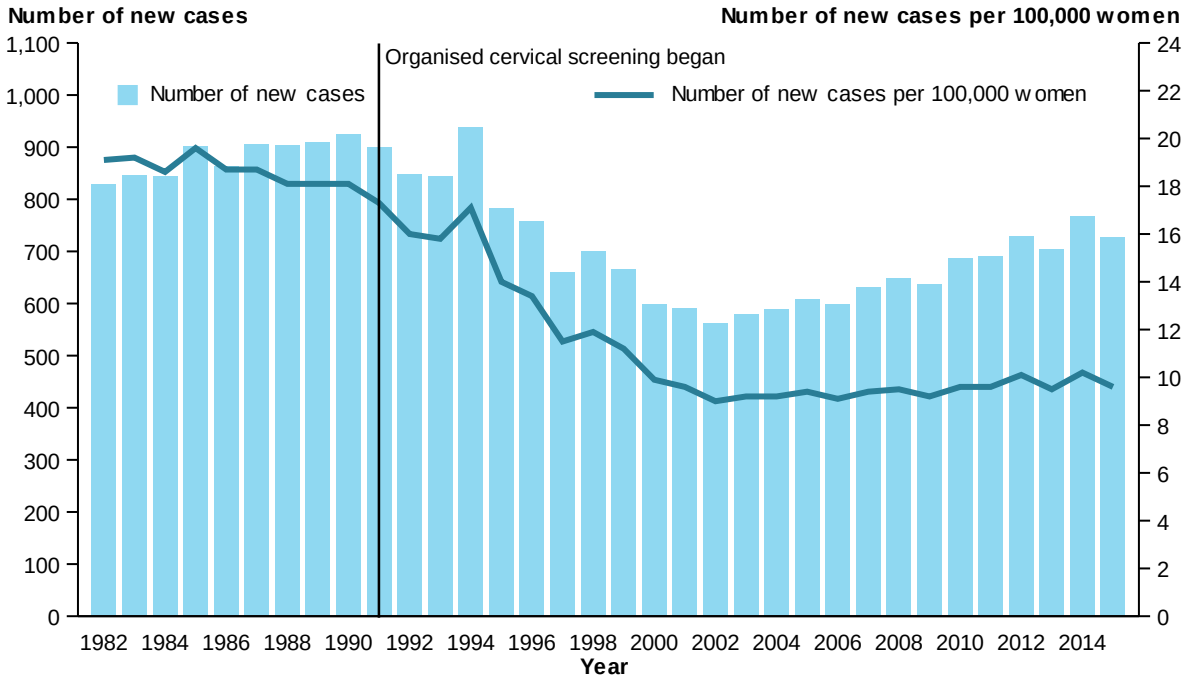
The ability of cervical screening to lower the incidence of cervical cancer (which then leads to lower mortality) has been demonstrated in annual statistical reports of the VCS Foundation (formerly Victorian Cytology Service). Linkage between the Victorian Cervical Cytology Register and the Victorian Cancer Register has shown that women who have never screened or who are lapsed screeners are much more likely to develop cervical cancer than women who are recently screened (VCS Foundation 2017).

Further to this, an Australian study of New South Wales women also demonstrated a greatly decreased risk of developing cervical cancer (and hence cervical cancer mortality) in women who participated in either regular or irregular cervical screening (Yang et al. 2008).

More recently, the AIHW used linked data to demonstrate that women aged 20–69 diagnosed with cervical cancer through cervical screening had an 87% lower risk of death from cervical cancer than did women diagnosed with cervical cancer who had never screened (AIHW 2018a). The majority of cervical cancers occurred in women who had either never screened or who were lapsed screeners (had not screened for some time) (AIHW 2018a), indicating the importance of cervical screening in preventing cervical cancers from developing. Prevention is possible because cervical cancer is one of the few cancers that has a precancerous stage that lasts for many years prior to the development of invasive disease, which provides an opportunity for detection and treatment (WHO 2014), thereby reducing cervical cancer incidence and mortality.

Prior to the introduction of the National Cervical Screening Program in 1991, ad hoc Pap tests that had been used in Australia since the 1960s had some effect on cervical cancer, but it was the introduction of organised cervical screening, with a recommended 2-year screening interval, along with state and territory cervical screening registers to remind women to screen and assist in the follow-up of abnormal results, that saw the incidence of cervical cancer drop dramatically to its historically low level of around 7 new cases per 100,000 women or 9–10 new cases per 100,000 women aged 20–69 (the target age group of the previous National Cervical Screening Program) (Figure 1.2.1).

Figure 1.2.1: Incidence of cervical cancer in women aged 20–69, 1982 to 2015



Note: Rates age-standardised to the Australian population as at 30 June 2001. Data for 2015 are estimated for NSW.

Source: AIHW Australian Cancer Database 2015 (AIHW 2019).

1.3 Participation in cervical screening

The AIHW reports on participation in Australia's three national cancer screening programs, including the National Cervical Screening Program. The latest participation data by population subgroup for the National Cervical Screening Program are shown in Table 1.3.1.

Across remoteness areas, participation was highest in *Inner regional* areas at 56.6% and lowest in *Very remote* areas at 46.3%. There was a clear association between participation and socioeconomic areas, with this lowest for women living in the lowest socioeconomic areas at 50.4% and highest for women living in the highest socioeconomic areas at 62.1%.

These data provide insights into patterns of participation in cervical screening, but there are other aspects of screening behaviour that require data linkage to explore—knowledge of which would provide the National Cervical Screening Program with key data to optimise the recruitment, retention, and management of women participating in cervical screening.

Box 1.3.1: Previous versus renewed National Cervical Screening Program

Between 1991 and 30 November 2017, the previous National Cervical Screening Program recommended 2-yearly Pap tests for women aged 20–69. From 1 December 2017, in light of a greater understanding of the role of HPV in the development of cervical cancer, and the introduction of HPV vaccination in 2007 expected to reduce the number of cervical abnormalities, a renewed National Cervical Screening Program commenced, offering 5-yearly HPV tests to women aged 25–74. However, all data within this report were collected from women participating in cervical screening prior to the introduction of the renewed program. Therefore all references to the National Cervical Screening Program in this report refer to the previous Pap test-based program.

Table 1.3.1: Participation in cervical screening by population groups, women aged 20–69, 2015–2016

Population group	Participation
State or territory	
NSW	55.7
Vic	57.8
Qld	53.6
WA	56.2
SA	57.7
Tas	56.0
ACT	56.2
NT	51.8
Remoteness area	
Major cities	56.4
Inner regional	56.6
Outer regional	54.2
Remote	52.1
Very remote	46.3
Socioeconomic area	
1 (most disadvantage)	50.4
2	53.6
3	54.8
4	57.1
5 (least disadvantage)	62.1
Australia	**55.4**

Note: Participation data shown are for ages 20–69 in 2015–2016. Rates across population subgroups are age-standardised to allow comparisons; rate for Australia is crude. No participation data by Indigenous status were available, although there is evidence that Aboriginal and Torres Strait Islanfer women have lower participation in cervical screening than non-Indigenous women (Whop et al. 2016).

Source: AIHW analysis of state and territory cervical screening register data (AIHW 2018d).

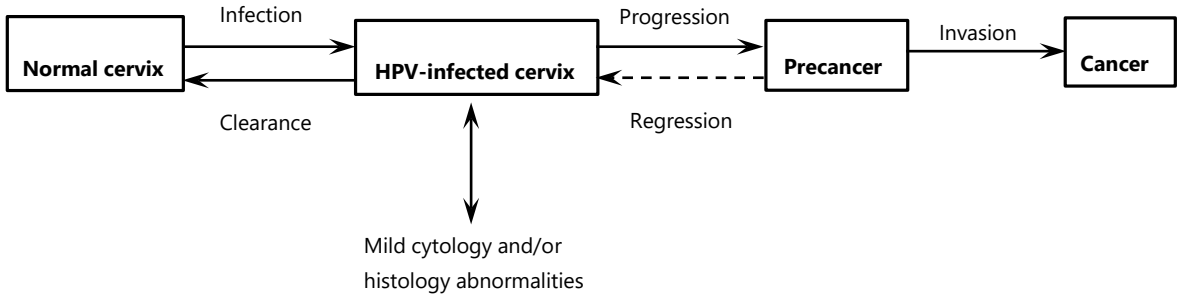
1.4 Cervical screening in an era of HPV vaccination

Nearly two decades ago it was determined that cervical cancer is a rare outcome of persistent infection with oncogenic (cancer-causing) human papillomavirus (HPV) (Bosch et al. 2002; Walboomers et al. 1999). In Australia, two of these HPV types, 16 and 18, have been detected in 70%–80% of cases of cervical cancer (Brotherton 2008), and Brotherton, Tabrizi and others (2017) detected HPV in 92.9% of 847 cervical cancers tested. The reasons for this not reaching 100% are twofold—first, in a country with a mature screening program such as Australia, there is a relatively high proportion of adenocarcinomas, not all of which are caused by HPV; and second, some cancers in which HPV cannot be found at diagnosis will have been HPV positive in the preceding years and may be HPV negative now due to the progression of the cancer and degeneration of the tissue sample (this is detailed more fully in Brotherton et al. 2019a).

The major role that HPV plays in the development of cervical cancer (the process of which is illustrated in Figure 1.4.1) and the development of HPV vaccines now allow for both primary and secondary strategies for the prevention of cervical cancer to be implemented in those countries with available resources.

Figure 1.4.1: Role of HPV infection in the development of cervical cancer

The four major steps in the development of the majority of cervical cancers are infection with HPV (from sexual activity), viral persistence (as most HPV infections clear with no treatment), progression to precancerous abnormalities (many of which will also regress with no treatment), and invasive cervical cancer (Schiffman et al. 2007; Schiffman & Kjaer 2003).



Notes

1. The development of cervical cancer is not unidirectional—most HPV-infected cells return to normal and a large proportion of precancerous abnormalities do not progress to cervical cancer, even in the absence of treatment.
2. While the cell changes caused by persistent infection with oncogenic HPV are necessary for precancerous changes to the cervix to develop, a range of other factors will influence whether precancerous changes will progress to cervical cancer; these include smoking, multiparity (specifically, more than 5 full-term pregnancies), a young age at first full-term pregnancy, oral contraceptive use, and immunosuppression (Cancer Council Australia 2014).

Source: Reproduced with permission from M Schiffman, National Cancer Institute (Schiffman & Kjaer 2003).

In 2007, primary prevention of cervical cancer in Australia through vaccination against HPV commenced to prevent women being infected with the oncogenic HPV types that cause the majority of cervical cancer. Cervical screening remains a vital secondary prevention strategy for both HPV-vaccinated and unvaccinated women.

In Australia, early studies demonstrated world-first effectiveness estimates of the HPV vaccine in reducing cervical abnormalities in a population using Victorian data (Brotherton et al. 2011; Gertig et al. 2013) and Queensland data (Crowe et al. 2014). Now that more time has passed since the introduction of the HPV vaccine, increasing numbers of women who are attending cervical screening will have been vaccinated prior to HPV exposure, providing potentially more accurate estimates of vaccine effectiveness in the long term when given routinely to HPV-unexposed adolescents. Further, through analysis of national data, nationally representative and better powered analyses can be undertaken. Such analysis is possible through linked cervical screening and HPV vaccination data to determine the HPV vaccination status of women who develop precancerous abnormalities, and linked cancer incidence and HPV vaccination data to determine the HPV vaccination status of women who develop cervical cancer.

Such analyses can provide valuable evidence for the effectiveness of HPV vaccination in its role in the primary prevention of cervical cancer, as well as providing valuable contextual information about the environment in which cervical screening currently operates, allowing this secondary prevention strategy to change and adapt if necessary to ensure that Australian women are optimally protected from cervical cancer.

2 Objectives

This report is part of a broader cancer screening data linkage project, the objectives of which are detailed below. This report aims to fulfil these objectives for the National Cervical Screening Program.

2.1 Premise of the broader data linkage project

On examining the available research related to Australia's three cancer screening programs, while there have been a number of rich and high-quality studies, the potential to make a significant additional contribution to these was identified. By building on previous studies, identifying and filling data gaps, and performing novel studies, this study aims to provide answers to key questions and a greater understanding of screening outcomes and behaviour across all three cancer screening programs.

To allow the investigation of the outcomes of, and screening behaviours relating to, cancer screening programs in Australia, this major data linkage project was undertaken to link data from:

- the eight state and territory BreastScreen registers
- the eight state and territory cervical screening registers
- the National Bowel Cancer Screening Program Register
- the Australian Cancer Database (ACD)
- the National Death Index (NDI)
- the National HPV Vaccination Program Register (NHVPR).

These data sources are detailed in the 'Data and methods' chapter.

2.2 Objectives of the broader data linkage project

The data linkage project has three objectives.

Objective 1 Determine key cancer outcomes in screening and non-screening individuals to determine whether screen-detected cancers are less likely to result in death than cancers detected outside screening programs.

Objective 2 Gain an understanding of the screening behaviour of participants, such as who screens, in which programs, and whether this is influenced by any common factors such as socioeconomic status, history of positive test results, or other events.

Objective 3 Use the linked data to enhance currently available screening data, such as analysis of linked cervical screening and human papillomavirus (HPV) vaccination data to look at the effect of HPV vaccination on cervical abnormalities, cancers and participation in cervical screening.

2.3 Dissemination of findings from the broader data linkage project

Given the size and complexity of this data linkage project, results of this project are disseminated over a series of reports, each with a particular focus, with other products used where appropriate to best communicate findings.

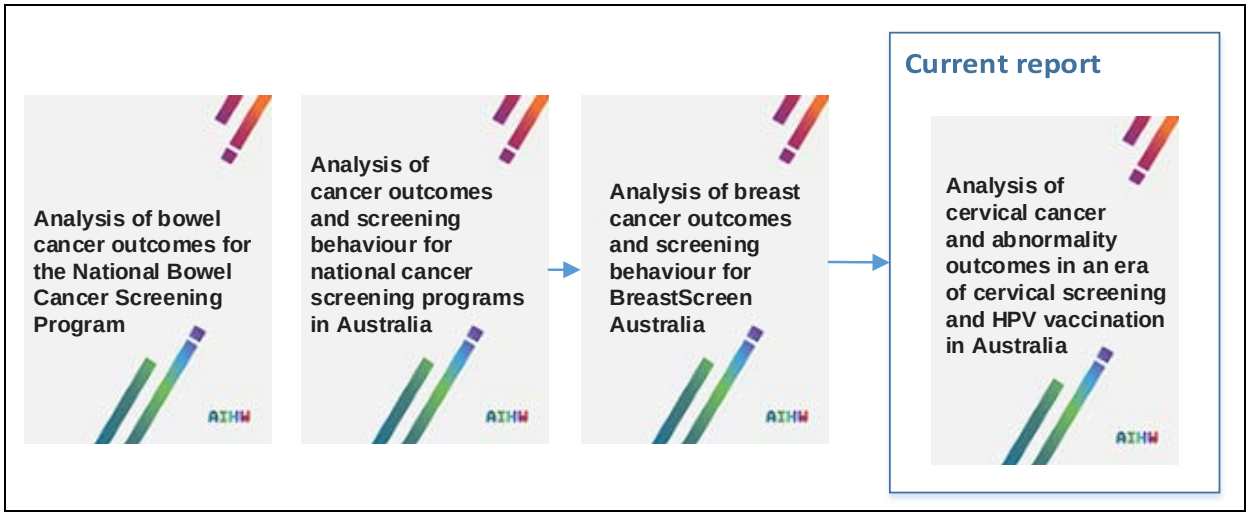
The first of these reports was *Analysis of cancer outcomes and screening behaviour for national cancer screening programs in Australia* (AIHW 2018a). It presented primary cancer outcomes for all three cancer screening programs, as well as examining screening behaviour across the three cancer screening programs.

The second of these report was *Analysis of breast cancer outcomes and screening behaviour for BreastScreen Australia* (AIHW 2018b) that included additional breast cancer outcomes analyses, and screening behaviour analyses specific to BreastScreen Australia participants.

This third report, *Analysis of cervical cancer and abnormality outcomes in an era of cervical screening and HPV vaccination in Australia*, presents more detailed analyses on cervical cancer outcomes, as well as including analyses on cervical abnormalities (key to cervical screening, as the detection and treatment of these prevents cervical cancers from developing). This report also includes cervical screening behaviour analyses specific to participants in cervical screening. Finally aspects of cervical cancer, cervical abnormality, and screening behaviour analyses are stratified by HPV vaccination status, to assess the effects and effectiveness of HPV vaccination in Australia.

All 3 reports follow on from a report from a similar data linkage project specific to the National Bowel Cancer Screening Program initially published in 2014 (AIHW 2014) and repeated in May 2018 (AIHW 2018c).

These four reports in combination provide comprehensive reporting of cancer outcomes and screening behaviour for national cancer screening programs in Australia.



3 Data and methods

3.1 Data sources for the broader data linkage project

The broader data linkage project included data from six data sources (Table 3.1.1), with a total of 20 individual data sets combined to form the master linked data set. This report focuses on the data sources specific to the National Cervical Screening Program, as highlighted in the table below.

Table 3.1.1: Data sources

Data source	Data set	Data provider
BreastScreen Australia	BreastScreen NSW register data	Cancer Institute NSW
	BreastScreen Victoria register data	BreastScreen Victoria
	BreastScreen Queensland register data	Queensland Health
	BreastScreen WA register data	WA Department of Health
	BreastScreen SA register data	SA Department for Health and Ageing
	BreastScreen Tasmania data	Department of Health Tasmania
	BreastScreen ACT data	ACT Health
	BreastScreen NT	NT Department of Health
National Cervical Screening Program	NSW Pap test register data	Cancer Institute NSW
	Victorian cervical cytology register data	Victorian Cytology Service Foundation
	Queensland Health Pap smear register data	Queensland Health
	WA Cervical Screening Register data	North Metropolitan Health Service, WA Health
	SA cervix screening register data	Victorian Cytology Service Foundation
	Tasmanian cervical screening register data	Department of Health Tasmania
	ACT cervical screening register	ACT Health
	NT cervical screening register data	NT Department of Health
National Bowel Cancer Screening Program	National Bowel Cancer Screening Program Register data	Department of Human Services
Australian Cancer Database	Australian Cancer Database	Australian Institute of Health and Welfare
National Death Index	National Death Index	Australian Institute of Health and Welfare
National HPV Vaccination Program	National HPV Vaccination Program Register data	Victorian Cytology Service Foundation

Further details about each of the six data sources follow.

BreastScreen Australia data

BreastScreen Australia is Australia's national breast cancer screening program, operational since 1991. BreastScreen services are delivered at the state and territory level. Eligibility is determined by age: women 40 and over can attend free 2-yearly mammograms, although only women in the target age group are actively targeted. From 1991, the target age group of BreastScreen Australia was women 50–69, widened to 50–74 from 1 July 2013.

To attend, a woman contacts BreastScreen in her state or territory to book a screening visit. At the time of her screening visit, a woman is able to self-report clinical details such as the presence and type of symptoms, as well as personal and family history of breast cancer.

Data for women who participate in BreastScreen Australia are collected and maintained on state and territory BreastScreen registers.

BreastScreen Australia data in this project are a subset of variables from each of the eight state and territory BreastScreen registers, for women screened between 1 January 2000 and 31 December 2014. The target group used for these data was women aged 50–69.

National Cervical Screening Program data

Australia's National Cervical Screening Program began operating in 1991. There were substantial changes to the cervical screening program on 1 December 2017, including a change in screening test, screening interval and target age group. However, this project includes only data collected under the previous program, and so only the National Cervical Screening Program as it existed from 1991 to 30 November 2017 is described here and considered in this project.

Under the previous program, it was recommended that women have 2-yearly Pap tests commencing between the ages of 18 and 20, or 1 or 2 years after first having sexual intercourse, whichever was later. Data for women who participated in the previous program were collected and maintained on state and territory cervical screening registers.

National Cervical Screening Program data in this project are a subset of variables from each of the eight state and territory cervical screening registers that operated under the previous program, for women screened between 1 January 2000 and 31 December 2014. The target group used for these data was women aged 20–69.

National Bowel Cancer Screening Program data

Australia's National Bowel Cancer Screening Program has operated since 1 August 2006. Eligibility to participate in this program is determined by age, with individuals who are registered as an Australian citizen or migrant in the Medicare enrolment file, or registered with a Department of Veterans' Affairs gold card, invited to screen when they reach one of the target ages. Invitees are sent an invitation pack containing an iFOBT kit (an immunochemical faecal occult blood test, the screening test of the National Bowel Cancer Screening Program) and can then choose to participate by completing the screening test at home and returning it to be processed in a pathology laboratory, or not to participate.

The target ages initially invited to screen in 2006 were people turning 55 and 65, with 50 year olds added from July 2008. Since then, additional ages have been progressively invited to participate in the program, and from 2019, the National Bowel Cancer Screening Program will offer all Australians aged 50–74 bowel screening every 2 years.

Data on people who are eligible to be invited to participate in bowel screening appears on the National Bowel Cancer Screening Program Register. This national register is maintained by the Department of Human Services (formerly Medicare Australia) on behalf of the Department of Health. Bowel screening that occurs outside the National Bowel Cancer Screening Program is not included in the national register, and therefore this project.

National Bowel Cancer Screening Program data in this project are a subset of variables from the National Bowel Cancer Screening Program Register, for individuals invited between 1 August 2006 and 31 December 2014. As the target ages have changed over this period,

invitations were used to determine screening eligibility. The target group used for these data was people aged 50–69.

Australian Cancer Database data

The Australian Cancer Database is a data collection of all primary, malignant cancers diagnosed in Australia since 1982. Data are collected by state and territory cancer registries from a number of sources and are supplied annually to the AIHW. The AIHW compiles and maintains the Australian Cancer Database, in partnership with the Australasian Association of Cancer Registries, which includes representatives from each state and territory cancer registry.

The Australian Cancer Database does not include: recurrences and metastases—only the first occurrence of a cancer is included; basal cell carcinomas and squamous cell carcinomas of the skin—these are not notifiable diseases; or benign, borderline malignancy or in situ tumours—this means that ductal carcinoma in situ and other breast in situ cases could not be included in this project.

The 2013 Australian Cancer Database was the latest version available at the time of data linkage for this project. This database includes cancer data to 2013 for all states and territories except New South Wales, for which cancer data was available only to 2012; therefore, only cancer incidence data from 1 January 1982 to 31 December 2012 were used.

Breast, cervical and bowel cancers were identified using International Statistical Classification of Disease and Related Health Problems, Tenth Revision (ICD-10) codes. Female breast cancers were defined as cancers coded in the ICD-10 as C50 where sex was female, cervical cancers were defined as cancers coded in the ICD-10 as C53 where sex was female, and bowel cancers were defined as cancers coded in the ICD-10 as C18–C20. The grouping of all cancers combined was defined as cancers coded in the ICD-10 as C00–C97, D45, D46, D47.1 and D47.3–D47.5.

National Death Index data

The National Death Index contains information on all deaths in Australia since 1980. It is maintained by the AIHW for the purpose of data linkage. The state and territory registrars of births, deaths and marriages supply these data monthly. While fact-of-death information is generally up to date in the National Death Index, underlying-cause-of-death information is usually some years behind. At the time of data linkage for this project, underlying-cause-of-death data contained in the National Death Index were available to 31 December 2015.

Deaths were considered to be from breast cancer if the ICD-10 code was C50, from cervical cancer if the ICD-10 code was C53, and from bowel cancer if the ICD-10 code was C18–C20 or C26.0 (Malignant neoplasm of the intestinal tract, part unspecified, which many bowel cancer deaths are coded as in Australia—ABS 2016). All-cause deaths were any deaths recorded, regardless of the underlying cause.

National HPV Vaccination Program data

The National HPV Vaccination Program was introduced on 1 April 2007 to immunise girls (and extended in 2013 to also immunise boys) against HPV types 16, 18, 6 and 11 (with an HPV vaccine against 9 HPV types introduced from 2018). In addition to the ongoing school-based program introduced in 2007 for girls aged 12–13, and in 2013 for boys aged 12–13, there was a catch-up program for girls aged 14–26 in 2007–2009, and for boys aged

14–15 in 2013–2014. An ongoing catch-up program for individuals aged up to 19 years was introduced in 2017.

Prior to December 2018, HPV vaccination records were sent to the National HPV Vaccination Program Register by school or community providers, state or territory departments of health, and general practitioners, depending on whether the vaccine was administered through school or by a general practitioner. The National HPV Vaccination Program Register was operated and maintained by the VCS Foundation on behalf of the Department of Health. As of January 2019, HPV vaccination records have been integrated into the Australian Immunisation Register, maintained by the Australian Department of Human Services.

National HPV Vaccination Program data in this project are a subset of variables from the then National HPV Vaccination Program Register, for females vaccinated between 1 April 2007 and 31 December 2014.

3.2 Data flow and data linkage methods for the broader data linkage project

Data flow

The AIHW Data Linkage Unit performed all data linkage for this project. To ensure privacy and confidentiality of participants, data suppliers sent two sets of data to the AIHW: the Data Linkage Unit was provided with identified data only, while the Cancer and Screening Unit (now the Screening Analysis and Monitoring Unit) was provided with de-identified analysis variables only. This ensured that no one person had access to both identified and analysis variables. Identification numbers common to both data sets supplied then allowed the Data Linkage Unit to inform the former Cancer and Screening Unit which individuals were common across the data sets. This data flow is illustrated in Figure 3.2.1.

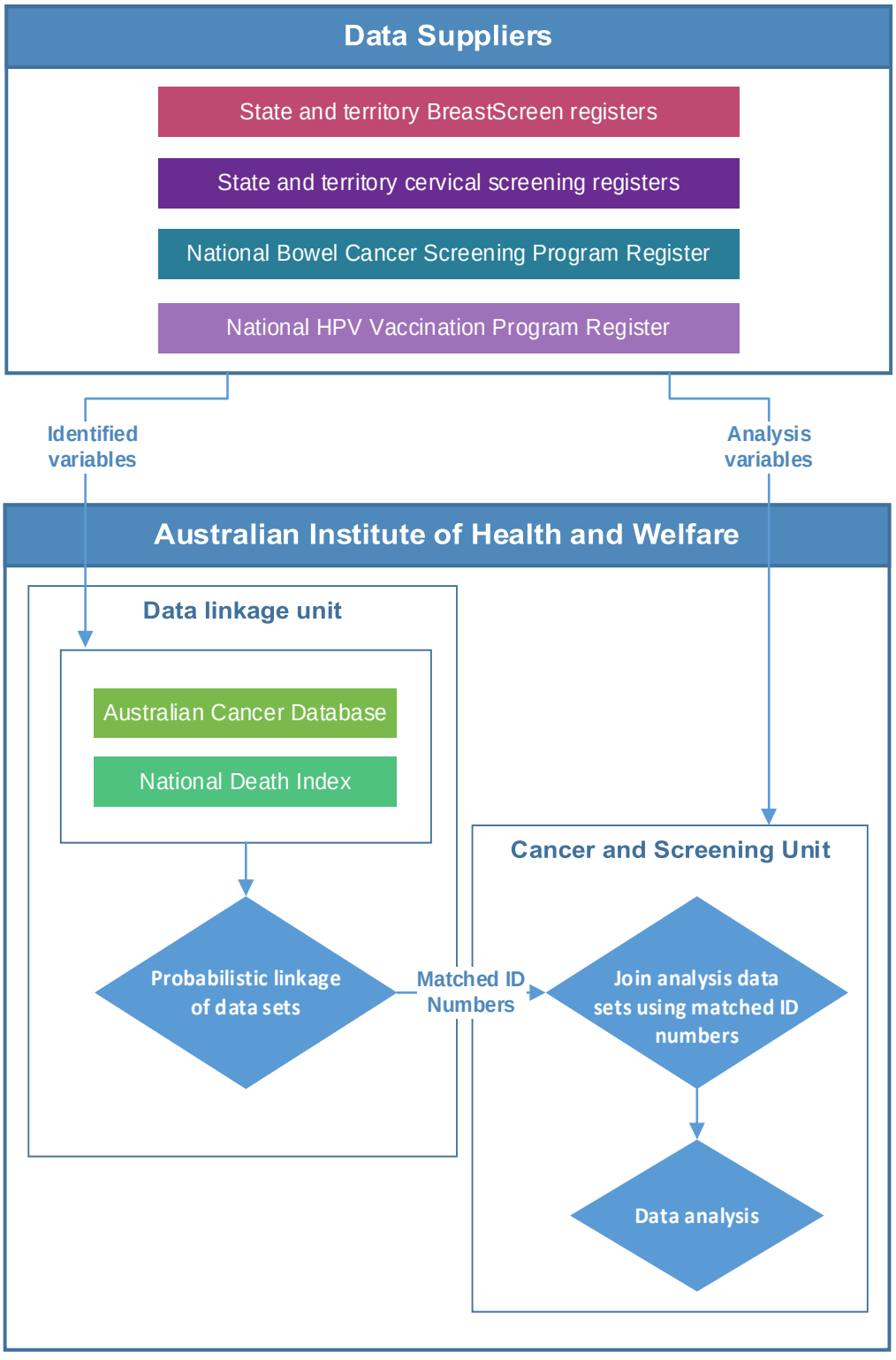
Data linkage

The AIHW Data Linkage Unit performed probabilistic data linkage based on the method developed by Fellegi and Sunter (1969).

Briefly, data linkage across the data sets was carried out in a step-wise fashion using the identifying variables of name, sex, date of birth and postcode. In the first step, links in which the identifying variables matched exactly were accepted. In the second step, the identifying variables were allowed to vary, with all potential pairs given a weight based on the amount of variation between records and the discriminatory ability of the variable. A sample-based clerical review determined a cut-off weight to accept a link, and all potential pairs above this cut-off were accepted as true links. In the final step, all remaining potential pairs were checked manually to determine if they were likely to be a link.

This is a robust method of data linkage; however, it is important to note that, due to the nature of probabilistic data linkage, there may be some unavoidable inaccuracy in the data linkages.

Figure 3.2.1: Data flow for the data linkage project



3.3 Methods used in this report

Statistical analyses

Cervical cancer survival by screen detection status and screening history

Cervical cancers (coded in the ICD-10 as C53) were identified on the Australian Cancer Database in women aged 20–69 with a date of diagnosis between 1 January 2002 and 31 December 2012 inclusive. These cervical cancers were linked with available data from state and territory cervical screening registers (from 1 January 2000), and the screening history prior to each cancer used to assign a screen detection status and screening history to each cervical cancer. Individuals diagnosed with cervical cancer were then linked with data from the National Death Index to ascertain date of death and cause of death for those who had died by 31 December 2015.

Screen detection status categories were allocated to cervical cancers as:

- **Screen-detected cancers**—cervical cancers diagnosed in women who had a Pap test with a cytology result of *high-grade or worse* 6 months to 2.5 years prior to diagnosis
- **Non-screen-detected cancers in screened women**—cervical cancers diagnosed in women who had a Pap test with a cytology result that was not *negative* or *high-grade or worse* 6 months to 2.5 years prior to diagnosis, or who had a Pap test with any cytology result more than 2.5 years prior to diagnosis
- **Interval cancers**—cervical cancers diagnosed in women who had a Pap test with a *negative* cytology result 6 months to 2.5 years prior to diagnosis
- **Non-screen-detected cancers in never-screened women**—cervical cancers diagnosed in women whose only Pap test was in the 6 months prior to diagnosis (and is therefore considered to be part of the diagnostic process and not a screening Pap test), or who did not have a Pap test prior to diagnosis.

Screening history categories were allocated to women diagnosed with cervical cancer as:

- **Recently screened**—women diagnosed with cervical cancer whose last Pap test prior to diagnosis was 6 months to 2.5 years prior to the cancer diagnosis.
- **Lapsed**—women diagnosed with cervical cancer whose last Pap test prior to diagnosis was more than 2.5 years prior to diagnosis, broken down into lapsed (2.5–3.5 years), lapsed (3.5–5.5 years), and lapsed (5.5+ years).
- **Never-screened**—women diagnosed with cervical cancer who had either never had a Pap test or whose only Pap test prior to diagnosis was in the 6 months prior to the cancer diagnosis, and is therefore considered to be part of the diagnostic process and not a screening Pap test.

While the screen detection status and screening history categories are appropriate for these analyses, they do have limitations that will mean some number of cervical cancers are assigned to a category that does not accurately reflect how the cervical cancer was detected.

The first limitation is due to categories being assigned based on a single Pap test in isolation, irrespective of the history of abnormalities preceding that test. For example, a single low-grade Pap test would not usually be followed by further investigation, but a history of repeated low-grade Pap tests would be. Therefore a cervical cancer that was preceded by repeated low-grade Pap tests with the last of these 6 months to 2.5 years prior to diagnosis would be categorised as a non-screen-detected cancer in screened women, whereas it may be more accurate to define this as a screen-detected cancer.

The second limitation is due to all Pap tests in the 6 months preceding the cervical cancer diagnosis being defined as 'diagnostic' Pap tests that are unrelated to screening, and therefore excluded from contributing to the allocation of cervical cancers. While this is a commonly used definition in cervical screening, it is likely that there will be some women who will have a screening Pap test with a result of high-grade or worse who will go on to be diagnosed with cervical cancer within 6 months. Cervical cancers in these women will be allocated to a category other than screen-detected cancer (depending on when or if there was a Pap test preceding this one), even though it may be more accurate to define this as a screen-detected cancer. To illustrate, adjusting the 6 month cut-off to a 3-month cut-off would result in a greater number of screen-detected cancers and non-screen-detected cancers in screened women, and fewer interval cancers and non-screen-detected cancers in never-screened women, which then also results in fewer lapsed screeners.

Cohort design

Retrospective cohort studies were undertaken to assess survival of women diagnosed with cervical cancer according to their screen detection status (that is, whether the cancer was detected as a result of a Pap test) as well as their screening history (that is, recency of their last Pap test) prior to diagnosis. For the cohort studies, women entered the cohort on the date of their cervical cancer diagnosis and were followed to 31 December 2015. For analyses that used death from cervical cancer as the event, individuals were censored if they died from a cause other than cervical cancer, or at 31 December 2015 if they did not die during the study period. Person time at risk was calculated in days from the date of cervical cancer diagnosis to either the date of event (for those who died from cervical cancer) or to date of censor (for those who did not die, or died from another cause).

Note that the first report from this project (AIHW 2018a) had separate categories for 'non-screen-detected cancers after a diagnostic test' (only Pap test prior to cancer diagnosis was less than 6 months before diagnosis) and 'non-screen-detected cancers in never-screened women' (no Pap test recorded prior to cancer diagnosis). In this report, these two categories have been combined into the single category of 'Non-screen-detected cancers in never-screened women' to reflect that none of these women screened prior to diagnosis.

Statistical tests

The χ^2 test was used to analyse differences across categorical variables. Kaplan–Meier survival curves were generated and log-rank tests used to assess differences in survival across groups.

Cox proportional hazards models (Cox 1972) were used to produce hazard ratios with 95% confidence intervals (CI), which were used to determine any reduction in risk of death for screening women compared with never-screened women. Analyses were adjusted for confounding by age at diagnosis, year of diagnosis, remoteness area, and socioeconomic disadvantage, as well as the clinical characteristic of histological type that was available on the Australian Cancer Database.

Ethics approvals

To access the data required for this data linkage project, ethics approvals were obtained from the AIHW Ethics Committee (EO 2014-4-130)—also used by the Department of Health for ethics approval to access National Bowel Cancer Screening Program Register data and National HPV Vaccination Program Register data—and state and territory human research ethics committees to access state and territory cancer registry data (through the Australian Cancer Database), BreastScreen register data, and cervical screening register data.

4 Cervical cancer outcomes

This section examines cervical cancer diagnoses in women aged 20–69 years in the period 1 January 2002 to 31 December 2012, who were followed up until 31 December 2015. Cervical cancers were restricted to women within this age range to align with the target age group of the National Cervical Screening Program for those years.

Although National Cervical Screening Program data were available from 2000, at least two years of screening history was required prior to the cervical cancer diagnosis to determine to which screening history category the cervical cancer should be allocated. Therefore cervical cancers were included only from 2002.

4.1 Description of cohort

As introduced in the methods section of this report, cervical cancers have been categorised according to their screen detection status and their screening history (Box 4.1.1).

Box 4.1.1: Cervical cancer definitions

Cervical cancers diagnosed in women aged 20–69 in the years 2002 to 2012 were categorised by both their screen detection status and screening history according to the following definitions:

Screen detection status

- **Screen-detected cancers**—cervical cancers diagnosed in women who had a Pap test with a cytology result of *high-grade or worse* 6 months to 2.5 years prior to diagnosis.
- **Non-screen-detected cancers in screened women**—cervical cancers diagnosed in women who had a Pap test with a cytology result that was not *negative* or *high-grade or worse* 6 months to 2.5 years prior to diagnosis, or who had a Pap test with any cytology result more than 2.5 years prior to diagnosis.
- **Interval cancers**—cervical cancers diagnosed in women who had a Pap test with a *negative* cytology result 6 months to 2.5 years prior to diagnosis.
- **Non-screen-detected cancers in never-screened women**—cervical cancers diagnosed in women whose only Pap test was in the 6 months prior to diagnosis (and is therefore considered to be part of the diagnostic process and not a screening Pap test), or who did not have a Pap test prior to diagnosis.

Screening history

- **Recently screened**—women diagnosed with cervical cancer whose last Pap test prior to diagnosis was 6 months to 2.5 years prior to the cancer diagnosis.
- **Lapsed**—women diagnosed with cervical cancer whose last Pap test prior to diagnosis was more than 2.5 years prior to diagnosis, broken down into lapsed (2.5–3.5 years), lapsed (3.5–5.5 years), and lapsed (5.5+ years).
- **Never-screened**—women diagnosed with cervical cancer who had either never had a Pap test or whose only Pap test prior to diagnosis was in the 6 months prior to the cancer diagnosis, and is therefore considered to be part of the diagnostic process and not a screening Pap test.

Analyses were also undertaken for the age groups of **20–39**, **40–49**, **50–59** and **60–69**.

The two attributes of screen detection status and screening history were used as each provides valuable information about how cervical cancer outcomes are related to the cervical screening that occurred (or did not occur) prior to the cancer diagnosis. Screen detection status tells us about cervical cancers detected as a direct consequence of screening (or otherwise) and their outcomes, but it does not tell us whether the woman was recently screened prior to the diagnosis—screening history provides this information.

There is considerable overlap between these categories—cervical cancers diagnosed in women who were recently screened are split between screen-detected cancers, interval cancers, and some non-screen-detected cancers in screened women. Non-screen-detected cancers in screened women that occurred more than 2.5 years prior to diagnosis occurred in lapsed screeners. The screen detection status category of non-screen-detected cancers in never-screened women are the same cervical cancers as those in the screening history category of never-screened.

The relationship between screen detection status and screening history is shown below, using cervical cancers diagnosed in women aged 20–69 in 2002–2012.

Screen detection status	Screening history				
	Recently screened	Lapsed (2.5–3.5 years)	Lapsed (3.5–5.5 years)	Lapsed (5.5+ years)	Never-screened
Screen-detected	354	. .	. .	. .	. .
Interval cancer	1,312				. .
Non-screen-detected in screened	297	523	445	455	. .
Non-screen-detected in never-screened	. .	. .	. .	. .	3,511

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Note that, because screening allows the detection of precancerous abnormalities prior to the development of cervical cancer, the cervical cancers that develop in screened women may not be typical of the majority of cervical cancers, which may affect their outcomes. This is particularly true for cervical cancers that develop in recently screened women. This will be explored further in the results.

Summary statistics

Between 1 January 2002 and 31 December 2012, 6,897 cervical cancers were diagnosed in women aged 20–69. Of these cervical cancers, 2,598 (37.7%) were diagnosed in women aged 20–39, 1,888 (27.4%) were diagnosed in women aged 40–49, 1,386 (20.1%) were diagnosed in women aged 50–59 and 1,025 (14.9%) were diagnosed in women aged 60–69.

Tables 4.1.1 and 4.1.2 show how cervical cancers in each of these age groups are categorised according to both screen detection status and screening history. This is also summarised graphically in figures 4.1.1 and 4.1.2.

Cervical cancers in never-screened women made up a greater proportion of cervical cancers with increasing age, these comprising 36.4% of cancers in women aged 20–39, 54.1% of cancers in women aged 40–49, 60.8% of cancers in women aged 50–59, and 68.4% of cancers in women aged 60–69.

Of the cervical cancers diagnosed in women aged 20–39, 21.2% were interval cancers, 35.3% were non-screen-detected in screened women, and 7.1% were screen-detected. These are all higher proportions than those in older age groups; the proportion of

non-screen-detected in screened women was notably almost as high as the proportion of never-screened cervical cancers in this age group (Table 4.1.2).

Likewise, cervical cancers diagnosed in women aged 20–39 also comprised the highest proportion of lapsed screeners and recently screened of all the age groups, with the proportion of recently screened cervical cancers almost as high as the proportion of never-screened cervical cancers in this age group (Table 4.1.2).

Table 4.1.1: Summary cervical cancer statistics, number of cervical cancers, 2002–2012

Cervical cancer category	20–39	40–49	50–59	60–69	20–69
Screen detection status					
Non-screen-detected in never-screened	946	1,021	843	701	3,511
Screening women					
Interval	550	357	250	155	1,312
Non-screen-detected in screened	918	423	241	138	1,720
Screen-detected	184	87	52	31	354
Screening history					
Never-screened	946	1,021	843	701	3,511
Screening women					
Lapsed (5.5+ years)	211	133	79	32	455
Lapsed (3.5–5.5 years)	258	92	59	36	445
Lapsed (2.5–3.5 years)	279	130	66	48	523
Recently screened	904	512	339	208	1,963
All cervical cancers	**2,598**	**1,888**	**1,386**	**1,025**	**6,897**

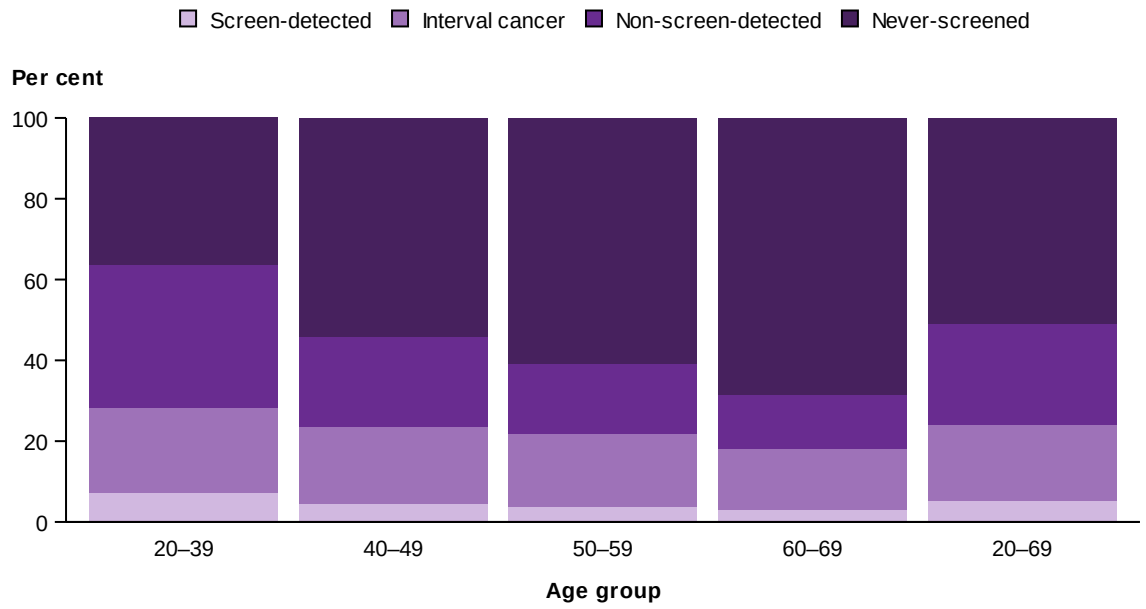
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.2: Summary cervical cancer statistics, proportion of cervical cancers, 2002–2012

Cervical cancer category	20–39	40–49	50–59	60–69	20–69
Screen detection status					
Non-screen-detected in never-screened	36.4	54.1	60.8	68.4	50.9
Screening women					
Interval	21.2	18.9	18.0	15.1	19.0
Non-screen-detected in screened	35.3	22.4	17.4	13.5	24.9
Screen-detected	7.1	4.6	3.8	3.0	5.1
Screening history					
Never-screened	36.4	54.1	60.8	68.4	50.9
Screening women					
Lapsed (5.5+ years)	8.1	7.0	5.7	3.1	6.6
Lapsed (3.5–5.5 years)	9.9	4.9	4.3	3.5	6.5
Lapsed (2.5–3.5 years)	10.7	6.9	4.8	4.7	7.6
Recently screened	34.8	27.1	24.5	20.3	28.5

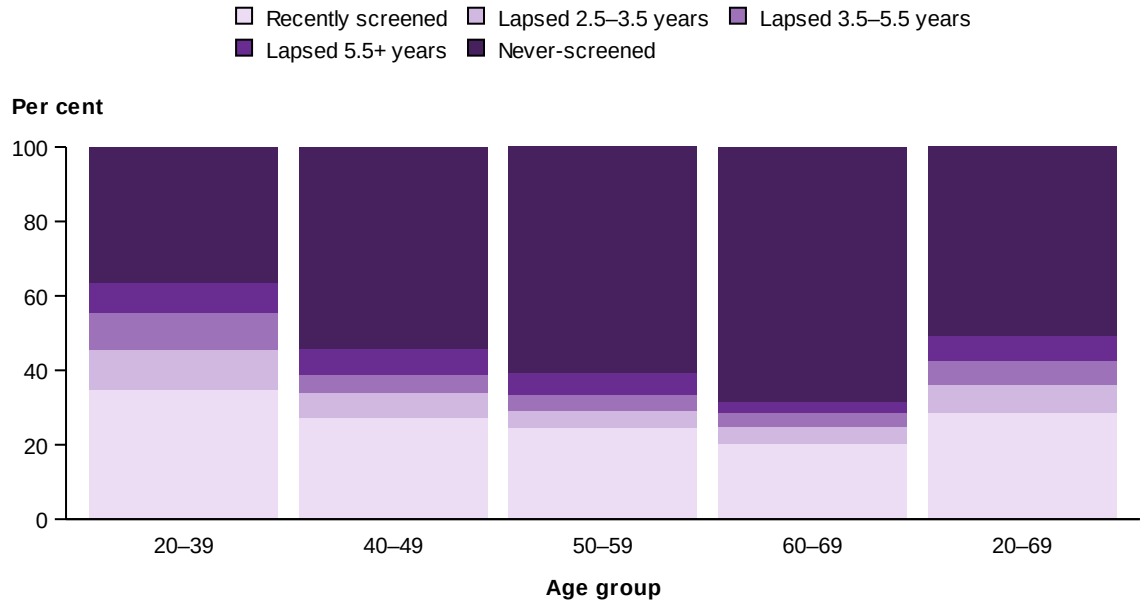
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.1.1: Distribution of cervical cancers by screen detection status



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.1.2: Distribution of cervical cancers, by screening history



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Descriptive statistics

Descriptive statistics tables allow assessment of similarities and differences between the individuals diagnosed within the different screen detection and screening history categories of cervical cancer by key factors such as age group at diagnosis, remoteness area of residence, socioeconomic area of residence, as well as cancer features that were available on the Australian Cancer Database.

Characteristics of women diagnosed with cervical cancers in each screen detection status category are shown in tables 4.1.3–4.1.7, and in each screening history category in tables 4.1.8–4.1.12.

Key features of women aged 20–69 by screen detection status are shown in Table 4.1.3.

Compared with non-screen-detected cervical cancers diagnosed in never-screened women:

- a higher proportion of screen-detected cervical cancers were diagnosed in women aged 20–39, and a lower proportion in women aged 40–49, 50–59 and 60–69
- a lower proportion of screen-detected cervical cancers were diagnosed in 2002–2007, and higher proportion in 2008–2012
- a lower proportion of screen-detected cancers were other or unspecified carcinomas or cancers.

Key features of women aged 20–69 by screening history are shown in Table 4.1.8.

Compared with cervical cancers diagnosed in never-screened women:

- a higher proportion of recently screened women were diagnosed with cervical cancer at age 20–39, and a lower proportion at ages 50–59 and 60–69
- a lower proportion of recently screened women were diagnosed with cervical cancer in 2002–2007, and higher proportion in 2008–2012
- a lower proportion of cervical cancers in recently screened women were squamous cell carcinomas—54.0% of cervical cancers in recently screened women compared with 74.3% in never-screened women.

Table 4.1.3: Characteristics of women diagnosed with cervical cancer by screen detection status, women aged 20–69, 2002–2012

		Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%
Age group	20–39	184	52.0	550	41.9	918	53.4	946	26.9	2,598	37.7
	40–49	87	24.6	357	27.2	423	24.6	1,021	29.1	1,888	27.4
	50–59	52	14.7	250	19.1	241	14.0	843	24.0	1,386	20.1
	60–69	31	8.8	155	11.8	138	8.0	701	20.0	1,025	14.9
Period of diagnosis	2002–2007	151	42.7	685	52.2	635	36.9	2,067	58.9	3,538	51.3
	2008–2012	203	57.3	627	47.8	1,085	63.1	1,444	41.1	3,359	48.7
Remoteness area	Major cities	234	66.1	889	67.8	1,119	65.1	2,275	65.1	4,517	65.7
	Inner regional	58	16.4	238	18.1	330	19.2	653	18.7	1,279	18.6
	Outer regional	41	11.6	135	10.3	197	11.5	414	11.8	787	11.5
	Remote and Very remote	20	5.7	43	3.3	71	4.1	154	4.4	288	4.2
Socioeconomic area	1 (most disadvantage)	82	23.2	254	19.4	342	19.9	868	24.8	1,546	22.5
	2	78	22.0	247	18.8	375	21.8	815	23.3	1,515	22.1
	3	52	14.7	235	17.9	351	20.4	681	19.5	1,319	19.2
	4	77	21.8	280	21.3	356	20.7	595	17.0	1,308	19.0
	5 (least disadvantage)	63	17.8	289	22.0	293	17.0	536	15.3	1,181	17.2
Histological type	Squamous cell carcinoma	268	75.7	600	45.7	1,075	62.5	2,607	74.3	4,550	66.0
	Adenocarcinoma	59	16.7	529	40.3	463	26.9	561	16.0	1,612	23.4
	Adenosquamous carcinoma	13	3.7	48	3.7	67	3.9	132	3.8	260	3.8
	Other or unspecified carcinomas	12	3.4	81	6.2	73	4.2	155	4.4	321	4.7
	Other or unspecified cancers	2	0.6	54	4.1	42	2.4	56	1.6	154	2.2
Total		**354**		**1,312**		**1,720**		**3,511**		**6,897**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.4: Characteristics of women diagnosed with cervical cancer by screen detection status, women aged 20–39, 2002–2012

		Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%
Age group	20–24	9	4.9	24	4.4	67	7.3	38	4.0	138	5.3
	25–29	43	23.4	127	23.1	236	25.7	161	17.0	567	21.8
	30–34	55	29.9	211	38.4	322	35.1	294	31.1	882	33.9
	35–39	77	41.8	188	34.2	293	31.9	453	47.9	1,011	38.9
Period of diagnosis	2002–2007	79	42.9	260	47.3	347	37.8	585	61.8	1,271	48.9
	2008–2012	105	57.1	290	52.7	571	62.2	361	38.2	1,327	51.1
Remoteness area	Major cities	122	66.7	380	69.6	621	67.7	644	68.4	1,767	68.3
	Inner regional	28	15.3	91	16.7	171	18.7	142	15.1	432	16.7
	Outer regional	23	12.6	58	10.6	87	9.5	116	12.3	284	11.0
	Remote and Very remote	10	5.5	17	3.1	38	4.1	40	4.3	105	4.1
Socioeconomic area	1 (most disadvantage)	37	20.3	95	17.4	171	18.7	195	20.7	498	19.3
	2	42	23.1	105	19.2	200	21.8	204	21.7	551	21.3
	3	29	15.9	90	16.5	193	21.1	179	19.0	491	19.0
	4	40	22.0	130	23.8	197	21.5	191	20.3	558	21.6
	5 (least disadvantage)	34	18.7	126	23.1	156	17.0	173	18.4	489	18.9
Histological type	Squamous cell carcinoma	144	78.3	295	53.6	614	66.9	688	72.7	1,741	67.0
	Adenocarcinoma	24	13.0	189	34.4	230	25.1	167	17.7	610	23.5
	Adenosquamous carcinoma	7	3.8	18	3.3	35	3.8	41	4.3	101	3.9
	Other or unspecified carcinomas	9	4.9	35	6.4	29	3.2	41	4.3	114	4.4
	Other or unspecified cancers	0	0.0	13	2.4	10	1.1	9	1.0	32	1.2
Total		**184**		**550**		**918**		**946**		**2,598**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.5: Characteristics of women diagnosed with cervical cancer by screen detection status, women aged 40–49, 2002–2012

		Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%
Age group	40–44	50	57.5	182	51.0	228	53.9	496	48.6	956	50.6
	45–49	37	42.5	175	49.0	195	46.1	525	51.4	932	49.4
Period of diagnosis	2002–2007	41	47.1	199	55.7	157	37.1	625	61.2	1,022	54.1
	2008–2012	46	52.9	158	44.3	266	62.9	396	38.8	866	45.9
Remoteness area	Major cities	58	66.7	247	69.6	275	65.3	626	61.6	1,206	64.1
	Inner regional	16	18.4	55	15.5	79	18.8	212	20.9	362	19.3
	Outer regional	9	10.3	40	11.3	50	11.9	126	12.4	225	12.0
	Remote and Very remote	4	4.6	13	3.7	17	4.0	53	5.2	87	4.6
Socioeconomic area	1 (most disadvantage)	29	33.3	66	18.6	87	20.7	262	25.8	444	23.6
	2	15	17.2	74	20.9	87	20.7	235	23.1	411	21.9
	3	8	9.2	67	18.9	82	19.5	187	18.4	344	18.3
	4	19	21.8	70	19.7	94	22.3	175	17.2	358	19.0
	5 (least disadvantage)	16	18.4	78	22.0	71	16.9	158	15.5	323	17.2
Histological type	Squamous cell carcinoma	61	70.1	151	42.3	245	57.9	762	74.6	1,219	64.6
	Adenocarcinoma	22	25.3	155	43.4	128	30.3	174	17.0	479	25.4
	Adenosquamous carcinoma	3	3.4	12	3.4	13	3.1	35	3.4	63	3.3
	Other or unspecified carcinomas	0	0.0	18	5.0	22	5.2	41	4.0	81	4.3
	Other or unspecified cancers	1	1.1	21	5.9	15	3.5	9	0.9	46	2.4
Total		**87**		**357**		**423**		**1,021**		**1,888**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.6: Characteristics of women diagnosed with cervical cancer by screen detection status, women aged 50–59, 2002–2012

		Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%
Age group	50–54	31	59.6	134	53.6	142	58.9	452	53.6	759	54.8
	55–59	21	40.4	116	46.4	99	41.1	391	46.4	627	45.2
Period of diagnosis	2002–2007	16	30.8	138	55.2	79	32.8	463	54.9	696	50.2
	2008–2012	36	69.2	112	44.8	162	67.2	380	45.1	690	49.8
Remoteness area	Major cities	32	61.5	163	65.2	138	57.3	553	65.8	886	64.1
	Inner regional	10	19.2	54	21.6	48	19.9	160	19.1	272	19.7
	Outer regional	6	11.5	25	10.0	43	17.8	94	11.2	168	12.1
	Remote and Very remote	4	7.7	8	3.2	12	5.0	33	3.9	57	4.1
Socioeconomic area	1 (most disadvantage)	10	19.2	55	22.0	48	19.9	217	25.8	330	23.9
	2	14	26.9	40	16.0	63	26.1	222	26.4	339	24.5
	3	9	17.3	42	16.8	43	17.8	166	19.8	260	18.8
	4	11	21.2	56	22.4	45	18.7	122	14.5	234	16.9
	5 (least disadvantage)	8	15.4	57	22.8	42	17.4	113	13.5	220	15.9
Histological type	Squamous cell carcinoma	36	69.2	94	37.6	141	58.5	643	76.3	914	65.9
	Adenocarcinoma	9	17.3	116	46.4	63	26.1	117	13.9	305	22.0
	Adenosquamous carcinoma	3	5.8	8	3.2	14	5.8	31	3.7	56	4.0
	Other or unspecified carcinomas	3	5.8	18	7.2	11	4.6	34	4.0	66	4.8
	Other or unspecified cancers	1	1.9	14	5.6	12	5.0	18	2.1	45	3.2
Total		**52**		**250**		**241**		**843**		**1,386**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.7: Characteristics of women diagnosed with cervical cancer by screen detection status, women aged 60–69, 2002–2012

		Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%
Age group	60–64	14	45.2	82	52.9	81	58.7	362	51.6	539	52.6
	65–69	17	54.8	73	47.1	57	41.3	339	48.4	486	47.4
Period of diagnosis	2002–2007	15	48.4	88	56.8	52	37.7	394	56.2	549	53.6
	2008–2012	16	51.6	67	43.2	86	62.3	307	43.8	476	46.4
Remoteness area	Major cities	22	71.0	99	64.3	85	61.6	452	64.9	658	64.5
	Inner regional	4	12.9	38	24.7	32	23.2	139	19.9	213	20.9
	Outer regional	3	9.7	12	7.8	17	12.3	78	11.2	110	10.8
	Remote and Very remote	2	6.5	5	3.3	4	2.9	28	4.0	39	3.8
Socioeconomic area	1 (most disadvantage)	6	19.4	38	24.7	36	26.1	194	27.9	274	26.9
	2	7	22.6	28	18.2	25	18.1	154	22.1	214	21.0
	3	6	19.4	36	23.4	33	23.9	149	21.4	224	22.0
	4	7	22.6	24	15.6	20	14.5	107	15.4	158	15.5
	5 (least disadvantage)	5	16.1	28	18.2	24	17.4	92	13.2	149	14.6
Histological type	Squamous cell carcinoma	27	87.1	60	38.7	75	54.3	514	73.3	676	66.0
	Adenocarcinoma	4	12.9	69	44.5	42	30.4	103	14.7	218	21.3
	Adenosquamous carcinoma	0	0.0	10	6.5	5	3.6	25	3.6	40	3.9
	Other or unspecified carcinomas	0	0.0	10	6.5	11	8.0	39	5.6	60	5.9
	Other or unspecified cancers	0	0.0	6	3.9	5	3.6	20	2.9	31	3.0
Total		**31**		**155**		**138**		**701**		**1,025**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.8: Characteristics of women diagnosed with cervical cancer by screening history, women aged 20–69, 2002–2012

		Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Age group	20–39	904	46.1	279	53.4	258	58.0	211	46.4	946	26.9	2,598	37.7
	40–49	512	26.1	130	24.9	92	20.7	133	29.2	1,021	29.1	1,888	27.4
	50–59	339	17.3	66	12.6	59	13.3	79	17.4	843	24.0	1,386	20.1
	60–69	208	10.6	48	9.2	36	8.1	32	7.0	701	20.0	1,025	14.9
Period of diagnosis	2002–2007	1,003	51.1	236	45.1	187	42.0	45	9.9	2,067	58.9	3,538	51.3
	2008–2012	960	48.9	287	54.9	258	58.0	410	90.1	1,444	41.1	3,359	48.7
Remoteness area	Major cities	1,327	67.9	336	64.2	286	64.4	293	64.7	2,275	65.1	4,517	65.7
	Inner regional	342	17.5	112	21.4	84	18.9	88	19.4	653	18.7	1,279	18.6
	Outer regional	207	10.6	55	10.5	57	12.8	54	11.9	414	11.8	787	11.5
	Remote and Very remote	79	4.0	20	3.8	17	3.8	18	4.0	154	4.4	288	4.2
Socioeconomic area	1 (most disadvantage)	399	20.4	101	19.3	82	18.5	96	21.2	868	24.8	1,546	22.5
	2	390	20.0	100	19.1	98	22.1	112	24.7	815	23.3	1,515	22.0
	3	345	17.7	117	22.4	88	19.8	88	19.4	681	19.5	1,319	19.2
	4	418	21.4	108	20.7	94	21.2	93	20.5	595	17.0	1,308	19.0
	5 (least disadvantage)	402	20.6	97	18.6	82	18.5	64	14.1	536	15.3	1,181	17.2
Histological type	Squamous cell carcinoma	1,061	54.0	297	56.8	276	62.0	309	67.9	2,607	74.3	4,550	66.0
	Adenocarcinoma	665	33.9	160	30.6	119	26.7	107	23.5	561	16.0	1,612	23.4
	Adenosquamous carcinoma	67	3.4	23	4.4	20	4.5	18	4.0	132	3.8	260	3.8
	Other or unspecified carcinomas	105	5.3	28	5.4	18	4.0	15	3.3	155	4.4	321	4.7
	Other or unspecified cancers	65	3.3	15	2.9	12	2.7	6	1.3	56	1.6	154	2.2
Total		**1,963**		**523**		**445**		**455**		**3,511**		**6,897**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.9: Characteristics of women diagnosed with cervical cancer by screening history, women aged 20–39, 2002–2012

		Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Age group	20–24	63	7.0	23	8.2	12	4.7	2	1.0	38	4.0	138	5.3
	25–29	221	24.5	71	25.5	69	26.7	45	21.3	161	17.0	567	21.8
	30–34	311	34.4	96	34.4	94	36.4	87	41.2	294	31.1	882	33.9
	35–39	309	34.2	89	31.9	83	32.2	777	36.5	453	47.9	1,011	38.9
Period of diagnosis	2002–2007	433	47.9	125	44.8	102	39.5	26	12.3	585	61.8	1,271	48.9
	2008–2012	471	52.1	154	55.2	156	60.5	185	87.7	361	38.2	1,327	51.1
Remoteness area	Major cities	625	69.5	180	64.5	178	69.3	140	66.4	644	68.4	1,767	68.3
	Inner regional	141	15.7	61	21.9	42	16.3	46	21.8	142	15.1	432	16.7
	Outer regional	97	10.8	27	9.7	27	10.5	17	8.1	116	12.3	284	11.0
	Remote and Very remote	36	4.0	11	3.9	10	3.9	8	3.8	40	4.2	105	4.1
Socioeconomic area	1 (most disadvantage)	170	18.9	49	17.6	41	16.0	43	20.4	195	20.7	498	19.2
	2	190	21.2	50	17.9	53	20.6	54	25.6	204	21.7	551	21.3
	3	147	16.4	66	23.7	50	19.5	49	23.2	179	19.0	491	19.0
	4	203	22.6	59	21.2	63	24.5	42	19.9	191	20.3	558	21.6
	5 (least disadvantage)	188	20.9	55	19.7	50	19.5	23	10.9	173	18.4	489	18.9
Histological type	Squamous cell carcinoma	563	62.3	170	60.9	167	64.7	153	72.5	688	72.7	1,741	67.0
	Adenocarcinoma	250	27.7	81	29.0	67	26.0	45	21.3	167	17.7	610	23.5
	Adenosquamous carcinoma	28	3.1	11	3.9	14	5.4	7	3.3	41	4.3	101	3.9
	Other or unspecified carcinomas	48	5.3	14	5.0	7	2.7	4	1.9	41	4.3	114	4.4
	Other or unspecified cancers	15	1.7	3	1.1	3	1.2	2	0.9	9	1.0	32	1.2
Total		**904**		**279**		**258**		**211**		**946**		**2,598**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.10: Characteristics of women diagnosed with cervical cancer by screening history, women aged 40–49, 2002–2012

		Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Age group	40–44	271	52.9	72	55.4	46	50.0	71	53.4	496	48.6	956	50.6
	45–49	241	47.1	58	44.6	46	50.0	62	46.6	525	51.4	932	49.4
Period of diagnosis	2002–2007	283	55.3	56	43.1	45	48.9	13	9.8	625	61.2	1,022	54.1
	2008–2012	229	44.7	74	56.9	47	51.1	120	90.2	396	38.8	866	45.9
Remoteness area	Major cities	346	67.8	88	67.7	54	58.7	92	70.2	626	61.3	1,206	63.9
	Inner regional	85	16.7	26	20.0	21	22.8	18	13.7	212	20.8	362	19.2
	Outer regional	57	11.2	11	8.5	12	13.0	19	14.5	126	12.3	225	11.9
	Remote and Very remote	22	4.3	5	3.9	5	5.4	2	1.5	53	5.2	87	4.6
Socioeconomic area	1 (most disadvantage)	108	21.2	27	20.8	20	21.7	27	20.6	262	25.7	444	23.5
	2	103	20.2	24	18.5	20	21.7	29	22.1	235	23.0	411	21.8
	3	90	17.7	27	20.8	19	20.7	21	16.0	187	18.3	344	18.2
	4	105	20.6	27	20.8	19	20.7	32	24.4	175	17.1	358	19.0
	5 (least disadvantage)	104	20.4	25	19.2	14	15.2	22	16.8	158	15.5	323	17.1
Histological type	Squamous cell carcinoma	248	48.4	67	51.5	57	62.0	85	63.9	762	74.6	1,219	64.6
	Adenocarcinoma	200	39.1	46	35.4	25	27.2	34	25.6	174	17.0	479	25.4
	Adenosquamous carcinoma	17	3.3	5	3.8	1	1.1	5	3.8	35	3.4	63	3.3
	Other or unspecified carcinomas	21	4.1	7	5.4	6	6.5	6	4.5	41	4.0	81	4.3
	Other or unspecified cancers	26	5.1	5	3.8	3	3.3	3	2.3	9	0.9	46	2.4
Total		**512**		**130**		**92**		**133**		**1,021**		**1,888**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.11: Characteristics of women diagnosed with cervical cancer by screening history, women aged 50–59, 2002–2012

		Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Age group	50–54	182	53.7	37	56.1	37	62.7	51	64.6	452	53.6	759	54.8
	55–59	157	46.3	29	43.9	22	37.3	28	35.4	391	46.4	627	45.2
Period of diagnosis	2002–2007	173	51.0	32	48.5	25	42.4	3	3.8	463	54.9	696	50.2
	2008–2012	166	49.0	34	51.5	34	57.6	76	96.2	380	45.1	690	49.8
Remoteness area	Major cities	221	65.2	41	62.1	29	49.2	42	53.2	553	65.6	886	63.9
	Inner regional	68	20.1	13	19.7	14	23.7	17	21.5	160	19.0	272	19.6
	Outer regional	36	10.6	11	16.7	14	23.7	13	16.5	94	11.2	168	12.1
	Remote and Very remote	14	4.1	1	1.5	2	3.4	7	8.9	33	3.9	57	4.1
Socioeconomic area	1 (most disadvantage)	72	21.2	14	21.2	7	11.9	20	25.3	217	25.7	330	23.8
	2	61	18.0	16	24.2	19	32.2	21	26.6	222	26.3	339	24.5
	3	60	17.7	12	18.2	10	17.0	12	15.2	166	19.7	260	18.8
	4	73	21.5	14	21.2	11	18.6	14	17.7	122	14.5	234	16.9
	5 (least disadvantage)	73	21.5	10	15.2	12	20.3	12	15.2	113	13.4	220	15.9
Histological type	Squamous cell carcinoma	152	44.8	30	45.5	36	61.0	53	67.1	643	76.3	914	65.9
	Adenocarcinoma	136	40.1	22	33.3	13	22.0	17	21.5	117	13.9	305	22.0
	Adenosquamous carcinoma	12	3.5	5	7.6	3	5.1	5	6.3	31	3.7	56	4.0
	Other or unspecified carcinomas	23	6.8	3	4.5	3	5.1	3	3.8	34	4.0	66	4.8
	Other or unspecified cancers	16	4.7	6	9.1	4	6.8	1	1.3	18	2.1	45	3.2
Total		**339**		**66**		**59**		**79**		**843**		**1,386**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.1.12: Characteristics of women diagnosed with cervical cancer by screening history, women aged 60–69, 2002–2012

		Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
		Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Age group	60–64	108	51.9	29	60.4	19	52.8	21	65.6	362	51.6	539	52.5
	65–69	100	48.1	19	39.6	17	47.2	11	34.4	339	48.4	486	47.3
Period of diagnosis	2002–2007	114	47.9	23	47.9	15	41.7	3	9.4	394	56.2	549	53.5
	2008–2012	94	52.1	25	52.1	21	58.3	29	90.6	307	43.8	476	46.3
Remoteness area	Major cities	135	65.2	27	56.3	25	69.4	19	59.4	452	64.5	658	64.1
	Inner regional	48	23.2	12	25.0	7	19.4	7	21.9	139	19.8	213	20.7
	Outer regional	17	8.2	6	12.5	4	11.1	5	15.6	78	11.1	110	10.7
	Remote and Very remote	7	3.4	3	6.3	0	0.0	1	3.1	28	4.0	39	3.8
Socioeconomic area	1 (most disadvantage)	49	23.7	11	22.9	14	38.9	6	18.8	194	27.7	274	26.7
	2	36	17.4	10	20.8	6	16.7	8	25.0	154	22.0	214	20.8
	3	48	23.2	12	25.0	9	25.0	6	18.8	149	21.3	224	21.8
	4	37	17.9	8	16.7	1	2.8	5	15.6	107	15.3	158	15.4
	5 (least disadvantage)	37	17.9	7	14.6	6	16.7	7	21.9	92	13.1	149	14.5
Histological type	Squamous cell carcinoma	98	47.1	30	62.5	16	44.4	18	56.3	514	73.3	676	66.0
	Adenocarcinoma	79	38.0	11	22.9	14	38.9	11	34.4	103	14.7	218	21.3
	Adenosquamous carcinoma	10	4.8	2	4.2	2	5.6	1	3.1	25	3.6	40	3.9
	Other or unspecified carcinomas	13	6.3	4	8.3	2	5.6	2	6.3	39	5.6	60	5.9
	Other or unspecified cancers	8	3.8	1	2.1	2	5.6	0	0.0	20	2.9	31	3.0
Total		**208**		**48**		**36**		**32**		**701**		**1,025**	

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

4.2 Summary cancer and death statistics

For women aged 20–69, of the 6,897 women diagnosed with cervical cancer in 2002–2012, 1,760 (25.5%) died before the end of 2015, 1,334 of them from cervical cancer. This means that almost a fifth (19.3%) of women diagnosed with cervical cancer died from it. However, there were differences according to the screen detection status and screening history of the cervical cancer, and age at diagnosis. The former are detailed in tables 4.2.1 and 4.2.2 and discussed below, while differences by age are shown in figures 4.2.1–4.2.10.

Screen detection status

Screen-detected cervical cancers had the lowest rate of cervical cancer death at 5.9%, followed by non-screen-detected cervical cancers in screened women at 10.8% and interval cancers at 12.8%. Non-screen-detected cervical cancers in never-screened women had the highest rate of cervical cancer death at 27.3% (Table 4.2.1; Figure 4.2.1).

Rates of death from cervical cancer and other causes are shown by screen detection status for the age groups 20–39, 40–49, 50–59 and 60–69 in figures 4.2.3, 4.2.5, 4.2.7 and 4.2.9.

Screening history

Recently screened and women who were lapsed screeners by 2.5–3.5 years and by 3.5–5.5 years all had similar rates of death from cervical cancer, at 10.5%, 9.8% and 11.5%, respectively. Death from cervical cancer in women who were lapsed screeners by 5.5 years or more was slightly higher at 14.7%, and much higher for never-screened women at 27.3%. (Table 4.2.2; Figure 4.2.2).

Rates of death from cervical cancer and other causes are shown by screening history for the age groups 20–39, 40–49, 50–59 and 60–69 in figures 4.2.4, 4.2.6, 4.2.8 and 4.2.10.

Screen detection status by screening history

Cervical cancer cases and cervical cancer deaths for screen detection status by screening history are shown in Table 4.2.3. Recently screened women had very low cervical cancer death rates when the cancer was screen-detected (5.9%) or non-screen-detected in screened women (5.7%), but a much higher rate when the cancer was an interval cancer (12.8%). The inclusion of interval cancers in the recently screened category therefore increases the overall cervical cancer death rate for cervical cancers diagnosed in recently screened women.

Table 4.2.1: Deaths before 2016 in women aged 20–69 diagnosed with cervical cancer in 2002–2012, by screen detection status

	Screen-detected	Interval cancer	Non-screen-detected in screened	Non-screen-detected in never-screened	Total
Number diagnosed with cervical cancer	354	1,312	1,720	3,511	6,897
Number died from cervical cancer	21	168	186	959	1,334
Rate of death from cervical cancer (%)	5.9	12.8	10.8	27.3	19.3
Number died from any cause	31	235	249	1,245	1,760
Rate of death from any cause (%)	8.8	17.9	14.5	35.5	25.5
Mean age at diagnosis *Minimum–Maximum*	*41.8* *21.9–69.5*	*44.1* *20.6–69.8*	*41.0* *20.6–70.0*	*48.3* *20.0–70.0*	*45.3* *20.0–70.0*
Median age at diagnosis	*38.9*	*42.9*	*38.9*	*48.0*	*44.4*
Mean age at death *Minimum–Maximum*	*54.5* *28.5–81.5*	*53.9* *24.8–79.9*	*48.0* *24.0–76.5*	*54.9* *21.4–80.6*	*53.8* *21.4–81.6*
Median age at death	*55.2*	*55.2*	*47.6*	*55.9*	*54.8*

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.2.2: Deaths before 2016 in women aged 20–69 diagnosed with cervical cancer in 2002–2012, by screening history

	Recently screened	Lapsed (2.5–3.5 years)	Lapsed (3.5–5.5 years)	Lapsed (5.5+ years)	Never-screened	Total
Number diagnosed with cervical cancer	1,963	523	445	455	3,511	6,897
Number died from cervical cancer	206	51	51	67	959	1,334
Rate of death from cervical cancer (%)	10.5	9.8	11.5	14.7	27.3	19.3
Number died from any cause	295	71	66	83	1,245	1,760
Rate of death from any cause (%)	15.0	13.6	14.8	18.2	35.5	25.5
Mean age at diagnosis *Minimum–Maximum*	*42.9* *20.6–69.8*	*41.0* *21.4–69.9*	*40.5* *22.6–69.9*	*42.4* *21.8–70.0*	*48.3* *20.0–70.0*	*45.3* *20.0–70.0*
Median age at diagnosis	*41.2*	*38.9*	*38.0*	*41.1*	*48.0*	*44.4*
Mean age at death *Minimum–Maximum*	*53.1* *24.8–81.5*	*47.9* *25.1–76.5*	*47.8* *24.0–71.2*	*49.3* *26.9–71.1*	*54.9* *21.4–80.6*	*53.8* *21.4–81.5*
Median age at death	*54.3*	*47.0*	*49.0*	*49.0*	*55.9*	*54.8*

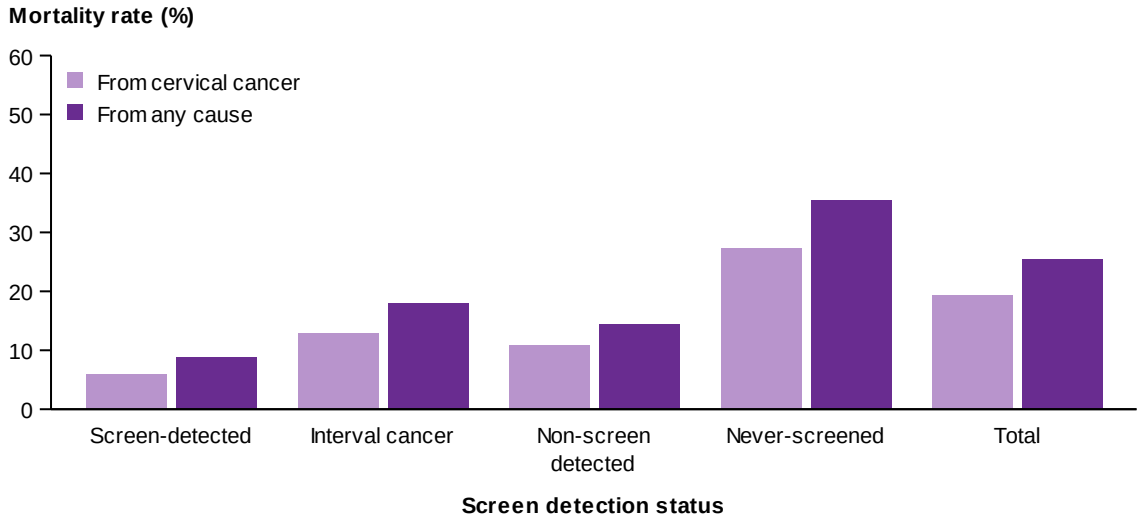
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.2.3: Deaths from cervical cancer before 2016 in women aged 20–69 diagnosed with cervical cancer in 2002–2012, by screen detection status and screening history

Screen detection status	Screening history				
	Recently screened	Lapsed (2.5–3.5 years)	Lapsed (3.5–5.5 years)	Lapsed (5.5+ years)	Never-screened
Screen-detected					
Number diagnosed with cervical cancer	354	. .	. .	. .	. .
Number died from cervical cancer	21	. .	. .	. .	. .
Rate of death from cervical cancer (%)	5.9	. .	. .	. .	. .
Interval cancer					
Number diagnosed with cervical cancer	1,312	. .	. .	. .	. .
Number died from cervical cancer	168	. .	. .	. .	. .
Rate of death from cervical cancer (%)	12.8	. .	. .	. .	. .
Non-screen-detected in screened					
Number diagnosed with cervical cancer	297	523	445	455	. .
Number died from cervical cancer	17	51	51	67	. .
Rate of death from cervical cancer (%)	5.7	9.8	11.5	14.7	. .
Non-screen-detected in never-screened					
Number diagnosed with cervical cancer	. .	. .	. .	. .	3,511
Number died from cervical cancer	. .	. .	. .	. .	959
Rate of death from cervical cancer (%)	. .	. .	. .	. .	27.3

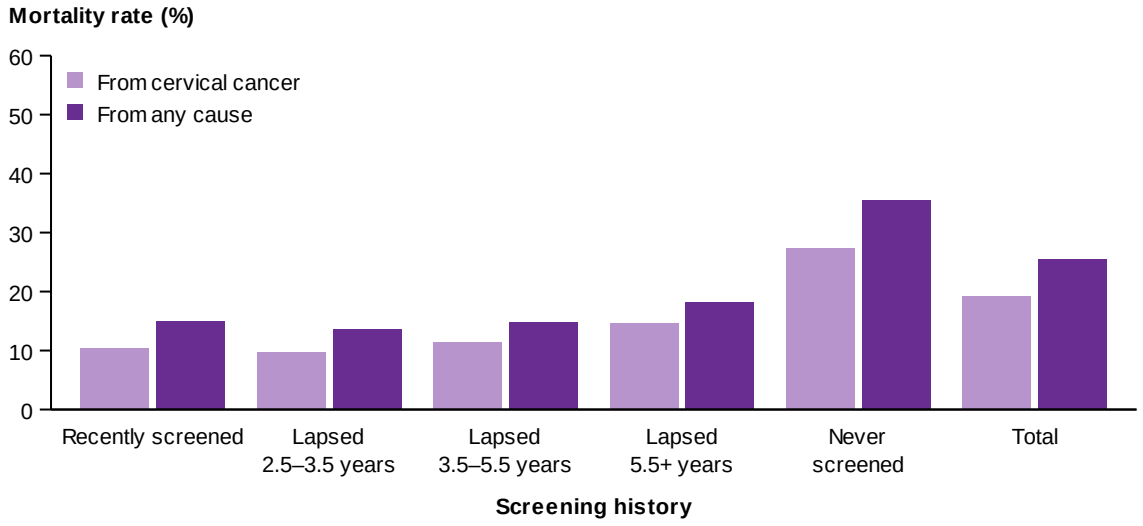
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.1: Deaths in women diagnosed with cervical cancer by screen detection status, women aged 20–69, 2002–2012



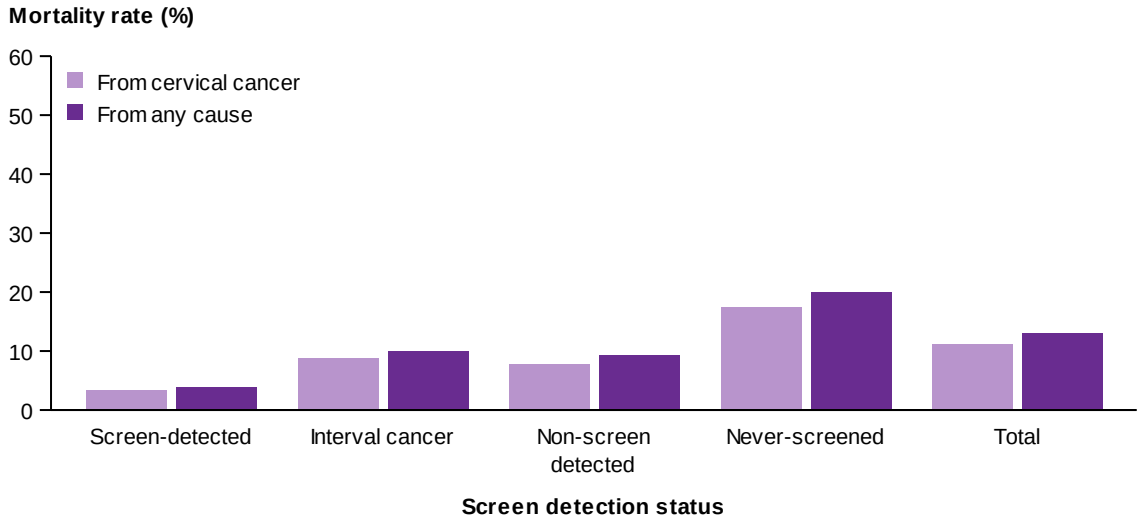
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.2: Deaths in women diagnosed with cervical cancer by screening history, women aged 20–69, 2002–2012



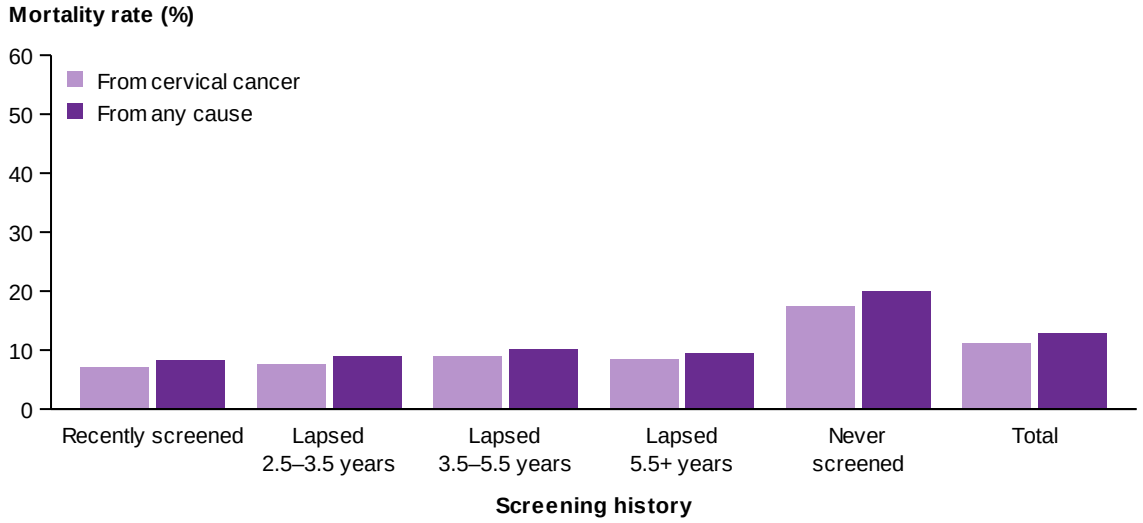
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.3: Deaths in women diagnosed with cervical cancer by screen detection status, women aged 20–39, 2002–2012



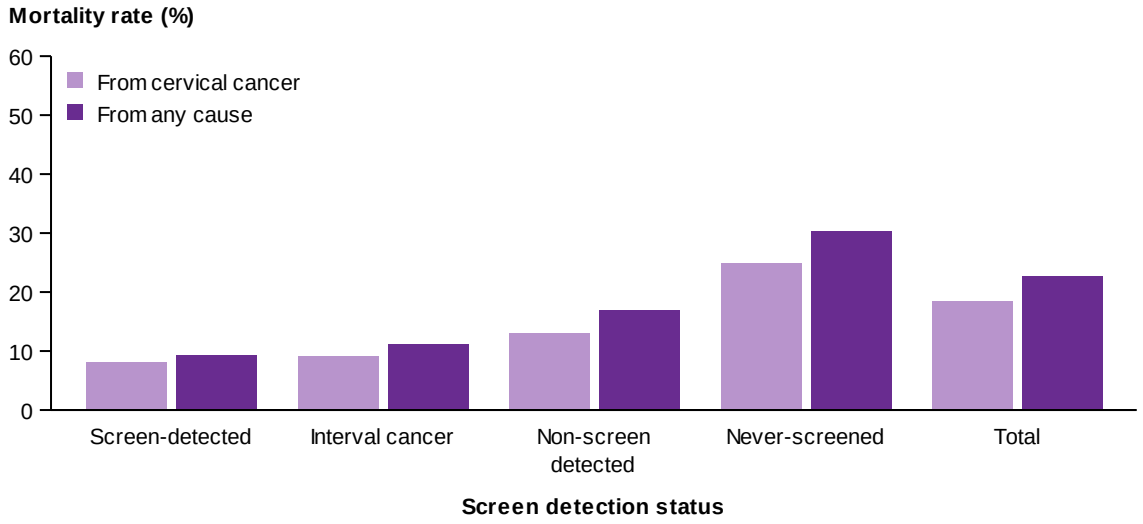
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.4: Deaths in women diagnosed with cervical cancer by screening history, women aged 20–39, 2002–2012



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.5: Deaths in women diagnosed with cervical cancer by screen detection status, women aged 40–49, 2002–2012

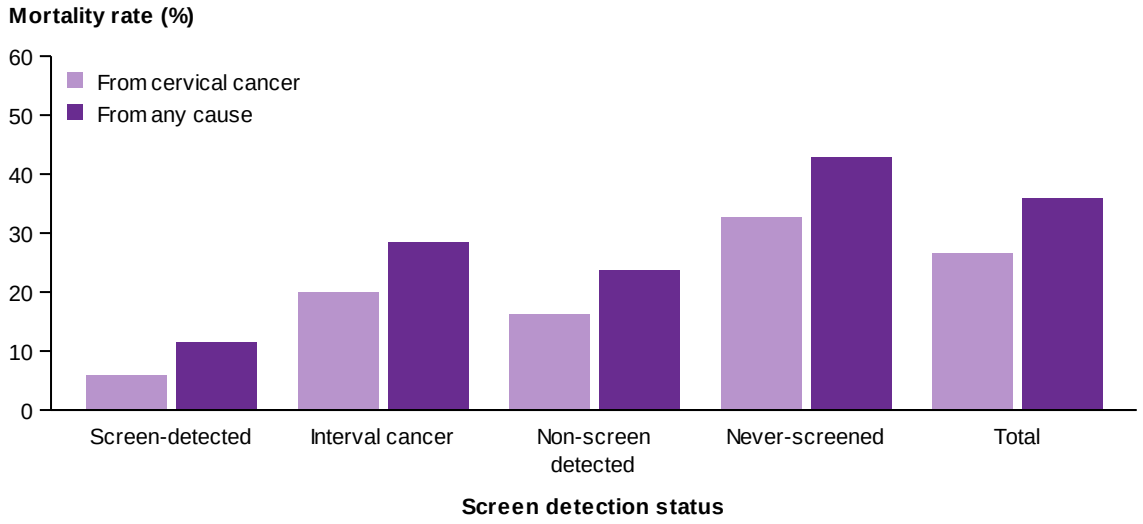


Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.6: Deaths in women diagnosed with cervical cancer by screening history, women aged 40–49, 2002–2012

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.7: Deaths in women diagnosed with cervical cancer by screen detection status, women aged 50–59, 2002–2012

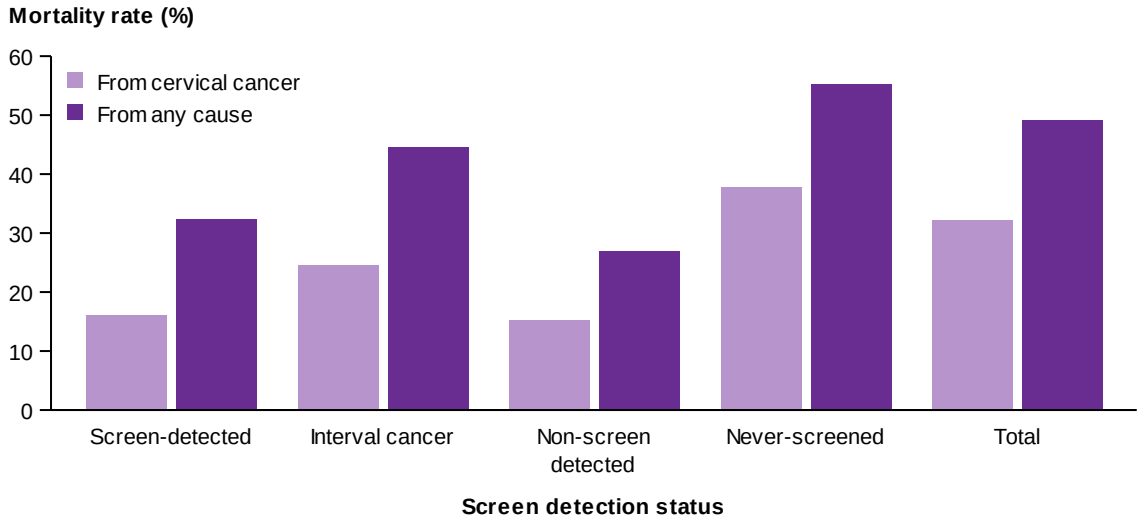


Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.8: Deaths in women diagnosed with cervical cancer by screening history, women aged 50–59, 2002–2012

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.9: Deaths in women diagnosed with cervical cancer by screen detection status, women aged 60–69, 2002–2012



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.2.10: Deaths in women diagnosed with cervical cancer by screening history, women aged 60–69, 2002–2012

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

4.3 Survival of women diagnosed with cervical cancer according to screen detection status

Results of survival for women aged 20–69 for screen-detected versus non-screen-detected cervical cancers have been previously reported (AIHW 2018a), but are repeated here, along with breakdowns by women aged 20–39, 40–49, 50–59 and 60–69, to provide more comprehensive results.

In tables 4.3.1–4.3.5, the number and proportion of women diagnosed with cervical cancer who died from cervical cancer in each year of follow-up, as well as the total by 31 December 2015 (the end of follow-up) by screen-detection status are shown.

The related survival curves are shown in figures 4.3.1–4.3.5.

From these tables and figures it can be seen that, while screen-detected cervical cancers always had a lower risk of cervical cancer death than never-screened cervical cancers, the scale of this was different across the age groups. The difference was smallest for women aged 20–39 (14.1 percentage points at the end of follow-up), and largest for women aged 50–59 (26.9 percentage points at the end of follow-up).

This was reflected in the general log rank test statistics showing there was a strong effect of screen detection status on cervical cancer mortality. For ages 20–39, 40–49, 50–59 and 60–69 the general log rank test statistics were: $\chi^2(3) = 62.65$ ($p<0.0001$), $\chi^2(3) = 62.07$ ($p<0.0001$), $\chi^2(3) = 46.57$ ($p<0.0001$) and $\chi^2(3) = 36.82$ ($p<0.0001$), respectively.

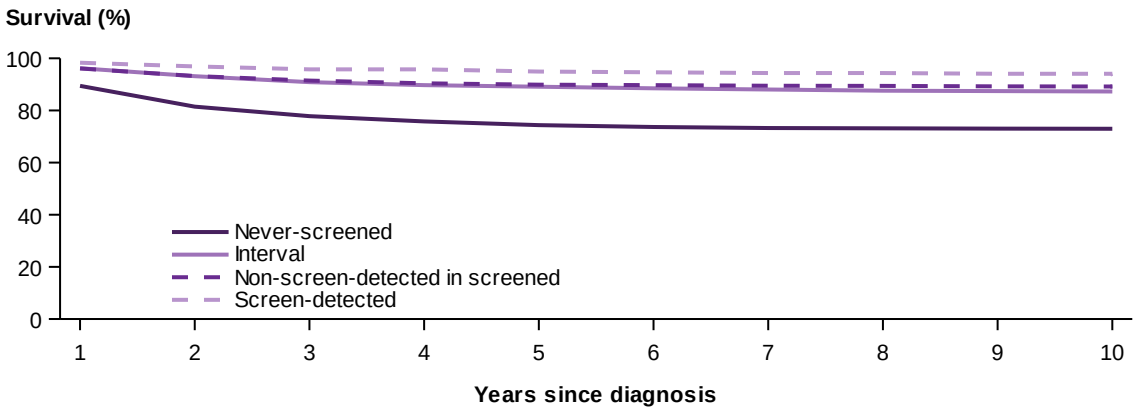
Note that, while tables and figures show 10 years of follow-up for all cervical cancers diagnosed in the period 2002–2012, not all of these were able to be followed for this length of time. In reality, only cervical cancers diagnosed in the period 2002–2005 had adequate time between diagnosis and 31 December 2015 to allow 10 years of follow-up.

Table 4.3.1: Cervical cancer deaths in women aged 20–69 diagnosed with cervical cancer, by screen detection status

		Deaths											
			Years since diagnosis										
Screen detection status		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Screen-detected	Number	354	6	5	4	0	3	1	1	0	1	0	21
	(%)		1.7	1.4	1.1	0.0	0.8	0.3	0.3	0.0	0.3	0.0	5.9
Non-screen-detected in screened	Number	1,720	67	50	30	18	9	3	4	1	3	1	186
	(%)		3.9	2.9	1.7	1.0	0.5	0.2	0.2	0.1	0.2	0.1	10.8
Interval	Number	1,312	50	40	30	15	8	8	6	6	2	2	168
	(%)		3.8	3.0	2.3	1.1	0.6	0.5	0.5	0.2	0.2	0.1	12.8
Non-screen-detected in never-screened	Number	3,511	373	280	128	71	50	25	14	4	4	0	959
	(%)		10.6	8.0	3.6	2.0	1.4	0.7	0.4	0.1	0.1	0.0	27.3

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.3.1: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 20–69, by screen detection status



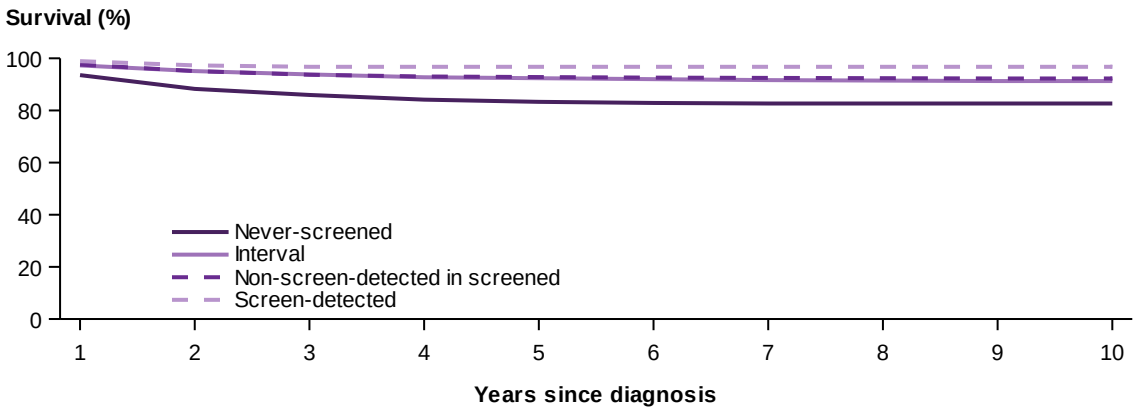
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.2: Cervical cancer deaths in women aged 20–39 diagnosed with cervical cancer, by screen detection status

		Deaths											
			Years since diagnosis										
Screen detection status		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Screen-detected	Number	184	2	3	1	0	0	0	0	0	0	0	6
	(%)		1.1	1.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Non-screen-detected in screened	Number	918	22	23	13	6	2	2	1	1	1	0	71
	(%)		2.4	2.5	1.4	0.7	0.2	0.2	0.1	0.1	0.1	0.0	7.7
Interval	Number	550	15	12	7	6	2	2	2	1	1	0	48
	(%)		2.7	2.2	1.3	1.1	0.4	0.4	0.4	0.2	0.2	0.0	8.7
Non-screen-detected in never-screened	Number	946	61	50	22	17	8	4	2	0	0	0	165
	(%)		6.4	5.3	2.3	1.8	0.8	0.4	0.2	0.0	0.0	0.0	17.4

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.3.2: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 20–39, by screen detection status



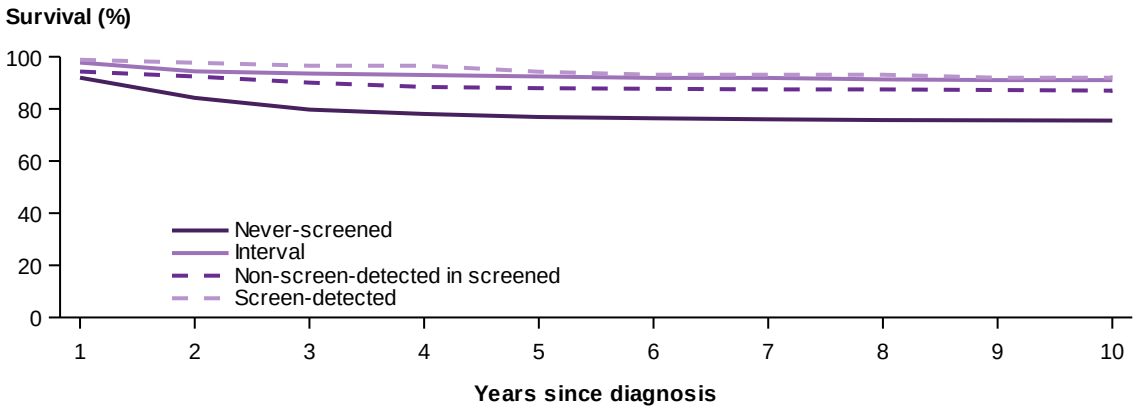
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.3: Cervical cancer deaths in women aged 40–49 diagnosed with cervical cancer, by screen detection status

		Deaths											
			Years since diagnosis										
Screen detection status		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Screen-detected	Number	87	1	1	1	0	2	1	0	0	1	0	7
	(%)		1.1	1.1	1.1	0.0	2.3	1.1	0.0	0.0	1.1	0.0	8.0
Non-screen-detected in screened	Number	423	25	8	10	7	2	1	1	0	1	0	55
	(%)		5.9	1.9	2.4	1.7	0.5	0.2	0.2	0.0	0.2	0.0	13.0
Interval	Number	357	8	12	3	2	2	2	0	2	1	0	32
	(%)		2.2	3.4	0.8	0.6	0.6	0.6	0.0	0.6	0.3	0.0	9.0
Non-screen-detected in never-screened	Number	1,021	83	79	46	17	12	5	4	3	1	0	253
	(%)		8.1	7.7	4.5	1.7	1.2	0.5	0.4	0.3	0.1	0.0	24.8

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.3.3: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 40–49, by screen detection status



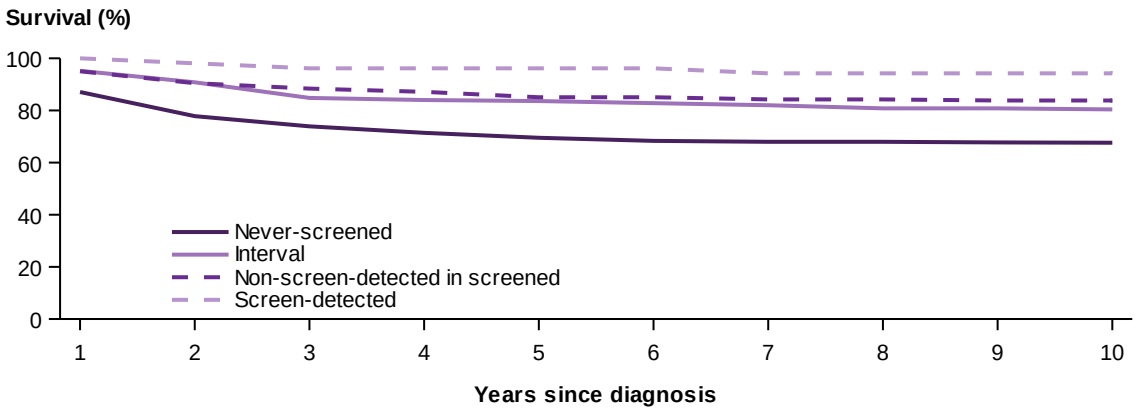
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.4: Cervical cancer deaths in women aged 50–59 diagnosed with cervical cancer, by screen detection status

		Deaths											
			Years since diagnosis										
Screen detection status		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Screen-detected	Number	52	0	1	1	0	0	0	1	0	0	0	3
	(%)		0.0	1.9	1.9	0.0	0.0	0.0	1.9	0.0	0.0	0.0	5.8
Non-screen-detected in screened	Number	241	12	11	5	3	5	0	2	0	1	0	39
	(%)		5.0	4.6	2.1	1.2	2.1	0.0	0.8	0.0	0.4	0.0	16.2
Interval	Number	250	13	11	15	2	1	2	2	3	0	0	50
	(%)		5.2	4.4	6.0	0.8	0.4	0.8	0.8	1.2	0.0	0.0	20.0
Non-screen-detected in never-screened	Number	843	110	78	33	21	16	10	3	0	2	0	276
	(%)		13.0	9.3	3.9	2.5	1.9	1.2	0.4	0.0	0.2	0.0	32.7

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.3.4: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 50–59, by screen detection status



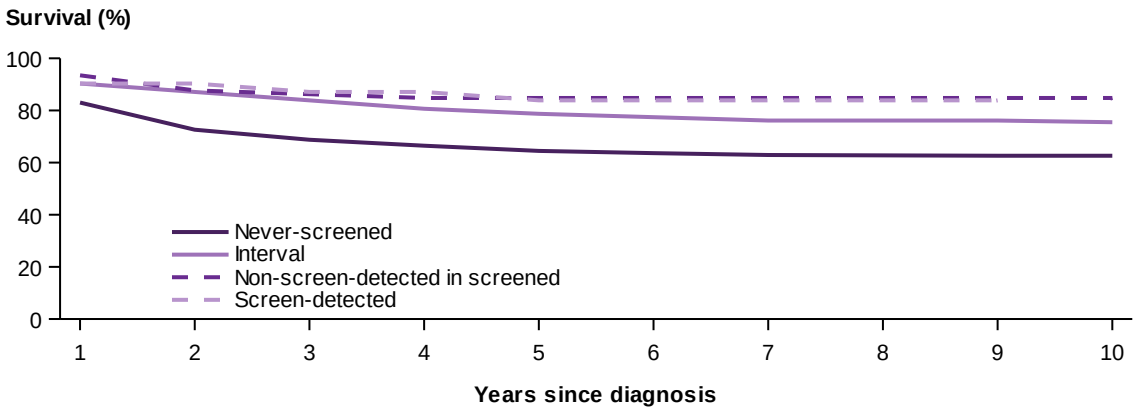
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.5: Cervical cancer deaths in women aged 60–69 diagnosed with cervical cancer, by screen detection status

		Deaths											
			Years since diagnosis										
Screen detection status		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Screen-detected	Number	31	3	0	1	0	1	0	0	0	0	0	5
	(%)		9.7	0.0	3.2	0.0	3.2	0.0	0.0	0.0	0.0	0.0	16.1
Non-screen-detected in screened	Number	138	9	8	2	2	0	0	0	0	0	0	21
	(%)		6.5	5.8	1.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	15.2
Interval	Number	155	16	5	5	5	3	2	2	0	0	0	38
	(%)		10.3	3.2	3.2	3.2	1.9	1.3	1.3	0.0	0.0	0.0	24.5
Non-screen-detected in never-screened	Number	701	119	73	27	16	14	6	5	1	1	0	265
	(%)		17.0	10.4	3.9	2.3	2.0	0.9	0.7	0.1	0.1	0.0	37.8

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.3.5: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 60–69, by screen detection status



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Univariate survival analyses

The Cox proportional hazards regression model was used to quantify the relationship between survival and a set of explanatory variables for women diagnosed with cervical cancer aged 20–69.

Univariate Cox proportional hazards models were fitted to each of the variables: screen detection status, age group at diagnosis, period of diagnosis, remoteness area, socioeconomic area, and histological type—the only additional information available for cervical cancer, as stage data were not available.

The crude hazard ratios are presented in Table 4.3.6a.

The crude hazard ratios showed that, compared with never-screened women, the risk of death from cervical cancer for women in all screening categories was significantly lower; this effect was strongest for those with screen-detected cancers, with a hazard ratio of 0.19 (0.12–0.29).

Statistically significant differences in unadjusted cervical cancer mortality hazard ratios were also found across age group at diagnosis and socioeconomic area—the risk of death from cervical cancer increased with increasing age, and increased with increasing disadvantage.

There were also differences across histological types of cervical cancer—compared to squamous cell carcinoma, the risk of cervical cancer death was lower for adenocarcinoma, and higher for adenosquamous carcinoma, and other or unspecified cervical carcinomas.

Histological types of cervical cancers within each screen detection status for each of the broad age groups used are shown in Table 4.3.6b.

It was unexpected that adenocarcinomas had lower mortality than squamous cell carcinoma. In consideration of a possible effect of an established cervical screening program on these outcomes, the crude mortality rate of never-screened women diagnosed with cancer was examined in Table 4.3.6c, and the univariate analysis repeated only on never-screened women diagnosed with cervical cancer in Table 4.3.6d. When only women who had never screened were included, the risk of death from adenocarcinoma was no longer statistically significantly lower than squamous cell carcinoma.

Table 4.3.6a: Crude cervical cancer mortality hazard ratios for women diagnosed with cervical cancer for screen detection status and other variables

Variable	HR	95% CI	*P* value
Screen detection status			
Never-screened	1.0	. .	. .
Screening women			
Interval	0.42	0.36–0.50	<0.001
Non-screen-detected in screened	0.36	0.31–0.42	<0.001
Screen-detected	0.19	0.12–0.29	<0.001
Age group at diagnosis			
20–39	1.0	. .	. .
40–49	1.72	1.47–2.01	<0.001
50–59	2.70	2.32–3.15	<0.001
60–69	3.59	3.06–4.20	<0.001
Period of diagnosis			
2002–2007	1.00	. .	. .
2008–2012	1.02	0.91–1.13	0.072
Remoteness area			
Major cities	1.0	. .	. .
Inner regional	1.00	0.87–1.16	0.958
Outer regional	1.44	1.23–1.68	<0.001
Remote and very remote areas	1.39	1.09–1.77	0.008
Socioeconomic area			
1 (most disadvantage)	1.0	. .	. .
2	0.94	0.81–1.09	0.377
3	0.73	0.62–0.86	<0.001
4	0.69	0.58–0.81	<0.001
5 (least disadvantage)	0.57	0.47–0.68	<0.001
Histological type			
Squamous carcinoma	1.0	. .	. .
Adenocarcinoma	0.64	0.55–0.74	<0.0001
Adenosquamous carcinoma	1.42	1.11–1.80	0.0046
Other and unspecified carcinoma	1.94	1.58–2.37	<0.001
Other invasive cancer	0.84	0.54–1.30	0.4245

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.6b: Histological type of cervical cancers, by screen detection status

Histological type	Screen-detected		Interval cancer		Non-screen-detected in screened		Non-screen-detected in never-screened		Total	
Age	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**	**Count**	**%**
20–39										
Squamous cell carcinoma	144	78.3	295	53.6	614	66.9	688	72.7	1,741	67.0
Adenocarcinoma	24	13.0	189	34.4	230	25.1	167	17.7	610	23.5
Adenosquamous	7	3.8	18	3.3	35	3.8	41	4.3	101	3.9
Other or unspecified carcinomas	9	4.9	35	6.4	29	3.2	41	4.3	114	4.4
Other or unspecified cancers	0	0.0	13	2.4	10	1.1	9	1.0	32	1.2
40–49										
Squamous cell carcinoma	61	70.1	151	42.3	245	57.9	762	74.6	1,219	64.6
Adenocarcinoma	22	25.3	155	43.4	128	30.3	174	17.0	479	25.4
Adenosquamous	3	3.4	12	3.4	13	3.1	35	3.4	63	3.3
Other or unspecified carcinomas	0	0.0	18	5.0	22	5.2	41	4.0	81	4.3
Other or unspecified cancers	1	1.1	21	5.9	15	3.5	9	0.9	46	2.4
50–59										
Squamous cell carcinoma	36	69.2	94	37.6	141	58.5	643	76.3	914	65.9
Adenocarcinoma	9	17.3	116	46.4	63	26.1	117	13.9	305	22.0
Adenosquamous	3	5.8	8	3.2	14	5.8	31	3.7	56	4.0
Other or unspecified carcinomas	3	5.8	18	7.2	11	4.6	34	4.0	66	4.8
Other or unspecified cancers	1	1.9	14	5.6	12	5.0	18	2.1	45	3.2
60–69										
Squamous cell carcinoma	27	87.1	60	38.7	75	54.3	514	73.3	676	66.0
Adenocarcinoma	4	12.9	69	44.5	42	30.4	103	14.7	218	21.3
Adenosquamous	0	0.0	10	6.5	5	3.6	25	3.6	40	3.9
Other or unspecified carcinomas	0	0.0	10	6.5	11	8.0	39	5.6	60	5.9
Other or unspecified cancers	0	0.0	6	3.9	5	3.6	20	2.9	31	3.0
20–69										
Squamous cell carcinoma	268	75.7	600	45.7	1,075	62.5	2,607	74.3	4,550	66.0
Adenocarcinoma	59	16.7	529	40.3	463	26.9	561	16.0	1,612	23.4
Adenosquamous	13	3.7	48	3.7	67	3.9	132	3.8	260	3.8
Other or unspecified carcinomas	12	3.4	81	6.2	73	4.2	155	4.4	321	4.7
Other or unspecified cancers	2	0.6	54	4.1	42	2.4	56	1.6	154	2.2

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.6c: Crude mortality by histological type for cervical cancers diagnosed in never-screened women

Histological type	Number diagnosed with cervical cancer	Number died from cervical cancer	Per cent died from cervical cancer
Squamous cell carcinoma	2,607	701	26.9
Adenocarcinoma	561	128	22.8
Adenosquamous carcinoma	132	49	37.1
Other and unspecified carcinoma	155	64	41.3
Other invasive cancer	56	17	30.4
Total	**3,511**	**959**	**27.3**

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.3.6d: Crude cervical cancer mortality hazard ratios for cervical cancers diagnosed in never-screened women

Histological type	HR	95% CI	*P* value
Squamous cell carcinoma	1.0	. .	. .
Adenocarcinoma	0.84	0.69–1.01	0.0612
Adenosquamous carcinoma	1.47	1.10–1.96	0.0096
Other and unspecified carcinoma	2.15	1.67–2.78	<0.0001
Other invasive cancer	1.58	0.98–2.56	0.0612

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Multivariate survival analyses

A multivariate Cox proportional hazards model was generated to calculate risk of death from cervical cancer by screen detected status after taking into account possible confounders. The following results show the resulting hazard ratios using 'Non-screen-detected cervical cancers in never-screened women' as the reference group.

Women aged 20–69

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer for women aged 20–69 was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.23 (0.15–0.35) (Table 4.3.7).

This finding was unchanged when cervical cancers were restricted to squamous cell carcinomas, with a hazard ratio of 0.24 (0.15–0.40) (Table 4.3.7).

Table 4.3.7: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 20–69 diagnosed with cervical cancer, by screen detection status

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.42	0.36–0.50	<0.0001
Non-screen-detected in screened	0.36	0.31–0.42	<0.0001
Screen-detected	0.19	0.12–0.29	<0.0001
Cervical cancer mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.49	0.42–0.59	<0.0001
Non-screen-detected in screened	0.44	0.38–0.52	<0.0001
Screen-detected	0.23	0.15–0.35	<0.0001
Cervical cancer mortality for squamous cell carcinoma only, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.56	0.45–0.71	<0.0001
Non-screen-detected in screened	0.51	0.42–0.62	<0.0001
Screen-detected	0.24	0.15–0.40	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with screen-detected cervical cancer compared with women diagnosed with cervical cancer who had never screened, with a hazard ratio of 0.27 (0.19–0.39) (Table 4.3.8).

Table 4.3.8: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 20–69 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
All-cause mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.45	0.39–0.52	<0.0001
Non-screen-detected in screened	0.38	0.33–0.43	<0.0001
Screen-detected	0.22	0.15–0.31	<0.0001
All-cause mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.52	0.45–0.60	<0.0001
Non-screen-detected in screened	0.48	0.41–0.55	<0.0001
Screen-detected	0.27	0.19–0.39	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 20–39

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer for women aged 20–39 was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.16 (0.07–0.37) (Table 4.3.9).

The current National Cervical Screening Program has a starting age of 25 because cervical cancer in women under 25 years of age is rare, and routine screening has not changed the rates of incidence or death from cervical cancer in this age group in Australia since the National Cervical Screening Program commenced in 1991 (DoH 2019). Therefore this analysis was repeated for women aged 25–39. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer for women aged 25–39 was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.17 (0.08–0.39) (Table 4.3.9).

This is unchanged from the finding for women aged 20–39, and indicates that the inclusion of women aged 20–24 in these analyses has no impact on the outcome, in line with the occurrence of cervical cancers in this age group being unaffected by cervical screening.

Table 4.3.9: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 20–39 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.48	0.35–0.66	<0.0001
Non-screen-detected in screened	0.43	0.32–0.56	<0.0001
Screen-detected	0.17	0.08–0.39	<0.0001
Cervical cancer mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.49	0.36–0.68	<0.0001
Non-screen-detected in screened	0.43	0.33–0.57	<0.0001
Screen-detected	0.16	0.07–0.37	<0.0001
Cervical cancer mortality for women aged 25–39, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.49	0.35–0.69	<0.0001
Non-screen-detected in screened	0.44	0.33–0.59	<0.0001
Screen-detected	0.17	0.08–0.39	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with screen-detected cervical cancer compared with women diagnosed with cervical cancer who had never screened, with a hazard ratio of 0.17 (0.08–0.36) (Table 4.3.10).

Table 4.3.10: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 20–39 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
All-cause mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.48	0.36–0.65	<0.0001
Non-screen-detected in screened	0.45	0.35–0.58	<0.0001
Screen-detected	0.18	0.08–0.38	<0.0001
All-cause mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.49	0.36–0.67	<0.0001
Non-screen-detected in screened	0.45	0.35–0.59	<0.0001
Screen-detected	0.17	0.08–0.36	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 40–49

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.31 (0.15–0.66) (Table 4.3.11).

Table 4.3.11: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 40–49 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.33	0.23–0.47	<0.0001
Non-screen-detected in screened	0.51	0.38–0.68	<0.0001
Screen-detected	0.29	0.14–0.61	0.0011
Cervical cancer mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.37	0.25–0.54	<0.0001
Non-screen-detected in screened	0.52	0.38–0.69	<0.0001
Screen-detected	0.31	0.15–0.66	0.0023

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with screen-detected cervical cancer compared with women diagnosed with cervical cancer who had never screened, with a hazard ratio of 0.29 (0.15–0.59) (Table 4.3.12).

Table 4.3.12: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 40–49 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
All-cause mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.33	0.24–0.46	<0.0001
Non-screen-detected in screened	0.55	0.42–0.71	<0.0001
Screen-detected	0.27	0.14–0.55	0.0003
All-cause mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.36	0.26–0.51	<0.0001
Non-screen-detected in screened	0.54	0.42–0.71	<0.0001
Screen-detected	0.29	0.15–0.59	0.0023

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 50–59

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.14 (0.05–0.45) (Table 4.3.13).

Table 4.3.13: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 50–59 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.54	0.40–0.73	<0.0001
Non-screen-detected in screened	0.45	0.32–0.63	<0.0001
Screen-detected	0.15	0.05–0.47	0.0011
Cervical cancer mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.58	0.43–0.80	0.0010
Non-screen-detected in screened	0.44	0.31–0.62	<0.0001
Screen-detected	0.14	0.05–0.45	0.0009

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with screen-detected cervical cancer compared with women diagnosed with cervical cancer who had never screened, with a hazard ratio of 0.22 (0.10–0.50) (Table 4.3.14).

Table 4.3.14: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 50–59 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
All-cause mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.59	0.45–0.76	<0.0001
Non-screen-detected in screened	0.51	0.39–0.68	<0.0001
Screen-detected	0.23	0.10–0.52	0.0004
All-cause mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.58	0.44–0.76	<0.0001
Non-screen-detected in screened	0.49	0.37–0.65	<0.0001
Screen-detected	0.22	0.10–0.50	0.0003

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 60–69

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in screen-detected cervical cancers compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.37 (0.15–0.89). Of note, and unlike younger age groups, there was almost no difference between screen-detected cervical cancers and non-screen-detected cervical cancers in screened women, the latter having a hazard ratio of 0.32 (0.20–0.50) (Table 4.3.15).

Fewer cervical cancers were diagnosed in women aged 60–69 than in other age groups, and only 31 of these were screen-detected, so this analysis was repeated for women aged 50–69 instead of 50–59 and 60–69 separately. The trend noted above was no longer apparent, with a hazard ratio of 0.23 (0.11–0.46) for screen-detected cervical cancers for women aged 50–69 (Table 4.3.15).

Table 4.3.15: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 60–69 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.57	0.41–0.80	0.0013
Non-screen-detected in screened	0.34	0.22–0.53	<0.0001
Screen-detected	0.36	0.15–0.86	0.0221
Cervical cancer mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.57	0.40–0.81	0.0019
Non-screen-detected in screened	0.32	0.20–0.50	<0.0001
Screen-detected	0.37	0.15–0.89	0.0260
Cervical cancer mortality for women aged 50–69, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.55	0.43–0.70	<0.0001
Non-screen-detected in screened	0.38	0.29–0.50	<0.0001
Screen-detected	0.23	0.11–0.46	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with screen-detected cervical cancer compared with women diagnosed with cervical cancer who had never screened, with a hazard ratio of 0.49 (0.26–0.91) (Table 4.3.16).

Table 4.3.16: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 60–69 diagnosed with cervical cancer by screen detection status

	HR	95% CI	P value
All-cause mortality, unadjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.71	0.55–0.92	0.0095
Non-screen-detected in screened	0.41	0.30–0.58	<0.0001
Screen-detected	0.48	0.25–0.89	0.0202
All-cause mortality, adjusted			
Non-screen-detected in never-screened	1.0	. .	. .
Screening women			
Interval	0.64	0.48–0.84	0.0013
Non-screen-detected in screened	0.38	0.27–0.53	<0.0001
Screen-detected	0.49	0.26–0.91	0.0249

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

4.4 Survival of women diagnosed with cervical cancer according to screening history

While results of survival from cervical cancer according to screen detection status have been previously reported (AIHW 2018a), those according to screening history have not. These are included here, along with breakdowns by women aged 20–39, 40–49, 50–59 and 60–69, to provide comprehensive results that can be considered alongside those by screen detection status.

In tables 4.4.1–4.4.5, the number and proportion of women diagnosed with cervical cancer who died from cervical cancer in each year of follow-up, as well as the total by 31 December 2015 (the end of follow-up) by screen-detection status are shown.

The related survival curves are shown in figures 4.4.1–4.4.5.

From these tables and figures it can be seen that, while cervical cancers in recently screened women and those who were lapsed by 2.5–3.5 years and 3.5–5.5 years always had a lower risk of cervical cancer death than never-screened cervical cancers, there were differences across the age groups.

This was reflected in the general log rank test statistics showing there was a strong effect of screen detection status on cervical cancer mortality. For ages 20–39, 40–49, 50–59 and 60–69 the general log rank test statistics were: $\chi^2(4) = 60.00$ ($p<0.0001$), $\chi^2(4) = 65.80$ ($p<0.0001$), $\chi^2(4) = 44.93$ ($p<0.0001$) and $\chi^2(4) = 40.30$ ($p<0.0001$), respectively.

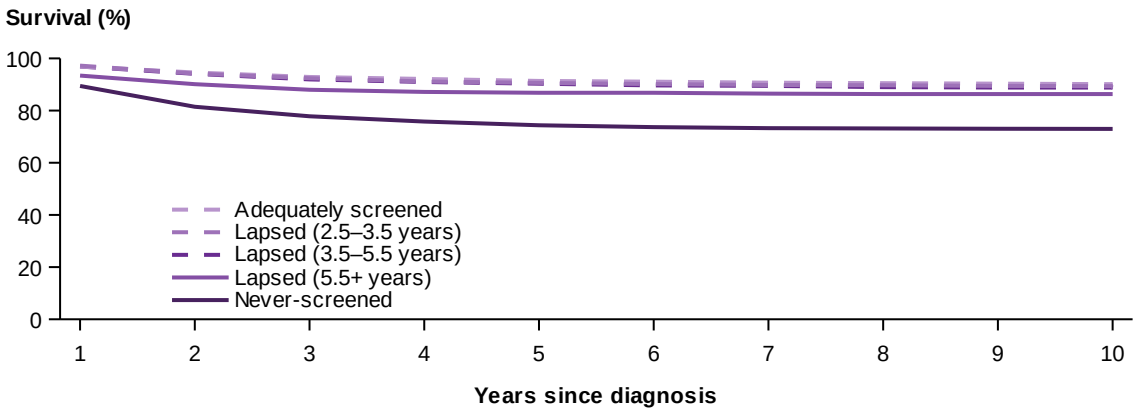
Note that, while tables and figures show 10 years of follow-up for all cervical cancers diagnosed in the period 2002–2012, not all of these were able to be followed for this length of time. In reality, only cervical cancers diagnosed in the period 2002–2005 had adequate time between diagnosis and 31 December 2015 to allow 10 years of follow-up.

Table 4.4.1: Cervical cancer deaths in women aged 20–69 diagnosed with cervical cancer, by screening history

		Deaths											
			Years since diagnosis										
Screening history		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Recently screened	Number	1,963	63	49	35	18	12	10	7	7	4	1	206
	(%)		3.2	2.5	1.8	0.9	0.6	0.5	0.4	0.4	0.2	0.1	10.5
Lapsed (2.5–3.5 years)	Number	523	16	13	11	5	4	1	1	0	0	0	51
	(%)		3.1	2.5	2.1	1.0	0.8	0.2	0.2	0.0	0.0	0.0	9.8
Lapsed (3.5–5.5 years)	Number	445	13	18	8	5	3	1	1	0	2	0	51
	(%)		2.9	4.0	1.8	1.1	0.7	0.2	0.2	0.0	0.4	0.0	11.5
Lapsed (5.5+ years)	Number	455	34	15	10	5	1	0	2	0	0	0	67
	(%)		7.5	3.4	2.2	1.1	0.2	0.0	0.4	0.0	0.0	0.0	15.1
Never-screened	Number	3,511	373	280	128	71	50	25	14	4	4	0	959
	(%)		10.6	8.0	3.6	2.0	1.4	0.7	0.4	0.1	0.1	0.0	27.3

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.4.1: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 20–69, by screening history



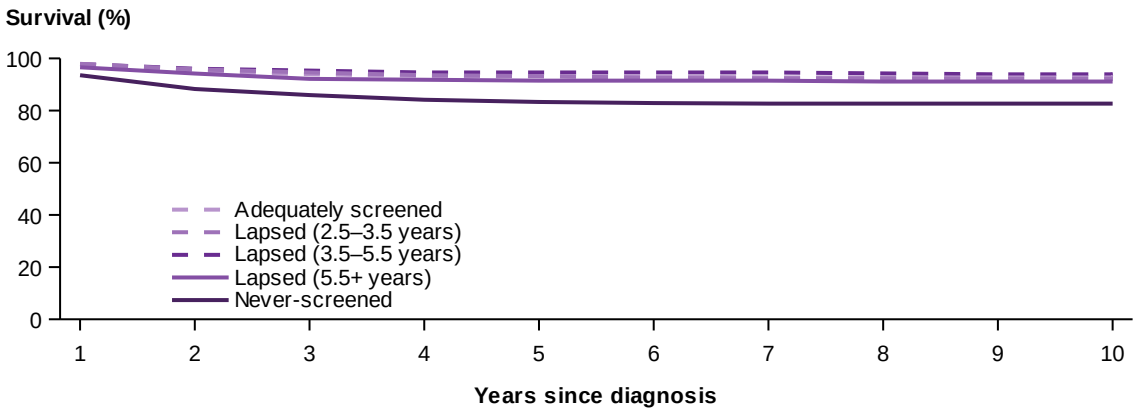
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.4.2: Cervical cancer deaths in women aged 20–39 diagnosed with cervical cancer by screening history

		Deaths											
			Years since diagnosis										
Screening history		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Recently screened	Number	904	19	18	8	7	2	3	2	2	2	0	63
	(%)		2.1	2.0	0.9	0.8	0.2	0.3	0.2	0.2	0.2	0.0	7.0
Lapsed (2.5–3.5 years)	Number	279	5	9	4	2	1	0	0	0	0	0	21
	(%)		1.8	3.2	1.4	0.7	0.4	0.0	0.0	0.0	0.0	0.0	7.5
Lapsed (3.5–5.5 years)	Number	258	7	6	6	2	0	1	1	0	0	0	23
	(%)		2.7	2.3	2.3	0.8	0.0	0.4	0.4	0.0	0.0	0.0	8.9
Lapsed (5.5+ years)	Number	211	8	5	3	1	1	0	0	0	0	0	18
	(%)		3.8	2.4	1.4	0.5	0.5	0.0	0.0	0.0	0.0	0.0	8.5
Never-screened	Number	946	61	50	22	17	8	4	2	0	0	0	165
	(%)		6.4	5.3	2.3	1.8	0.8	0.4	0.2	0.0	0.0	0.0	17.4

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.4.2: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 20–39 by screening history



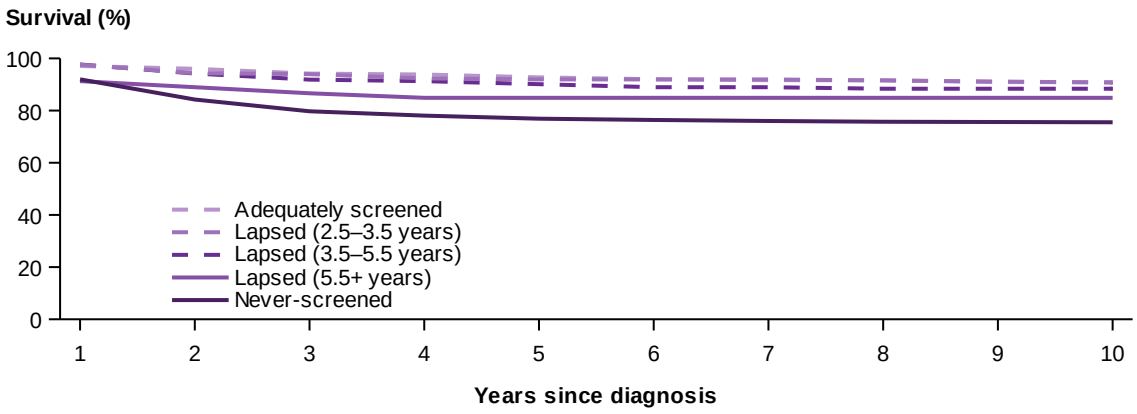
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.4.3: Cervical cancer deaths in women aged 40–49 diagnosed with cervical cancer by screening history

		Deaths											
			Years since diagnosis										
Screening history		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Recently screened	Number	512	11	13	5	3	4	3	0	2	2	0	43
	(%)		2.1	2.5	1.0	0.6	0.8	0.6	0.0	0.4	0.4	0.0	8.4
Lapsed (2.5–3.5 years)	Number	130	6	2	5	1	2	1	1	0	0	0	18
	(%)		4.6	1.5	3.8	0.8	1.5	0.8	0.8	0.0	0.0	0.0	13.8
Lapsed (3.5–5.5 years)	Number	92	4	4	0	2	0	0	0	0	1	0	11
	(%)		4.3	4.3	0.0	2.2	0.0	0.0	0.0	0.0	1.1	0.0	12.0
Lapsed (5.5+ years)	Number	133	13	2	4	3	0	0	0	0	0	0	22
	(%)		9.8	1.5	3.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	16.5
Never-screened	Number	1,021	83	79	46	17	12	5	4	3	1	0	253
	(%)		8.1	7.7	4.5	1.7	1.2	0.5	0.4	0.3	0.1	0.0	24.8

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.4.3: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 40–49 by screening history



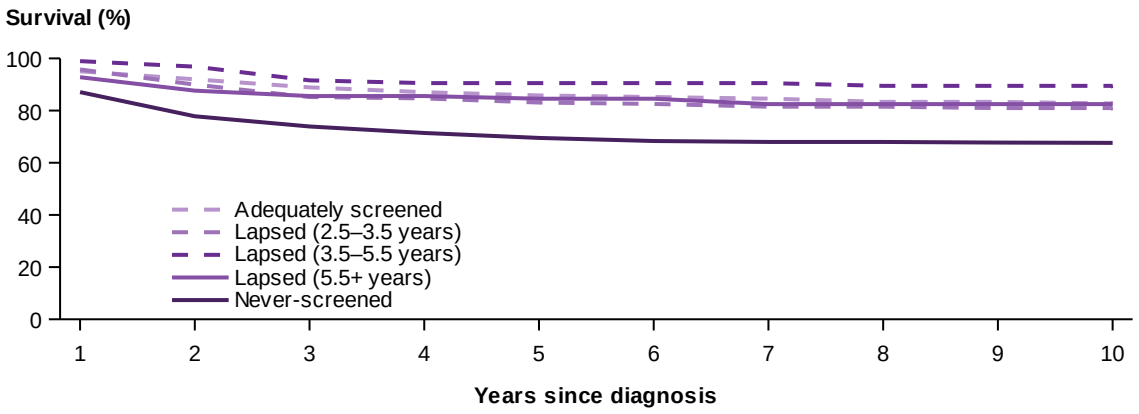
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.4.4: Cervical cancer deaths in women aged 50–59 diagnosed with cervical cancer by screening history

		Deaths											
			Years since diagnosis										
Screening history		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Recently screened	Number	339	14	12	16	3	2	2	3	3	0	0	56
	(%)		4.1	3.5	4.7	0.9	0.6	0.6	0.9	0.9	0.0	0.0	16.5
Lapsed (2.5–3.5 years)	Number	66	3	1	2	1	1	0	0	0	0	0	8
	(%)		4.5	1.5	3.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0	12.1
Lapsed (3.5–5.5 years)	Number	59	1	5	1	1	3	0	0	0	1	0	12
	(%)		1.7	8.5	1.7	1.7	5.1	0.0	0.0	0.0	1.7	0.0	20.3
Lapsed (5.5+ years)	Number	79	7	5	2	0	0	0	2	0	0	0	16
	(%)		8.9	6.3	2.5	0.0	0.0	0.0	2.5	0.0	0.0	0.0	20.3
Never-screened	Number	843	110	78	33	21	16	10	3	0	2	0	276
	(%)		13.0	9.3	3.9	2.5	1.9	1.2	0.4	0.0	0.2	0.0	32.7

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.4.4: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 50–59 by screening history



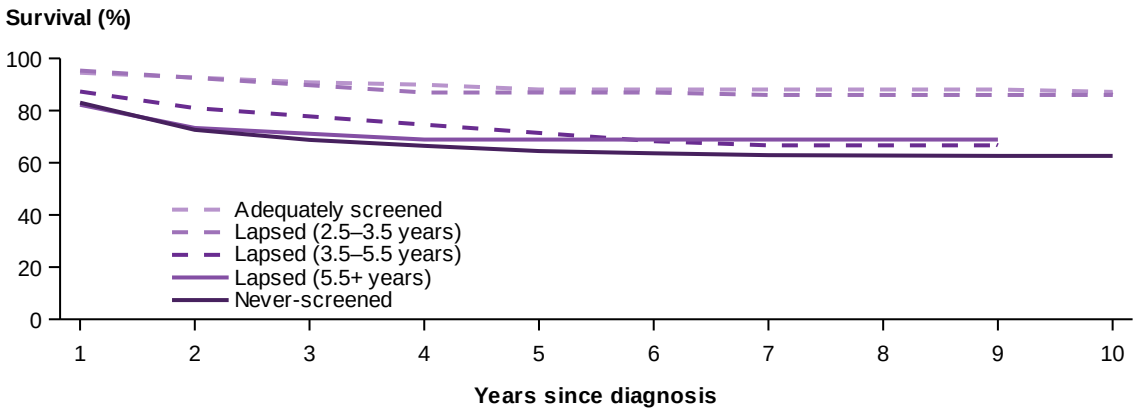
Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.4.5: Cervical cancer deaths in women aged 60–69 diagnosed with cervical cancer by screening history

		Deaths											
			Years since diagnosis										
Screening history		2002–2012 diagnoses	1	2	3	4	5	6	7	8	9	10	At 31/12/2015
Recently screened	Number	208	19	6	6	5	4	2	2	0	0	0	44
	(%)		9.1	2.9	2.9	2.4	1.9	1.0	1.0	0.0	0.0	0.0	21.2
Lapsed (2.5–3.5 years)	Number	48	2	1	0	1	0	0	0	0	0	0	4
	(%)		4.2	2.1	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	8.3
Lapsed (3.5–5.5 years)	Number	36	1	3	1	0	0	0	0	0	0	0	5
	(%)		2.8	8.3	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.9
Lapsed (5.5+ years)	Number	32	6	3	1	1	0	0	0	0	0	0	11
	(%)		18.8	9.4	3.1	3.1	0.0	0.0	0.0	0.0	0.0	0.0	34.4
Never-screened	Number	701	119	73	27	16	14	6	5	1	1	0	265
	(%)		17.0	10.4	3.9	2.3	2.0	0.9	0.7	0.1	0.1	0.0	37.8

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Figure 4.4.5: Crude survival for cervical cancer mortality following a diagnosis of cervical cancer in women aged 60–69 by screening history



Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Univariate survival analyses

The Cox proportional hazards regression model was used to quantify the relationship between survival and a set of explanatory variables for women diagnosed with cervical cancer aged 20–69.

Univariate Cox proportional hazards models were fitted to each of the variables: screen detection status, age group at diagnosis, period of diagnosis, remoteness area, socioeconomic area, and histological type. The crude hazard ratios are presented in Table 4.4.6a.

The crude hazard ratios showed that, compared with never-screened women, the risk of death from cervical cancer for women in all screening history categories was significantly lower. Risk was similar across the screening history categories of recently screened, lapsed (2.5–3.5 years), and lapsed (3.5–5.5 years), and was a little higher for lapsed (5.5+ years).

Statistically significant differences in unadjusted cervical cancer mortality hazard ratios were also found across age group at diagnosis and socioeconomic area—the risk of death from cervical cancer increased with increasing age, and increased with increasing disadvantage.

There were also differences across histological types of cervical cancer—compared to squamous cell carcinoma, the risk of cervical cancer death was lower for adenocarcinoma, and higher for adenosquamous carcinoma, and other or unspecified cervical carcinomas.

Histological types of cervical cancers within each screen history category for each of the broad age groups used are shown in Table 4.4.6b.

The analysis results shown in Table 4.3.6c and Table 4.3.6d apply equally here, as the never-screened group is the same for both screen-detection status and screening history. As shown in these tables, when only women who had never screened were included, the risk of death from adenocarcinoma was no longer statistically significantly lower than that for squamous cell carcinoma.

Table 4.4.6a: Crude cervical cancer mortality hazard ratios for women diagnosed with cervical cancer for screening history and other variables

Variable	HR	95% CI	*P* value
Screening history			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.53	0.41–0.67	<0.0001
Lapsed (3.5–5.5 years)	0.38	0.29–0.51	<0.0001
Lapsed (2.5–3.5 years)	0.32	0.24–0.42	<0.0001
Recently screened	0.34	0.29–0.40	<0.0001
Age group at diagnosis			
20–39	1.0	. .	. .
40–49	1.72	1.47–2.01	<0.0001
50–59	2.70	2.32–3.15	<0.0001
60–69	3.59	3.06–4.20	<0.0001
Period of diagnosis			
2002–2007	1.00	. .	. .
2008–2012	1.02	0.91–1.13	0.7891
Remoteness area			
Major cities	1.0	. .	. .
Inner regional	1.00	0.87–1.16	0.9584
Outer regional	1.44	1.23–1.68	<0.0001
Remote and Very remote areas	1.39	1.09–1.77	0.0076
Socioeconomic area			
1 (most disadvantage)	1.0	. .	. .
2	0.94	0.81–1.09	0.3774
3	0.73	0.62–0.86	0.0001
4	0.69	0.58–0.81	<0.0001
5 (least disadvantage)	0.57	0.47–0.68	<0.0001
Histological type			
Squamous cell carcinoma	1.0	. .	. .
Adenocarcinoma	0.64	0.55–0.74	<0.0001
Adenosquamous carcinoma	1.42	1.11–1.80	0.0046
Other and unspecified carcinoma	1.94	1.58–2.37	<0.0001
Other and unspecified cancer	0.76	0.50–1.18	0.2235

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table 4.4.6b: Histological type of cervical cancers, by screening history

Histological type	Recently screened		Lapsed (2.5–3.5 years)		Lapsed (3.5–5.5 years)		Lapsed (5.5+ years)		Never-screened		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
20–39												
Squamous cell	563	62.3	170	60.9	167	64.7	153	72.5	688	72.7	1,741	67.0
Adenocarcinoma	250	27.7	81	29.0	67	26.0	45	21.3	167	17.7	610	23.5
Adenosquamous	28	3.1	11	3.9	14	5.4	7	3.3	41	4.3	101	3.9
Other/unspecified carcinomas	48	5.3	14	5.0	7	2.7	4	1.9	41	4.3	114	4.4
Other/unspecified cancers	15	1.7	3	1.1	3	1.2	2	0.9	9	1.0	32	1.2
40–49												
Squamous cell	248	48.4	67	51.5	57	62.0	85	63.9	762	74.6	1,219	64.6
Adenocarcinoma	200	39.1	46	35.4	25	27.2	34	25.6	174	17.0	479	25.4
Adenosquamous	17	3.3	5	3.8	1	1.1	5	3.8	35	3.4	63	3.3
Other/unspecified carcinomas	21	4.1	7	5.4	6	6.5	6	4.5	41	4.0	81	4.3
Other/unspecified cancers	26	5.1	5	3.8	3	3.3	3	2.3	9	0.9	46	2.4
50–59												
Squamous cell	152	44.8	30	45.5	36	61.0	53	67.1	643	76.3	914	65.9
Adenocarcinoma	136	40.1	22	33.3	13	22.0	17	21.5	117	13.9	305	22.0
Adenosquamous	12	3.5	5	7.6	3	5.1	5	6.3	31	3.7	56	4.0
Other/unspecified carcinomas	23	6.8	3	4.5	3	5.1	3	3.8	34	4.0	66	4.8
Other/unspecified cancers	16	4.7	6	9.1	4	6.8	1	1.3	18	2.1	45	3.2
60–69												
Squamous cell	98	47.1	30	62.5	16	44.4	18	56.3	514	73.3	676	66.0
Adenocarcinoma	79	38.0	11	22.9	14	38.9	11	34.4	103	14.7	218	21.3
Adenosquamous	10	4.8	2	4.2	2	5.6	1	3.1	25	3.6	40	3.9
Other/unspecified carcinomas	13	6.3	4	8.3	2	5.6	2	6.3	39	5.6	60	5.9
Other/unspecified cancers	8	3.8	1	2.1	2	5.6	0	0.0	20	2.9	31	3.0
20–69												
Squamous cell	1,061	54.0	297	56.8	276	62.0	309	67.9	2,607	74.3	4,550	66.0
Adenocarcinoma	665	33.9	160	30.6	119	26.7	107	23.5	561	16.0	1,612	23.4
Adenosquamous	67	3.4	23	4.4	20	4.5	18	4.0	132	3.8	260	3.8
Other/unspecified carcinomas	105	5.3	28	5.4	18	4.0	15	3.3	155	4.4	321	4.7
Other/unspecified cancers	65	3.3	15	2.9	12	2.7	6	1.3	56	1.6	154	2.2

Note: 'Squamous cell' = squamous cell carcinoma.

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Multivariate survival analyses

A multivariate Cox proportional hazards model was generated to calculate risk of death from cervical cancer by screening history after taking into account possible confounders. The following results show the resulting hazard ratios using 'Never-screened women' as the reference group.

Women aged 20–69

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.40 (0.34–0.47), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.39 (0.29–0.52) (Table 4.4.7).

This finding was unchanged for women screened within 3.5 years when cervical cancers were restricted to squamous cell carcinomas, with hazard ratios of 0.42 (0.34–0.52) and 0.39 (0.26–0.57), but lapsed screeners greater than 3.5 years were affected (Table 4.4.7).

Excluding interval cancers from this analysis results in a large change to the risk of death from cervical cancer for recently screened women compared with never-screened women (no other results are affected, since interval cancers are all considered recently screened). Without interval cancers, and after adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who were recently screened compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.22 (0.16–0.31) (Table 4.4.7).

Considering the screening history of cervical cancers diagnosed in women aged 20–69, of the cervical cancers diagnosed, 51% occurred in women who had never screened, and 72% occurred in women who had either never screened or were lapsed screeners.

When cervical cancers were restricted to squamous cell carcinomas, 57% occurred in women who had never screened and 77% in never screened or lapsed screeners.

Table 4.4.7: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 20–69 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.53	0.41–0.67	<0.0001
Lapsed (3.5–5.5 years)	0.38	0.29–0.51	<0.0001
Lapsed (2.5–3.5 years)	0.32	0.24–0.42	<0.0001
Recently screened	0.34	0.29–0.40	<0.0001
Cervical cancer mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.63	0.49–0.81	0.0003
Lapsed (3.5–5.5 years)	0.48	0.36–0.63	<0.0001
Lapsed (2.5–3.5 years)	0.39	0.29–0.52	<0.0001
Recently screened	0.40	0.34–0.47	<0.0001
Cervical cancer mortality for squamous cell carcinoma only, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.82	0.62–1.09	0.1713
Lapsed (3.5–5.5 years)	0.54	0.38–0.77	0.0005
Lapsed (2.5–3.5 years)	0.39	0.26–0.57	<0.0001
Recently screened	0.42	0.34–0.52	<0.0001
Cervical cancer mortality, excluding interval cancers, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.62	0.49–0.80	<0.0001
Lapsed (3.5–5.5 years)	0.47	0.36–0.63	<0.0001
Lapsed (2.5–3.5 years)	0.38	0.29–0.51	<0.0001
Recently screened	0.22	0.16–0.31	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.44 (0.39–0.51), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.42 (0.33–0.54) (Table 4.4.8).

Table 4.4.8: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 20–69 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
All-cause mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.52	0.42–0.65	<0.0001
Lapsed (3.5–5.5 years)	0.39	0.30–0.50	<0.0001
Lapsed (2.5–3.5 years)	0.34	0.27–0.44	<0.0001
Recently screened	0.38	0.33–0.43	<0.0001
All-cause mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.66	0.53–0.82	0.0002
Lapsed (3.5–5.5 years)	0.50	0.39–0.64	<0.0001
Lapsed (2.5–3.5 years)	0.42	0.33–0.54	<0.0001
Recently screened	0.44	0.39–0.51	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 20–39

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.38 (0.28–0.51), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.41 (0.26–0.64) (Table 4.4.9).

In this age group, the risk of death was also lower for women who had a Pap test within the 3.5–5.5 years before diagnosis, with a hazard ratio of 0.53 (0.34–0.82), and for those who had a Pap test more than 5.5 years before diagnosis, with a hazard ratio of 0.49 (0.30–0.79) (Table 4.4.9).

The current National Cervical Screening Program has a starting age of 25 because cervical cancer in women under 25 years of age is rare, and routine screening has not changed the rates of incidence or death from cervical cancer in this age group in Australia since the National Cervical Screening Program commenced in 1991 (DoH 2019). Therefore this analysis was repeated for women aged 25–39. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer for women aged 25–39 was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.38 (0.28–0.51), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.42 (0.26–0.68) (Table 4.4.9).

This is unchanged from the finding for women aged 20–39, and indicates that the inclusion of women aged 20–24 in these analyses has no impact on the outcome, in line with cervical cancers in this age group being not affected by cervical screening.

Considering the screening history of cervical cancers diagnosed in women aged 20–39, of the cervical cancers diagnosed, 36% occurred in women who had never screened, and 65% occurred in women who had either never screened or were lapsed screeners.

When cervical cancers were restricted to squamous cell carcinomas, 40% occurred in women who had never screened and 68% in never screened or lapsed screeners.

Table 4.4.9: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 20–39 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.49	0.30–0.79	0.0038
Lapsed (3.5–5.5 years)	0.50	0.32–0.77	0.0016
Lapsed (2.5–3.5 years)	0.41	0.26–0.65	0.0001
Recently screened	0.38	0.28–0.50	<0.0001
Cervical cancer mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.49	0.30–0.79	0.0039
Lapsed (3.5–5.5 years)	0.53	0.34–0.82	0.0044
Lapsed (2.5–3.5 years)	0.41	0.26–0.64	0.0001
Recently screened	0.38	0.28–0.51	<0.0001
Cervical cancer mortality for women aged 25–39, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.49	0.30–0.81	0.0047
Lapsed (3.5–5.5 years)	0.53	0.34–0.83	0.0057
Lapsed (2.5–3.5 years)	0.42	0.26–0.68	0.0004
Recently screened	0.38	0.28–0.51	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women with a screening history within the 5.5 years prior to diagnosis compared with women diagnosed with cervical cancer who had never screened (Table 4.4.10).

Table 4.4.10: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 20–39 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
All-cause mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.49	0.31–0.77	0.0023
Lapsed (3.5–5.5 years)	0.50	0.33–0.75	0.0009
Lapsed (2.5–3.5 years)	0.43	0.29–0.66	<0.0001
Recently screened	0.40	0.30–0.52	<0.0001
All-cause mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.49	0.31–0.77	0.0023
Lapsed (3.5–5.5 years)	0.53	0.35–0.80	0.0027
Lapsed (2.5–3.5 years)	0.43	0.28–0.65	<0.0001
Recently screened	0.39	0.30–0.52	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 40–49

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who were recently screened compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.33 (0.24–0.47) (Table 4.4.11).

Considering the screening history of cervical cancers diagnosed in women aged 40–49, of the cervical cancers diagnosed, 54% occurred in women who had never screened, and 73% occurred in women who had either never screened or were lapsed screeners.

When cervical cancers were restricted to squamous cell carcinomas, 63% occurred in women who had never screened and 80% in never-screened or lapsed screeners.

Table 4.4.11: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 40–49 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.70	0.45–1.09	0.1122
Lapsed (3.5–5.5 years)	0.46	0.25–0.84	0.0113
Lapsed (2.5–3.5 years)	0.53	0.33–0.85	0.0086
Recently screened	0.30	0.22–0.42	<0.0001
Cervical cancer mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.72	0.47–1.12	0.1495
Lapsed (3.5–5.5 years)	0.45	0.25–0.83	0.0107
Lapsed (2.5–3.5 years)	0.55	0.34–0.89	0.0140
Recently screened	0.33	0.24–0.47	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type it was found that the risk of death from all causes was significantly lower in women who were recently screened compared with cervical cancers diagnosed in never-screened women, with a hazard ratio of 0.35 (0.26–0.47) (Table 4.4.12).

Table 4.4.12: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 40–49 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
All-cause mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.74	0.50–1.09	0.1299
Lapsed (3.5–5.5 years)	0.49	0.28–0.83	0.0080
Lapsed (2.5–3.5 years)	0.51	0.33–0.79	0.0029
Recently screened	0.33	0.25–0.44	<0.0001
All-cause mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.76	0.51–1.13	0.1686
Lapsed (3.5–5.5 years)	0.47	0.27–0.80	0.0057
Lapsed (2.5–3.5 years)	0.52	0.33–0.81	0.0036
Recently screened	0.35	0.26–0.47	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 50–59

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.45 (0.34–0.61), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.33 (0.16–0.67) (Table 4.4.13).

Considering the screening history of cervical cancers diagnosed in women aged 50–59, of the cervical cancers diagnosed, 61% occurred in women who had never screened, and 76% occurred in women who had either never screened or were lapsed screeners.

When cervical cancers were restricted to squamous cell carcinomas, 70% occurred in women who had never screened and 83% in never screened or lapsed screeners.

Table 4.4.13: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 50–59 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.60	0.36–1.00	0.0496
Lapsed (3.5–5.5 years)	0.56	0.32–1.00	0.0505
Lapsed (2.5–3.5 years)	0.33	0.16–0.66	0.0019
Recently screened	0.44	0.33–0.59	<0.0001
Cervical cancer mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.57	0.34–0.95	0.0294
Lapsed (3.5–5.5 years)	0.54	0.30–0.96	0.0371
Lapsed (2.5–3.5 years)	0.33	0.16–0.67	0.0021
Recently screened	0.45	0.34–0.61	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.48 (0.37–0.62), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.38 (0.22–0.66) (Table 4.4.14).

Table 4.4.14: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 50–59 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
All-cause mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.69	0.45–1.05	0.0833
Lapsed (3.5–5.5 years)	0.59	0.35–0.97	0.0357
Lapsed (2.5–3.5 years)	0.41	0.24–0.71	0.0016
Recently screened	0.50	0.39–0.63	<0.0001
All-cause mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.64	0.42–0.99	0.0429
Lapsed (3.5–5.5 years)	0.54	0.32–0.89	0.0155
Lapsed (2.5–3.5 years)	0.38	0.22–0.66	0.0006
Recently screened	0.48	0.37–0.62	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Women aged 60–69

After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from cervical cancer was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.47 (0.34–0.65), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.17 (0.06–0.46) (Table 4.4.15).

Fewer cervical cancers were diagnosed in women aged 60–69 than in other age groups, so this analysis was repeated for women aged 50–69 instead of 50–59 and 60–69 separately. The trend noted above was largely unchanged, with a hazard ratio of 0.44 (0.36–0.56) for women aged 50–69 who had a Pap test within the 2.5 years before diagnosis and a hazard ratio of 0.24 (0.14–0.43) for women aged 50–69 who had a Pap test within the 2.5–3.5 years before diagnosis (Table 4.4.15).

Considering the screening history of cervical cancers diagnosed in women aged 60–69, of the cervical cancers diagnosed, 68% occurred in women who had never screened, and 80% occurred in women who had either never screened or were lapsed screeners. When cervical cancers were restricted to squamous cell carcinomas, 76% occurred in women who had never screened and 86% in never screened or lapsed screeners.

Table 4.4.15: Unadjusted and adjusted hazard ratios for cervical cancer mortality for women aged 60–69 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
Cervical cancer mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.91	0.50–1.67	0.7669
Lapsed (3.5–5.5 years)	0.32	0.13–0.78	0.0121
Lapsed (2.5–3.5 years)	0.17	0.07–0.47	0.0005
Recently screened	0.48	0.35–0.66	<0.0001
Cervical cancer mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.92	0.50–1.69	0.7815
Lapsed (3.5–5.5 years)	0.30	0.12–0.73	0.0081
Lapsed (2.5–3.5 years)	0.17	0.06–0.46	0.0004
Recently screened	0.47	0.34–0.65	<0.0001
Cervical cancer mortality for women aged 50–69, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.64	0.44–0.95	0.0271
Lapsed (3.5–5.5 years)	0.43	0.26–0.70	0.0006
Lapsed (2.5–3.5 years)	0.24	0.14–0.43	<.0001
Recently screened	0.44	0.36–0.56	<.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Analyses were repeated for all-cause mortality. After adjusting for age group at diagnosis, remoteness area, socioeconomic area, and histological type, the risk of death from all causes was significantly lower in women who had a Pap test within the 3.5 years before diagnosis compared with cervical cancers diagnosed in never-screened women. For women who had a Pap test within the 2.5 years before diagnosis the hazard ratio was 0.55 (0.43–0.71), and for women who had a Pap test within the 2.5–3.5 years before diagnosis the hazard ratio was 0.34 (0.19–0.60) (Table 4.4.16).

Table 4.4.16: Unadjusted and adjusted hazard ratios for all-cause mortality for women aged 60–69 diagnosed with cervical cancer by screening history

	HR	95% CI	P value
All-cause mortality, unadjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.79	0.45–1.37	0.3921
Lapsed (3.5–5.5 years)	0.45	0.24–0.84	0.0123
Lapsed (2.5–3.5 years)	0.35	0.20–0.63	0.0004
Recently screened	0.60	0.47–0.76	<0.0001
All-cause mortality, adjusted			
Never-screened	1.0	. .	. .
Screening women			
Lapsed (5.5+ years)	0.76	0.43–1.33	0.3407
Lapsed (3.5–5.5 years)	0.39	0.21–0.74	0.0038
Lapsed (2.5–3.5 years)	0.34	0.19–0.60	0.0002
Recently screened	0.55	0.43–0.71	<0.0001

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

4.5 Cervical cancers in HPV-vaccinated and HPV-unvaccinated women

The long-term aim of HPV vaccination is to reduce the incidence of cervical cancer through preventing the HPV infections that would otherwise have persisted and eventually resulted in cervical cancer. However, because cervical cancer can take decades to develop, sufficient time needs to have passed for the cervical cancers that would have resulted to be prevented, and therefore show in the data. With the HPV vaccination program commencing for girls in April 2007 and cervical cancer incidence data available to 2012, it is expected that it is still too soon to see any effect of HPV vaccination on cervical cancer incidence rates in Australia. This project provides an opportunity to investigate cervical cancer in HPV-vaccinated and unvaccinated females either to provide evidence that it is too early, or to show an outcome.

Analysis design

A population approach was taken, with the same characteristics used for females in the population and women diagnosed with cancers, with both groups disaggregated by HPV vaccination status. The characteristics used were females born between 1 January 1981 and 1 January 2000—that is, women were a maximum of 26 years old at the commencement of the study period on 1 April 2007 and at least 12 years old by the end of the study period on 31 December 2012. In addition to cervical cancers, breast cancers and thyroid cancers were also analysed by HPV vaccination status, following the methodology of Luostarinen and others (2018) who also used these two HPV-unrelated cancers for comparison.

Analysis results

Results of the population approach are shown in Table 4.5.1. In this cohort of 6.4 million females born between 1 January 1981 and 1 January 2000, crude incidence rates of cervical cancer, breast cancer and thyroid cancer diagnosed between 1 April 2007 and 31 December 2012 were similar in completely HPV-vaccinated and unvaccinated women.

- Cervical cancer incidence was 1.6 new cases per 100,000 females for HPV-vaccinated women compared with 2.2 new cases for unvaccinated females.
- Breast cancer incidence was 1.8 new cases per 100,000 females for HPV-vaccinated women compared with 2.1 new cases for unvaccinated females.
- Thyroid cancer incidence was 3.9 new cases per 100,000 females for HPV-vaccinated women compared with 3.6 new cases for unvaccinated females.

These results demonstrate no clear reduction in cancer incidence for HPV-vaccinated versus HPV-unvaccinated females, but 5 years of follow-up is unlikely to be long enough to detect any difference between these two groups. The slightly lower incidence of cervical cancer in HPV-vaccinated than in HPV-unvaccinated females may be the start of a trend, but additional years of data are required.

In 2012, the final year of data in the study, and 5 years since the start of the vaccination program, there was a greater than twofold difference in rates between vaccinated and unvaccinated women (2.5 versus 5.9 per 100,000). Breast cancer incidence was also slightly lower in vaccinated women but thyroid cancer was slightly higher. It is likely that there are differences in the underlying risk factors for these cancers between vaccinated and unvaccinated women because vaccination was not a randomised event and women who chose to be vaccinated against HPV may have different characteristics to those who didn't. This is supported by the fact that in 2007, the first year of vaccination and when there would be no opportunity for the vaccine to have prevented cancer, cancer rates were different between vaccinated and unvaccinated women.

Table 4.5.1: Incidence of cervical cancer, breast cancer and thyroid cancer in women born 1981–2000, by HPV vaccination status, 2007 to 2012

		Vaccinated			Incomplete			Unvaccinated		
		Number	Population	Rate	Number	Population	Rate	Number	Population	Rate
Cervical cancer	2007	0	300,006	0.0	5	92,498	5.4	6	2,377,154	0.3
	2008	5	916,846	0.5	11	289,875	3.8	22	1,628,420	1.4
	2009	15	1,158,416	1.3	11	409,715	2.7	23	1,344,669	1.7
	2010	17	1,261,147	1.3	20	426,728	4.7	41	1,279,210	3.2
	2011	28	1,359,783	2.1	20	440,015	4.5	39	1,214,218	3.2
	2012	36	1,462,866	2.5	17	451,356	3.8	69	1,172,200	5.9
	Total	**101**	**6,459,064**	**1.6**	**84**	**2,110,187**	**4.0**	**200**	**9,015,871**	**2.2**
Breast cancer	2007	0	300,006	0.0	4	92,498	4.3	8	2,377,154	0.3
	2008	13	916,846	1.4	9	289,875	3.1	8	1,628,420	0.5
	2009	13	1,158,416	1.1	5	409,715	1.2	26	1,344,669	1.9
	2010	17	1,261,147	1.3	14	426,728	3.3	39	1,279,210	3.0
	2011	26	1,359,783	1.9	19	440,015	4.3	39	1,214,218	3.2
	2012	47	1,462,866	3.2	25	451,356	5.5	71	1,172,200	6.1
	Total	**116**	**6,459,064**	**1.8**	**76**	**2,110,187**	**3.6**	**191**	**9,015,871**	**2.1**
Thyroid cancer	2007	1	300,006	0.3	26	92,498	28.1	17	2,377,154	0.7
	2008	27	916,846	2.9	24	289,875	8.3	38	1,628,420	2.3
	2009	43	1,158,416	3.7	21	409,715	5.1	60	1,344,669	4.5
	2010	46	1,261,147	3.6	28	426,728	6.6	57	1,279,210	4.5
	2011	62	1,359,783	4.6	30	440,015	6.8	59	1,214,218	4.9
	2012	76	1,462,866	5.2	30	451,356	6.6	98	1,172,200	8.4
	Total	**255**	**6,459,064**	**3.9**	**159**	**2,110,187**	**7.5**	**329**	**9,015,871**	**3.6**

Note: Rate is number of women per 100,000 women in the population.

Source: AIHW analysis of linked state and territory cervical screening register data, the National HPV Vaccination Program Register, and the Australian Cancer Database data.

Table 4.5.1 shows that a number of completely vaccinated women were subsequently diagnosed with cervical cancer. HPV vaccination was introduced on 1 April 2007 as both an ongoing school-based program for vaccinating 12–13 year old girls and a short-term 'catch-up' program vaccinating women up to age 26. Many of those vaccinated during the 3-year catch-up period were already sexually active, and therefore might have already been exposed to the HPV types covered by the quadrivalent HPV vaccine. The vaccine cannot treat or help resolve infection that is already there—it works only by preventing infection in the first place. It also does not cover all of the HPV types that can cause cervical cancer, only the most common ones. This is why screening remains important, even in vaccinated women.

With national cancer data available only to the end of 2012 in this study, most of the cervical cancers diagnosed in the selected cohort over this period would be in women who were already sexually active at the time of HPV vaccination. It is only at some time in the future when more women who were sexually naïve at time of vaccination reach the age at which they would have developed cervical cancer were it not for being vaccinated, that there will be fewer cervical cancers diagnosed in vaccinated women, and thus a lower incidence rate. However, it is important to realise that it will always be possible for vaccinated women to develop cervical cancer from HPV types not covered by the vaccine.

To further investigate the occurrence of cervical cancer in vaccinated women, all cervical cancers diagnosed in HPV-vaccinated women were reviewed using the available data from this project. For this, all cervical cancers diagnosed between 1 April 2007 and 31 December 2012 were extracted, irrespective of the age of the women, and all cases in which women were clinically completely vaccinated prior to the diagnosis date identified.

There were 102 of these, listed by age at diagnosis in Table 4.5.2.

Table 4.5.2: Cervical cancer diagnoses in HPV-vaccinated women, by age, 2007–2012

Diagnosis age	HPV-vaccinated women
<20	3
20–24	19
25–29	69
30–34	10
Total	**101**

Note: 'Vaccinated' = clinically completely vaccinated prior to diagnosis; 'Unvaccinated' = not clinically completely vaccinated prior to diagnosis.

Source: AIHW analysis of linked state and territory cervical screening register data, the National HPV Vaccination Program Register, and the Australian Cancer Database data.

The factors considered in the review of these 101 cervical cancers included age at diagnosis, age at clinically complete vaccination, and dates of vaccination and the commencement of cervical screening relative to each other. Using these, it was concluded that 99 of the 101 cervical cancers in HPV-vaccinated females occurred in women who were likely to have been exposed to HPV prior to vaccination, and so were not consistent with vaccine failure. The other two cases of cervical cancer diagnosed in HPV-vaccinated women were of a type not caused by HPV, and therefore not able to be prevented by HPV vaccination.

Details of how this conclusion was reached follow.

First, the date of their first cervical screening test was considered—with no other information on a woman's sexual history available in these data, the date of a woman's first cervical screening test is used as a proxy for sexual debut, because during the period of this study screening was recommended to commence at age 18 or 1–2 years after first sexual activity, whichever was later.

Of the 101 cervical cancers, 86 occurred in women who had their first cervical screening test prior to the date on which they were clinically completely vaccinated, in which case the vaccine would not be considered maximally effective due to likely prior exposure. In these 86 women, the median time from their first cervical screening test to their HPV vaccination clinical completion date was 4.2 years (the median time from first cervical screening test to cervical cancer diagnosis in these women was 6.8 years).

Given that these 86 cervical cancers were diagnosed in women who were likely to be sexually active and thus had a greater likelihood of exposure prior to receiving the HPV vaccine, these 86 cervical cancer cases are highly unlikely to represent a failure of HPV vaccination.

There were 15 women remaining with a clinical completion date prior to the date of their first cervical screening test. Clinical completion age was considered in these cervical cancer cases, as not all sexually active women engage in cervical screening. Of these 15 cervical cancers, 13 occurred in women with a clinical completion age above 16, ranging between 18 and 27 years (median age of 24). It is reasonable to consider that these women may also have been sexually active prior to receiving the HPV vaccine (the median age of first sexual activity in Australia is 16–17 (Rissel et al. 2003; Rissel et al. 2014)) and thus, with the data available, these cases are also unlikely to represent vaccine failure.

There were 2 cervical cancers that remained after these exclusions were applied.

These 2 cases were both diagnosed in young women within 1–4 years of being clinically completely vaccinated. Both cervical cancers were of the same histological type—a rare form of cervical cancer that is called clear cell adenocarcinoma (also known as clear cell carcinoma of the cervix). Clear cell adenocarcinoma—as has recently been shown for many histological types of adenocarcinomas—is not caused by infection with oncogenic HPV (Ueno et al. 2013; Stolnicu et al. 2018; Hodgson & Park 2019).

It will be very important and highly valuable to repeat these analyses when more data are available, and ideally with HPV typing routinely available and recorded for all cervical cancers, given the long-term aim of the HPV vaccine to reduce cervical cancer.

5 Cervical abnormality outcomes

Abnormalities, particularly high-grade abnormalities, play an important role in cervical screening, as it is the detection and treatment of these that allows cervical screening to prevent cervical cancers from developing.

Box 5.1.1: Histology versus cytology

Cervical **histology** is the examination of tissue from the cervix (usually collected by a biopsy) through a microscope. Histology is more accurate than cytology because it allows the examination of cells and other structures as they would appear *in situ.*

While cervical **cytology**, the examination of the cells collected from the cervix, is a very useful tool, it should be stressed that it is not diagnostic (unlike cervical histology).

As a screening tool, the aim of cervical cytology is to identify those individuals who may have a cervical abnormality (as indicated by the presence of abnormal cells in the specimen collected) and therefore require further diagnostic testing. Since the Pap test collects an arbitrary sample of cells from the surface of the cervix at an arbitrary point in time, and further requires a level of judgment in the interpretation of sampled cells, cervical cytology cannot accurately reveal all abnormalities that may exist in the cervical tissue *in situ* in a single sample.

It was previously thought that the development of cervical cancer involved progression from low-grade to moderate-grade to high-grade abnormalities; it is now understood that low grade and high-grade abnormalities represent different HPV infection processes. Low-grade abnormalities occur as a result of acute HPV infection, most of which will resolve spontaneously. High-grade abnormalities are the result of persistent infection with an oncogenic HPV type. Most high-grade abnormalities also regress over time (Raffle et al. 2003), but regression takes longer (Cancer Council Australia 2014). An important difference between non-oncogenic and oncogenic HPV types is that oncogenic HPV types integrate their DNA into the host genome, which is why these are associated with oncogenic changes to the cells of the cervix, whereas non-oncogenic HPV types are unable to integrate their DNA into the host genome and therefore can cause only low-grade changes to cells (Chhieng & Hui 2011).

As high-grade abnormalities are potential precursors to cervical cancer, their detection through cervical screening provides an opportunity for treatment before cancer can develop. Thus, cervical screening aims to detect high-grade abnormalities in line with its broader aim to reduce the incidence of cervical cancer.

High-grade abnormalities need to be diagnosed using histology to ensure treatment is appropriate and to avoid unnecessary treatment in women where the cytology has predicted disease that is not present. While colposcopy (examination of the cervix using a magnifying instrument called a colposcope) is used as part of this process, in Australia, it is considered best practice to confirm high-grade disease with histology before treatment (NHMRC 2005).

5.1 Histology after high-grade cytology

Under the 2005 clinical management guidelines (NHMRC 2005), a cytology result of possible or definite high-grade or cervical cancer is followed by colposcopy and, if indicated, biopsy to confirm a high-grade or cancer finding on histology.

Analysis design

All cytology results of high-grade or cancer between 1 January 2007 and 31 December 2011 for women aged 20–69 were selected. These years were chosen as these were after the introduction of the 2005 clinical management guidelines, and also allowed for at least 3 years of follow-up after all cytology tests.

The first high-grade cytology test for each woman in the period was selected, and then the first histology test after this date was interpreted as the biopsy that followed the cytology test. Time between the cytology test date and the histology test date for each woman in this cohort was then calculated.

Analysis results

There were 107,949 women with high-grade cytology between 2007 and 2011; of these, 78,331 (72.6%) had a subsequent histology test, and 25,602 (23.7%) did not. The remaining 4,016 (3.7%) had a histology test on the same day as their high-grade cytology test.

These data were further stratified by the recommendation following the high-grade cytology test, which is based on the woman's cytology test result as well as her screening history (and in some cases age) to determine the most appropriate follow-up (Table 5.1.1).

Table 5.1.1: Biopsies after high-grade cytology, women aged 20–69, 2007–2011

Laboratory recommendation after high-grade cytology	Biopsy after high-grade cytology		No biopsy after high-grade cytology		Biopsy same day as high-grade cytology	
R0 No recommendation	224	0.3%	173	0.7%	42	1.0%
R1 Repeat smear 3 years	0	0.0%	0	0.0%	0	0.0%
R2 Repeat smear 2 years	7	0.0%	10	0.0%	0	0.0%
R3 Repeat smear 12 months	58	0.1%	49	0.2%	11	0.3%
R4 Repeat smear 6 months	63	0.1%	93	0.4%	4	0.1%
R5 Repeat smear 6–12 weeks	239	0.3%	254	1.0%	0	0.0%
R6 Colposcopy/biopsy recommended	72,331	92.3%	20,149	78.7%	1,285	32.0%
R7 Already under gynaecological management	2,526	3.2%	3,802	14.9%	2,369	59.0%
R8 Referral to specialist	1,457	1.9%	394	1.5%	31	0.8%
R9 Other management recommended	375	0.5%	355	1.4%	189	4.7%
RS Symptomatic—Clinical management required	1,051	1.3%	323	1.3%	85	2.1%
Total	**78,331**	**. .**	**25,602**	**. .**	**4,016**	**. .**

Source: AIHW analysis of linked state and territory cervical screening register data.

The majority of biopsies occurred after a high-grade cytology for which the recommendation code was 'R6 Colposcopy/biopsy recommended'. Of the 93,765 high-grade cytology with a recommendation of 'R6 Colposcopy/biopsy recommended', 77.1% had a subsequent histology test and 21.5% did not (the remaining 1.4% had histology on the same day so did not fall in either category).

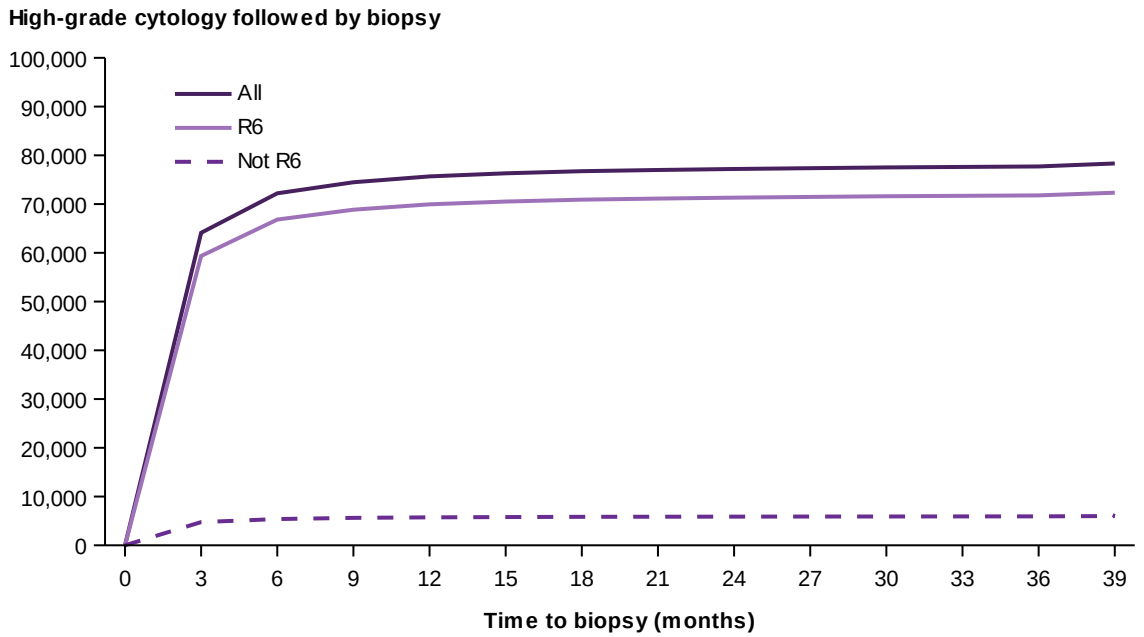
Conversely, of the 14,184 high-grade cytology with a recommendation other than 'R6 Colposcopy/biopsy recommended', 42.3% had a subsequent histology test and 38.4% did not (the remaining 19.3% had histology on the same day so did not fall in either category).

Time to biopsy

For high-grade cytology followed by biopsy, time between high-grade cytology and biopsy (as indicated by a histology test with a date greater than 1 day after the date of the high-grade cytology test) is shown in Figure 5.1.1. In addition to the group that includes biopsy after high-grade cytology irrespective of recommendation, time to biopsy is also explored for two subgroups, these being high-grade cytology with a recommendation 'R6 Colposcopy/biopsy recommended', and those with recommendations other than 'R6 Colposcopy/biopsy recommended'.

The overall pattern is similar for all three groups—of the high-grade cytology that is followed by histology, around 80% achieved this within 3 months (81.8% for all recommendations, 82.1% for a recommendation of R6, 79.3% for recommendations other than R6), and around 90% within 6 months (92.2% for all recommendations, 92.4% for a recommendation of R6, 89.7% for recommendations other than R6) (Figure 5.1.1).

Figure 5.1.1: Time from high-grade cytology to biopsy, all high-grade cytology, high-grade cytology with a recommendation of R6, and high-grade cytology with a recommendation other than R6, women aged 20–69, 2007–2011



Source: AIHW analysis of linked state and territory cervical screening register data.

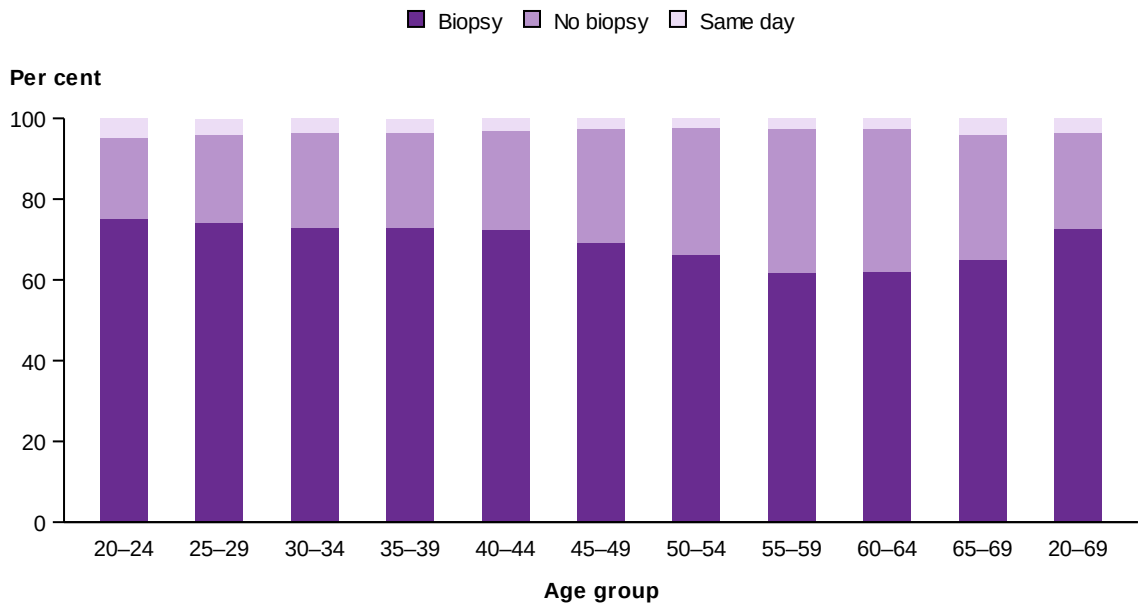
Time to biopsy was disaggregated by age, remoteness area and socioeconomic area to determine if these had any effect on this measure.

Age

As expected, the highest number of high-grade cytology occurred in younger women, decreasing with increasing age. The proportion of high-grade cytology followed by biopsy was also highest in the younger age groups—75.2% of high-grade cytology in women aged

20–24 were followed by biopsy, falling to just under 62% for women aged 55–59 and 60–64, then rising slightly to 64.9% for women aged 65–69 (Figure 5.1.2).

Figure 5.1.2: High-grade cytology followed by biopsy, by age, 2007–2011



Source: AIHW analysis of linked state and territory cervical screening register data.

Time to biopsy for those high-grade cytology that were followed by histology differed a little with age, particularly within 3 months of the high-grade cytology, for which relatively fewer biopsies had occurred for women aged 20–24, followed by women aged 50–69. The proportion of high-grade cytology that had been followed by histology is shown in Table 5.1.2 for the first 12 months after the high-grade cytology.

Table 5.1.2: Proportion of biopsies that occurred within 3, 6, 9 and 12 months of a high-grade cytology, by age, women aged 20–69, 2007–2011

Age group	High-grade cytology followed by biopsy	3 months	6 months	9 months	12 months
20–24	17,553	78.5	90.2	93.8	95.7
25–29	19,128	82.5	92.4	95.2	96.8
30–34	13,869	83.3	92.5	95.4	96.9
35–39	9,851	84.3	93.6	96.1	97.2
40–44	6,357	83.3	93.6	95.9	97.1
45–49	4,576	82.3	93.2	96.2	97.2
50–54	2,995	81.8	93.1	95.7	96.7
55–59	1,877	80.0	91.3	94.0	95.6
60–64	1,285	78.9	90.4	92.7	94.8
65–69	840	79.0	91.8	93.9	95.1
Total	**78,331**	**81.8**	**92.2**	**95.1**	**96.6**

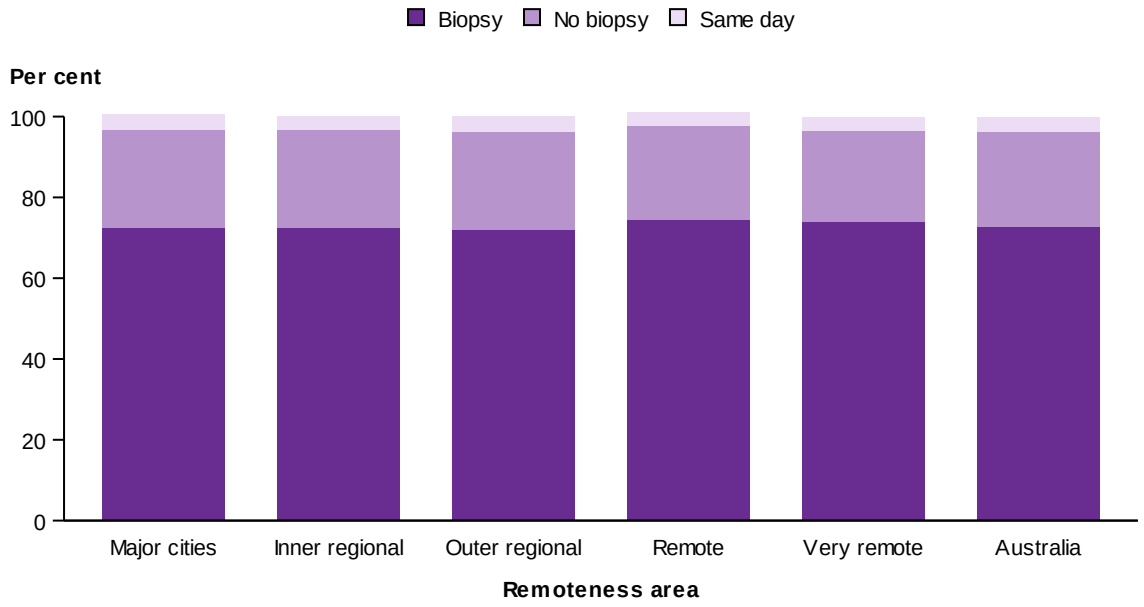
Note: Proportions shown are of all high-grade cytology that are followed by biopsy, not of all high-grade cytology.

Source: AIHW analysis of linked state and territory cervical screening register data.

Remoteness area

The proportion of high-grade cytology that was followed by histology was very similar across remoteness areas, being 72.5% in *Major cities*, 72.6% in *Inner regional*, 72.0% in *Outer regional*, 74.5% in *Remote* and 74.0% in *Very remote* areas (Figure 5.1.3).

Figure 5.1.3: High-grade cytology followed by biopsy, by remoteness area, women aged 20–69, 2007–2011



Source: AIHW analysis of linked state and territory cervical screening register data.

However, there were some differences across remoteness areas when time to biopsy was measured, particularly for biopsies within 3 months of the high-grade cytology. Of the high-grade cytology that was followed by histology, the proportion of biopsies that occurred within 3 months decreased with increasing remoteness, being highest for women residing in *Major cities* at 83.2%, followed by *Inner regional* at 79.5% and *Outer regional* areas at 78.5%. This was lower again for women residing in *Remote* areas at 75.0%, and lowest for women residing in *Very remote* areas at 63.3% (Table 5.1.3).

Table 5.1.3: Proportion of biopsies that occurred within 3, 6, 9 and 12 months of a high-grade cytology, by remoteness area, women aged 20–69, 2007–2011

Remoteness area	High-grade cytology followed by biopsy	3 months	6 months	9 months	12 months
Major cities	55,141	83.2	92.8	95.4	96.9
Inner regional	13,815	79.5	92.0	95.1	96.6
Outer regional	6,936	78.5	89.7	93.7	95.7
Remote	1,278	75.0	86.5	90.8	93.7
Very remote	839	63.3	80.6	88.1	92.4
Total	**78,331**	**81.8**	**92.2**	**95.1**	**96.6**

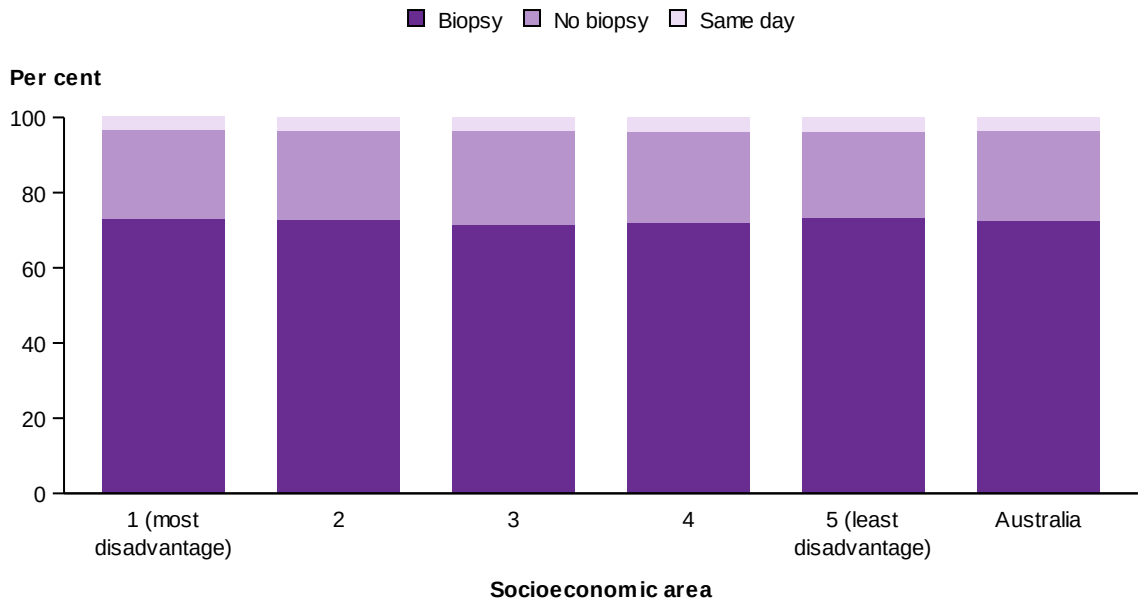
Note: Proportions shown are of all high-grade cytology that are followed by biopsy, not of all high-grade cytology; only includes women with a valid postcode that could be mapped to a remoteness area.

Source: AIHW analysis of linked state and territory cervical screening register data.

Socioeconomic area

The proportion of high-grade cytology that was followed by histology was very similar across socioeconomic areas, being 73.0% in group 1 (areas of most disadvantage), 72.8% in group 2, 71.4% in group 3, 72.2% in group 4, and 73.3% in group 5 (areas of least disadvantage) (Figure 5.1.4).

Figure 5.1.4: High-grade cytology followed by biopsy, by socioeconomic area, women aged 20–69, 2007–2011



Source: AIHW analysis of linked state and territory cervical screening register data.

However, there were some differences across socioeconomic areas when time to biopsy was measured, particularly for biopsies within 3 months of the high-grade cytology. Of the high-grade cytology that was followed by histology, the proportion of biopsies that occurred within 3 months increased with decreasing levels of disadvantage. This was lowest for women residing in areas of most disadvantage (group 1) at 78.6%, followed by group 2 at 80.1%, group 3 at 80.8, group 4 at 83.3%, and highest for women residing in areas of least disadvantage (group 5) at 85.6% (Table 5.1.4).

Table 5.1.4: Proportion of biopsies that occurred within 3, 6, 9 and 12 months of a high-grade cytology, by socioeconomic area, women aged 20–69, 2007–2011

Socioeconomic area	High-grade cytology followed by biopsy	3 months	6 months	9 months	12 months
1 (most disadvantage)	14,173	78.6	90.7	94.3	96.2
2	14,916	80.1	91.8	94.9	96.4
3	15,339	80.8	91.9	94.7	96.3
4	16,058	83.3	92.8	95.4	96.8
5 (least disadvantage)	17,074	85.6	93.4	95.9	97.3
Total	**78,331**	**81.8**	**92.2**	**95.1**	**96.6**

Note: Proportions shown are of all high-grade cytology that are followed by biopsy, not of all high-grade cytology; only includes women with a valid postcode that could be mapped to a socioeconomic area.

Source: AIHW analysis of linked state and territory cervical screening register data.

5.2 Recurrence rates for women with high-grade squamous intraepithelial lesions

Women who are diagnosed with a high-grade abnormality by histology are treated. Following a period of clinical management, under the 2005 clinical management guidelines (NHMRC 2005), women undergo 'test of cure' whereby cervical cytology and human papillomavirus (HPV) tests ('co-tests') are conducted at 12-month intervals and if both are negative on 2 consecutive occasions, the woman is returned to the usual 2-yearly screening interval.

After clinical management, it is possible for some women to have a high-grade abnormality detected on histology. This can represent either persistent disease, or recurrent disease. These analyses aim to estimate the recurrence rates for women who are diagnosed with (and assumed to have been treated for) a high-grade squamous intraepithelial lesion (HSIL).

Analysis design

All HSIL histology results (defined as cervical intraepithelial neoplasia (CIN) 2, CIN3, or CIN for which the grade was not specified) between 1 January 2007 and 31 December 2011 for women aged 20–69 were selected. These years were chosen as these were after the introduction of the 2005 clinical management guidelines, and also allowed for at least 3 years of follow-up after all histology tests. Histology tests were excluded if there had ever been a previous cervical cancer, or if a squamous or glandular high-grade abnormality had been diagnosed by histology in the previous 48 months (to exclude prevalent abnormalities). Where multiple histology tests were recorded for a woman, the first HSIL histology test was selected. Co-testing outcomes under test of cure were identified, as were any HSIL histology diagnosed 12 months or more from the date of the original HSIL histology.

Recurrence was defined as a subsequent HSIL histology 12 months or more after the original HSIL histology test date, with at least 1 negative co-test (that is, where both the cervical cytology test and HPV test were negative) between the original HSIL histology test date and the subsequent HSIL histology test date (noting that 2 consecutive negative co-tests are required for a woman to be considered 'cured' and able to return to routine cervical screening).

Analysis results

There were 71,509 women aged 20–69 diagnosed with HSIL between 2007 and 2011.

Of these:

- 68,462 had no subsequent HSIL histology in the follow-up period of this study
- 1,283 subsequent HSIL that occurred in women who had had at least 1 negative co-test, which is the definition used here to identify recurrence (noting that 2 consecutive negative co-tests are required for an HSIL to be considered completely treated)
- 782 had a subsequent HSIL after a positive co-test which was considered to be persistence rather than recurrence
- 982 had a subsequent HSIL but with no history of a co-test, suggesting that the original HSIL had not been considered adequately treated to commence test of cure.

The 1,283 subsequent HSIL that by this definition represent recurrence equates to a recurrence rate of 1.8% of all HSIL diagnosed in 2007–2011, with a median time to recurrence of 1.9 years and the mean time to occurrence of 2.4 years.

The recurrence categories are further disaggregated by year of original HSIL diagnosis and age at original HSIL diagnosis. There were fewer recurrences after an HSIL in 2011 compared with an HSIL in 2007, which is likely due to HSIL diagnosed in the earlier years having a longer period of time after which a subsequent HSIL could develop (Table 5.2.1).

Table 5.2.1: Recurrence by year of original HSIL, women aged 20–69, 2007–2011

Year of original HSIL	2007	2008	2009	2010	2011	Total
Recurrence						
Number	349	328	257	210	139	1,283
%	27.2	25.6	20.0	16.4	10.8	. .
Total HSIL						
Number	13,930	14,705	14,289	14,183	14,402	71,509
%	19.5	20.6	20.0	19.8	20.1	. .

Source: AIHW analysis of linked state and territory cervical screening register data.

Recurrence was highest for younger women, and decreased with increasing age. The highest recurrence rate of 2.6% was experienced by women aged 20–24 at the time of their original HSIL, falling to 1.8% for women aged 25–29 and 30–34, decreasing through the age groups to be below 1% for women aged 50–69 (Table 5.2.2).

Table 5.2.2: Recurrence by age at original HSIL, women aged 20–69, 2007–2011

Age group	20–24	25–29	30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69
Recurrence										
Number	425	356	251	123	67	33	13	7	4	4
%	2.6	1.8	1.8	1.4	1.3	1.0	0.7	0.7	0.6	1.0
Total HSIL	**16,626**	**19,432**	**13,762**	**9,081**	**5,258**	**3,468**	**1,734**	**1,032**	**708**	**408**

Source: AIHW analysis of linked state and territory cervical screening register data.

Recurrence was also examined for different age groups for each year. While the noted decrease in recurrence rate between 2007 and 2011 was present for all age groups, the size of the decrease differed. Women aged 20–24 had the greatest decrease in recurrence rate of around 73%, whereas the decrease for women aged 25–29 and 30–39 was around 55% and 57% respectively. Women aged 35 to 69 were grouped together due to smaller numbers, with an overall decrease in recurrence rate from 2007 to 2011 of 38% (Table 5.2.3).

It is not clear from these data why there should be a greater decrease in HSIL recurrence rates among young women from 2007 to 2011, but this may be related to HPV vaccination in younger women reducing risk of recurrent disease (Velentzis et al. 2019). Future research may be able to confirm this trend and elucidate whether HPV vaccination plays a role.

Table 5.2.3: Recurrence by year of original HSIL, by age, 2007–2011

Year of original HSIL	2007	2008	2009	2010	2011	% decrease
20–24	1.0	0.8	0.6	0.5	0.3	73.4
25–29	0.7	0.6	0.6	0.5	0.3	55.3
30–34	0.5	0.5	0.4	0.3	0.2	56.7
35–69	0.5	0.5	0.3	0.3	0.3	38.4
Total HSIL	**364**	**337**	**263**	**222**	**153**	**58.0**

Source: AIHW analysis of linked state and territory cervical screening register data.

5.3 High-grade abnormalities in HPV-vaccinated and HPV-unvaccinated women

As introduced in Chapter 4.5, the long-term aim of HPV vaccination is to reduce the incidence of cervical cancer through preventing the HPV infections that would otherwise have persisted and eventually resulted in cervical cancer. However, because cervical cancer can take decades to develop, sufficient time needs to have passed for the cervical cancers that would have resulted to be prevented, in order for such reduction in the rates of cervical cancer to be detected.

Progress towards this long-term aim can be measured by assessing whether HPV vaccination has prevented these HPV infections, by investigating if there are fewer high-grade cervical abnormalities in women who are HPV-vaccinated compared with HPV-unvaccinated women.

This is possible because Australia was one of the first countries to introduce a national HPV vaccination program on 1 April 2007, with data on HPV doses delivered collected by the National HPV Vaccination Program Register. Australia has had an established cervical screening program operating since 1991, with data on all cervical screening tests (including histology tests) collected by state and territory cervical screening registers. Linkage of these two data sources enables women with high-grade abnormalities to be disaggregated by HPV vaccination status, to assess the effectiveness of HPV vaccination in preventing high-grade abnormalities.

While early studies were able to show the effectiveness of the HPV vaccine in reducing cervical abnormalities in Victoria (Brotherton et al. 2011; Gertig et al. 2013; Brotherton et al. 2015) and Queensland (Crowe et al. 2014) now that more time has passed since the introduction of the HPV vaccine, it is very valuable to update these results and assess if there have been improvements as cohorts vaccinated at a younger age enter screening.

These analyses also represent the first national linkage of these data.

Analysis design

Women born from 1 January 1992 onwards who had a Pap test between 1 April 2007 and 31 December 2014, and no high-grade abnormality in the previous 48 months and no previous cervical cancer or hysterectomy, were selected. The study period was defined as 1 April 2007 (when HPV vaccination commenced in Australia) to 31 December 2014. Women entered the cohort, with events and person-time counted, from the date of their first Pap test in the study period until the outcome (high-grade cervical abnormality on histology), 2 and a half years after their last negative Pap test, end of the study period, hysterectomy, or death, whichever came first.

Women were assigned a vaccination status based on their final dose of quadrivalent HPV vaccine under a 3-dose schedule—either unvaccinated (that is, received no doses of HPV vaccine), or completely vaccinated (received 3 doses of HPV vaccine at clinically appropriate intervals).

Proportional hazard regression with age as the time axis, adjusted for remoteness area of residence and socioeconomic area of residence, was used to estimate risk of high-grade abnormality according to vaccination status. Using age as the time axis allows the baseline hazard to change as a function of age, controlling for potential confounding due to age.

Two high-grade abnormality outcomes were investigated—any high grade abnormality, and the precancerous abnormality CIN3 and/or adenocarcinoma in situ (AIS).

Analysis results

In the cohort of women born in 1992 or later, 174,995 women were completely vaccinated and 48,845 were unvaccinated. Completely vaccinated women were found to have fewer high-grade abnormalities than unvaccinated women, at 8.5 high-grade abnormalities per 1,000 women compared with 13.2 high-grade abnormalities per 1,000 unvaccinated women.

Hazard ratios from the proportional hazards model confirmed that, compared with unvaccinated women, completely vaccinated women were less likely to have a high-grade abnormality, with a hazard ratio of 0.59 (0.54–0.65) (Table 5.3.1).

Results were similar when data were restricted to CIN3 and/or AIS (smaller numbers are due to the omission of data from 2 states whose histology data did not distinguish between CIN2 and CIN3). In this smaller cohort, 80,435 women were completely vaccinated and 24,202 were unvaccinated.

Completely vaccinated women were found to have less than half the incidence rate of unvaccinated women, at 2.8 cases of CIN3 and/or AIS per 1,000 women compared with 6.0 cases of CIN3 and/or AIS per 1,000 women for unvaccinated women. A hazard ratio of 0.43 (0.35–0.53) confirmed that completely vaccinated women had a 57% lower risk of CIN3 and/or AIS than unvaccinated women (Table 5.3.1).

Table 5.3.1: High-grade abnormality rate and hazard ratio by HPV vaccination status

	Number of women	Number of abnormalities	Crude rate	HR
High-grade abnormality				
Unvaccinated	48,845	645	13·2	1·0
Completely vaccinated	174,995	1,496	8·5	0·59 (0·54–0·65)
CIN3/AIS+				
Unvaccinated	24,202	145	6·0	1·0
Completely vaccinated	80,435	227	2·8	0·43 (0·35–0·53)

Note: 'Unvaccinated' refers to women screened who did not receive any dose of HPV vaccine; 'Completely vaccinated' refers to screened women who received 3 doses of HPV vaccine at clinically appropriate intervals'; 'Crude rate' is number of abnormalities per 1,000 women.

Source: AIHW analysis of linked state and territory cervical screening data, NHVPR data, ACD data and NDI data.

Crude rates of high-grade abnormalities were calculated across remoteness areas, socioeconomic areas, state and territory, and age at vaccination (for completely vaccinated women). Across all population subgroups, completely vaccinated women had lower rates of high-grade abnormalities than unvaccinated women (note that caution is advised when interpreting rates where the numerator is less than 20) (Table 5.3.2).

Across remoteness areas, among completely vaccinated women, the high-grade abnormality rate was lowest in *Major cities* at 7.9 per 1,000 women, and highest in *Remote* and *Very remote* areas at 12.6 and 12.7, respectively. Across socioeconomic areas, among completely vaccinated women, the high-grade abnormality rate was lowest in areas of least disadvantage at 7.0 per 1,000 women, but similar across other socioeconomic areas at around 9 high-grade abnormalities per 1,000 women (Table 5.3.2).

Age at vaccination is a strong predictor of the rate of high-grade abnormalities among completely vaccinated women. Vaccination at ages under 14 is associated with the lowest high-grade abnormality rate of 6.3 high-grade abnormalities per 1,000, followed by vaccination at ages 14–15 with a high-grade abnormality rate of 10.2 per 1,000. Vaccination at ages 16 and over offers the lowest protection against the development of high-grade abnormalities, with a high-grade abnormality rate in these women of 17.0 per 1,000 (Table 5.3.2).

Table 5.3.2: High-grade abnormality rate and hazard ratio by HPV vaccination status, by remoteness area, socioeconomic area, state and territory and age at vaccination

	Unvaccinated			Completely vaccinated		
	Number of women	Number of abnormalities	Crude rate	Number of women	Number of abnormalities	Crude rate
Remoteness area						
Major cities	34,021	407	12.0	113,616	897	7.9
Inner regional	8,920	125	14.0	38,876	359	9.2
Outer regional	4,572	88	19.2	17,988	179	10.0
Remote	754	13	17.2	2,466	31	12.6
Very remote	473	7	14.8	1,894	24	12.7
Socioeconomic area						
1 (most disadvantage)	10,322	161	15.6	32,423	288	8.9
2	9,960	123	12.3	36,748	346	9.4
3	9,839	125	12.7	35,356	306	8.7
4	9,214	115	12.5	34,965	302	8.6
5 (least disadvantage)	9,076	112	12.3	34,284	240	7.0
State and territory						
NSW	14,130	201	14.2	51,916	459	8.8
Vic	9,449	126	13.3	37,861	336	8.9
Qld	10,513	158	15.0	42,644	379	8.9
WA	8,472	96	11.3	19,445	182	9.4
SA	3,697	33	8.9	13,138	63	4.8
Tas	1,346	15	11.1	4,270	42	9.8
ACT	705	10	14.2	3,160	13	4.1
NT	533	6	11.3	2,561	22	8.6
Age at vaccination						
<14	. .	. .	. .	2,400	15	6.3
14–15	. .	. .	. .	4,690	48	10.2
16+	. .	. .	. .	1,528	26	17.0

Note: 'Unvaccinated' refers to women screened who did not receive any dose of HPV vaccine; 'Completely vaccinated' refers to screened women who received 3 doses of HPV vaccine at clinically appropriate intervals'; 'Crude rate' is number of abnormalities per 1,000 women; caution is advised in interpreting crude rates where the numerator is less than 20.

Source: AIHW analysis of linked state and territory cervical screening data, NHVPR data, ACD data and NDI data.

Herd immunity is the phenomenon whereby a sufficient proportion of the population is immunised against an infectious disease to reduce the prevalence of that disease, thereby making it harder for the disease to spread.

In 2014, Tabrizi and others (2014) reported a lower prevalence of HPV types targeted by the quadrivalent HPV vaccine in unvaccinated women, which suggested herd immunity in Australia as a result of HPV vaccination introduced in 2007. To determine whether there is also evidence of herd immunity within the cohorts used in these analyses, a pre-vaccination cohort was established that included women screened between 2000 and 2006, according to the same specifications as the unvaccinated and completely vaccinated cohorts used in the above analyses (that is, the prevaccination cohort is of same age women followed for an equal length of time as the unvaccinated and completely vaccinated cohorts).

It was found that the pre-vaccination cohort had a higher high-grade abnormality rate than unvaccinated women, at 26.4 high-grade abnormalities per 1,000 women compared with 13.2 high-grade abnormalities per 1,000 unvaccinated women. Hazard ratios from the proportional hazards model confirmed that, compared with the pre-vaccination cohort, unvaccinated women were less likely to have a high-grade abnormality, with a hazard ratio of 0.73 (0.67–0.79) (Table 5.3.3).

Together, these results support herd immunity in Australian women as a result of HPV vaccination, since even women who are unvaccinated experienced fewer high-grade abnormalities than unvaccinated women prior to HPV vaccination. This is illustrated in Figure 5.3.1.

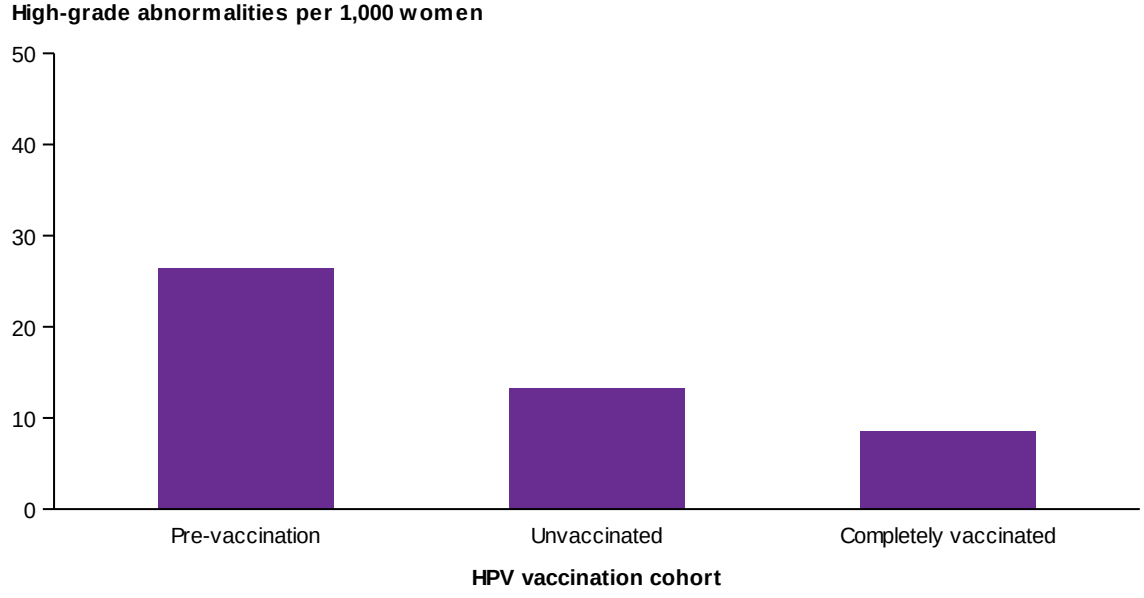
Table 5.3.3: High-grade abnormality rate and hazard ratio by HPV vaccination cohort

HPV vaccination cohort	Number of women	Number of high-grade abnormalities	Crude rate	HR
Pre-vaccination	270,163	7,135	26.4	1·0
Unvaccinated	48,845	645	13.2	0.73 (0.67–0.79)
Completely vaccinated	174,995	1,496	8.5	0.43 (0.41–0.45)

Note: 'Prevaccination' refers to women screened prior to the introduction of HPV vaccination; 'Unvaccinated' refers to women screened who did not receive any dose of HPV vaccine; 'Completely vaccinated' refers to screened women who received 3 doses of HPV vaccine at clinically appropriate intervals; 'Crude rate' is number of abnormalities per 1,000 women.

Source: AIHW analysis of linked state and territory cervical screening data, NHVPR data, ACD data and NDI data.

Figure 5.3.1: High-grade abnormality rate by HPV vaccination cohort



Note: 'Prevaccination' refers to women screened prior to the introduction of HPV vaccination; 'Unvaccinated' refers to women screened who did not receive any dose of HPV vaccine; 'Completely vaccinated' refers to screened women who received 3 doses of HPV vaccine at clinically appropriate intervals; 'Crude rate' is number of abnormalities per 1,000 women.

Source: AIHW analysis of linked state and territory cervical screening data, NHVPR data, ACD data and NDI data.

6 Cervical screening behaviour

Screening behaviour is determined by two factors—initiation of screening (women screening for the first time) and rescreening (women screening again). Both are required to acheive adequate levels of participation in the National Cervical Screening Program, for the greatest reductions in cervical cancer incidence, morbidity and mortality to be realised.

This chapter examines what may influence a woman's decision to screen and rescreen. It also reports on participation in cervical screening of HPV-vaccinated and unvaccinated women to determine whether there is any relationship between previous HPV vaccination and likelihood of participating in cervical screening.

Note that, while Pap tests were the screening test for the National Cervical Screening Program until December 2017 and so were most often used as a screening test, Pap tests were also performed as part of diagnosis and follow-up of abnormalities. With no data on the reason for Pap test available, in these analyses, all Pap tests are interpreted as participation in cervical screening.

6.1 Effect of participation in BreastScreen Australia on participation in cervical screening

We have previously reported on the impact of participation in cervical screening on participation in BreastScreen Australia (AIHW 2018b). This chapter focuses on the impact of participation in BreastScreen Australia on participation in cervical screening—specifically on naïve cervical screeners (that is for women who did not have a recorded Pap test prior to becoming eligible for participation in BreastScreen Australia at age 40).

Analysis design

Women who had either one or more Pap tests between the ages of 40 and 69 and between 1 January 2000 and 31 December 2014 or one or more screening mammograms through BreastScreen Australia between the ages of 40 and 69 and between 1 January 2000 and 31 December 2014 were included in the these analyses.

In this section, women were categorised as **regular screeners**, **irregular screeners**, or **non-screeners**. Regular screeners were those who screened at least 3 times with a mean screening interval of 30 months or less, as previously described (Roder et al. 2008); irregular screeners were those who had screened, but did not conform to this definition. Non-screeners were those who had never had a Pap test (for cervical screening) or a screening mammogram (for breast cancer screening through BreastScreen Australia).

The first analyses examined the cervical screening behaviour of women according to their previous BreastScreen Australia screening behaviour, to determine whether participation in BreastScreen Australia would prompt women to commence participation in cervical screening. Since women are not able to screen through BreastScreen Australia until age 40, women who had commenced cervical screening prior to age 40 were excluded from the analysis, as were older women who had commenced cervical screening prior to participating in BreastScreen Australia.

There were 994,607 women who had never previously participated in cervical screening who were regular screeners in BreastScreen Australia. Of these women:

- 245,365 (24.7%) subsequently became regular cervical screeners

- 159,893 (16.1%) subsequently became irregular cervical screeners
- 589,349 (59.2%) remained non-cervical screeners.

There were 1,065,543 women who had never previously participated in cervical screening who were irregular screeners in BreastScreen Australia. Of these women:

- 58,775 (5.5%) subsequently became regular cervical screeners
- 109,470 (10.3%) subsequently became irregular cervical screeners
- 897,298 (84.2%) remained non-cervical screeners (Table 6.1.1).

This means that 573,503 women first participated in cervical screening after they commenced screening through BreastScreen Australia. Further, if they became regular screeners through BreastScreen Australia, they were also likely to become regular cervical screeners as well.

Note that there were an additional 678,575 women who participated in cervical screening from age 40 but had never been screened through BreastScreen Australia. The majority (69.1%) of these were irregular cervical screeners (Table 6.1.1).

Table 6.1.1: Cervical screening behaviour, by prior BreastScreen Australia screening behaviour, aged 40–69 at date of first BreastScreen

	Cervical screening behaviour					
	Regular screener		Irregular screener		Non-screener	
BreastScreen Australia screening behaviour	Number	%	Number	%	Number	%
Regular screener	245,365	24.7	159,893	16.1	589,349	59.2
Irregular screener	58,775	5.5	109,470	10.3	897,298	84.2
Non-screener	209,559	30.9	469,016	69.1	. .	. .

Source: AIHW analysis of linked state and territory cervical screening register data and state and territory BreastScreen register data.

When women aged under 50 at the time of their earliest recorded BreastScreen Australia round (considered early screeners, since they are not targeted by BreastScreen until age 50) were excluded from the analysis, the proportion of regular BreastScreen Australia screeners who were also regular cervical screeners rose slightly to 26.9% and the proportion who were non-screeners fell to 54.2% (Table 6.1.2).

Table 6.1.2: Cervical screening behaviour, by prior BreastScreen Australia screening behaviour, aged 50–69 at date of first BreastScreen.

	Cervical screening behaviour					
	Regular screener		Irregular screener		Non-screener	
BreastScreen Australia screening behaviour	Number	%	Number	%	Number	%
Regular screener	183,425	26.9	128,113	18.8	369,379	54.2
Irregular screener	35,471	8.1	75,923	17.4	323,973	74.4
Non-screener	209,558	30.9	469.016	69.1	. .	. .

Source: AIHW analysis of linked state and territory cervical screening register data and state and territory BreastScreen register data.

These data together indicate that women who had never had a Pap test prior to participating in BreastScreen Australia were more likely to become regular cervical screeners once they commenced and then screened regularly through BreastScreen Australia.

6.2 Screening and rescreening

The following analyses explore patterns of screening and rescreening of women aged 20–69.

Screening by symptom status

The 2005 clinical management guidelines (NHMRC 2005) introduced national cytology coding that included a recommendation for women who had symptoms at the time of their Pap test: 'RS Symptomatic—Clinical management required' (although other recommendation codes may have been used for women who had symptoms at the time of their Pap test). The number and proportion of cytology tests for which the presence of symptoms were reported in women aged 20–69 for the years 2007 to 2014 are shown in Table 6.2.1.

Cytology tests for which the presence of symptoms was reported comprised around 1.5% of all cytology tests performed each year between 2007 and 2014 (Table 6.2.1).

Table 6.2.1: Cytology tests for which symptoms were present, women aged 20–69, 2007 to 2014

	2007	2008	2009	2010	2011	2012	2013	2014
RS tests	29,412	27,444	29,627	29,972	31,541	31,142	32,442	32,335
Total tests	2,083,360	2,046,414	2,077,613	2,019,056	2,058,821	2,101,354	2,161,856	2,138,353
%	1.4	1.3	1.4	1.5	1.5	1.5	1.5	1.5

Source: AIHW analysis of linked state and territory cervical screening register data.

There were differences in the proportion of cytology tests for which the presence of symptoms were reported across states and territories (Table 6.2.2). As this is unlikely to represent a true difference in the number of women who had symptoms at the time of their screen, this indicates that there were state and territory differences in practices associated with recording symptoms and applying the recommendation code of 'RS Symptomatic—Clinical management required'. The repercussion of this is that it is not possible to know the true proportion of women who screened who had symptoms suggestive of cervical cancer.

Table 6.2.2: Proportion of cytology tests for which symptoms were present, by state and territory, women aged 20–69, 2007 to 2014

Year	2007	2008	2009	2010	2011	2012	2013	2014
NSW	1.8	1.6	1.9	1.9	1.9	1.8	1.8	1.8
Vic	2.5	2.4	2.4	2.5	2.7	2.5	2.5	2.6
Qld	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4
WA	0.6	0.8	1.1	1.1	1.2	1.2	1.4	1.3
SA	0.1	0.0	0.1	0.1	0.2	0.2	0.2	0.2
Tas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
ACT	2.1	2.3	2.1	1.7	1.9	1.8	1.7	2.0
NT	0.0	0.0	0.1	0.0	0.1	0.1	0.2	0.1

Source: AIHW analysis of linked state and territory cervical screening register data.

Rescreening after first Pap test

These analyses examine the proportion of women who participate in cervical screening who screen for a second time, and the proportion who do not. Note that a woman's first screen is the first in the period 1 January 2000 to 31 December 2014.

There were 6,909,111 women aged 20–69 who had a first Pap test between 2000 and 2014. Of these women, 5,615,696 (81.3%) screened a second time, while 1,293,415 (18.7%) did not. The proportion of women who did not have a second Pap test was relatively high for women aged 20–24 and women aged 65–69 at the time of their first Pap test (Table 6.2.3). Women aged 65–69 may not screen again once they reach the upper end of the target age group, but it is not clear why a higher proportion of women aged 20–24 do not screen again.

Table 6.2.3: Proportion of women who screened for the first time who had a second Pap test, by age at first Pap test, women aged 20–69, 2000–2014

Age group	Second Pap test		No second Pap test	
	Number	%	Number	%
20–24	1,284,403	77.2	379,229	22.8
25–29	816,445	79.7	207,677	20.3
30–34	759,849	84.0	145,136	16.0
35–39	686,640	86.5	107,461	13.5
40–44	611,710	86.3	96,806	13.7
45–49	504,515	85.1	88,548	14.9
50–54	404,302	85.1	70,954	14.9
55–59	277,385	83.6	54,589	16.4
60–64	193,012	79.5	49,687	20.5
65–69	77,435	45.3	93,328	54.7
20–69	**5,615,696**	**81.3**	**1,293,415**	**18.7**

Source: AIHW analysis of linked state and territory cervical screening register data.

The proportion of women who had a second Pap test was slightly lower for those residing in *Major cities* and *Very remote* areas; it was also slightly lower in women residing in areas of most disadvantage and slightly higher in those in areas of least disadvantage (Table 6.2.4).

Table 6.2.4: Proportion of women who screened for the first time who had a second Pap test, by remoteness area or socioeconomic area at first Pap test, women aged 20–69, 2000–2014

	Second Pap test		No second Pap test	
	Number	%	Number	%
Remoteness area				
Major cities	4,095,925	80.7	980,562	19.3
Inner regional	934,943	83.4	185,829	16.6
Outer regional	465,468	82.6	98,335	17.4
Remote	69,426	81.6	15,604	18.4
Very remote	40,738	80.5	9,869	19.5
Socioeconomic area				
1 (most disadvantage)	1,036,322	80.2	255,495	19.8
2	1,048,118	81.0	245,268	19.0
3	1,077,002	80.9	254,967	19.1
4	1,145,210	81.5	259,805	18.5
5 (least disadvantage)	1,270,981	82.6	267,815	17.4

Source: AIHW analysis of linked state and territory cervical screening register data.

Rescreening after a negative cytology test

These analyses explore rescreening after a negative Pap test. While the recommended screening interval was 2 years, women were not reminded to screen until 27 months (or in some jurisdictions 30 months) after their last negative Pap test.

A cohort of women aged 20–69 with a negative Pap test between 1 January 2007 and 31 December 2011 with a recommendation of 'R2 Repeat smear 2 years' was selected, as these women were expected to rescreen 2 years after their negative Pap test. These years were chosen as these were after the introduction of the 2005 clinical management guidelines, and also allowed for at least 3 years of follow-up after negative Pap tests.

It was found that a high proportion of women rescreened after a negative Pap test—of the 4,686,024 women identified with a negative Pap test in the selected cohort, 42.7% rescreened within 27 months (appropriate rescreening), 26.7% rescreened between 27 months and 36 months (late rescreening that may be due to women waiting to receive the 27-month reminder letter from their state or territory cervical screening register), and 15.3% rescreened at more than 36 months (late rescreening). Just 15.2% did not rescreen (note that some may have rescreened after 2014, beyond the scope of this study) (Table 6.2.5).

This means that a large proportion of women rescreened prior to receiving a reminder letter from their state or territory cervical screening register, although for around a quarter this reminder letter might have been a prompt to rescreen. Examining these trends by age, a higher proportion of younger women rescreened after 3 years, whereas older women were better at screening within 27 months or 36 months (rescreen rates for women aged 65–69 should be disregarded since a number of these would not be expected to rescreen, having reached the upper end of the target age range) (Table 6.2.5).

Table 6.2.5: Proportion of women who rescreened after a negative Pap test, by age, women aged 20–69, 2007–2011

	Rescreened within 27 months		Rescreened between 27 and 36 months		Rescreened more than 36 months		Did not rescreen	
	Number	%	Number	%	Number	%	Number	%
20–24	212,889	37.6	145,352	25.7	115,322	20.4	93,049	16.4
25–29	218,160	38.9	142,522	25.4	112,407	20.1	87,381	15.6
30–34	237,975	40.8	154,887	26.6	107,627	18.5	82,712	14.2
35–39	256,455	41.5	171,317	27.7	106,482	17.2	84,340	13.6
40–44	239,534	42.6	159,778	28.4	87,697	15.6	75,019	13.3
45–49	237,919	44.2	153,673	28.6	75,155	14.0	71,512	13.3
50–54	211,587	47.7	123,560	27.8	52,923	11.9	55,875	12.6
55–59	184,239	50.6	100,426	27.6	36,425	10.0	43,251	11.9
60–64	145,915	52.4	74,405	26.7	21,793	7.8	36,474	13.1
65–69	57,931	34.1	24,647	14.5	2,725	1.6	84,684	49.8
20–69	**2,002,604**	**42.7**	**1,250,567**	**26.7**	**718,556**	**15.3**	**714,297**	**15.2**

Source: AIHW analysis of linked state and territory cervical screening register data.

The proportion of women who rescreened within 27 months of a negative Pap test was slightly higher for those residing in *Major cities* and slightly lower in *Very remote* areas; the proportion of women who rescreened within 27 months of a negative Pap test was also slightly lower in women residing in areas of most disadvantage and slightly higher in those residing in areas of least disadvantage (Table 6.2.6).

Table 6.2.6: Proportion of women who rescreened after a negative Pap test, by remoteness area, socioeconomic area, state and territory, women aged 20–69, 2007–2011

	Rescreened within 27 months		Rescreened between 27 and 36 months		Rescreened more than 36 months		Did not rescreen	
	Number	%	Number	%	Number	%	Number	%
Remoteness area								
Major cities	1,469,436	43.3	894,324	26.4	514,206	15.2	514,179	15.2
Inner regional	336,843	41.5	226,332	27.9	126,737	15.6	122,381	15.1
Outer regional	162,246	41.3	106,275	27.1	61,856	15.7	62,371	15.9
Remote	21,482	39.1	15,071	27.4	9,335	17.0	9,033	16.4
Very remote	11,851	37.2	8,223	25.8	6,147	19.3	5,612	17.6
Socioeconomic area								
1 (most disadvantage)	330,976	39.7	221,667	26.6	135,708	16.3	145,896	17.5
2	360,533	41.4	233,333	26.8	136,864	15.7	141,030	16.2
3	390,903	42.5	244,557	26.6	141,911	15.4	141,455	15.4
4	422,470	43.4	260,872	26.8	148,728	15.3	141,846	14.6
5 (least disadvantage)	485,908	45.9	283,111	26.7	151,114	14.3	139,449	13.2
State and territory								
NSW	632,193	41.4	404,902	26.5	244,269	16.0	245,538	16.1
Vic	511,528	44.0	321,536	27.7	172,363	14.8	156,644	13.5
Qld	405,939	43.3	226,645	24.2	147,967	15.8	156,200	16.7
WA	211,317	45.2	122,204	26.1	64,522	13.8	69,418	14.9
SA	150,109	42.2	106,489	29.9	49,378	13.9	49,790	14.0
Tas	39,725	37.6	33,083	31.4	16,898	16.0	15,818	15.0
ACT	32,611	39.1	23,566	28.3	14,272	17.1	12,891	15.5
NT	19,182	39.8	12,142	25.2	8,887	18.4	7,998	16.6

Source: AIHW analysis of linked state and territory cervical screening register data.

Rescreening after a possible or definite low-grade squamous intraepithelial lesion

These analyses explore rescreening after a Pap test result of possible or definite low-grade squamous intraepithelial lesion (LSIL). A cohort of women aged 20–69 with a Pap test result of possible or definite LSIL between 1 January 2007 and 31 December 2011 with a recommendation of 'R3 Repeat smear 12 months' was selected. These years were chosen as these were after the introduction of the 2005 clinical management guidelines, and also allowed for at least 3 years of follow-up after negative Pap tests.

It was found that a high proportion of women rescreened at the appropriate time after a Pap test result of possible or definite LSIL—of the 219,910 women identified with a Pap test result of possible or definite LSIL in the selected cohort, 66.1% rescreened within 15 months, 21.6% rescreened between 15 and 27 months, 3.2% rescreened between 27 months and 36 months, and 3.8% rescreened at more than 36 months. Just 5.4% did not rescreen (although some may have rescreened after 2014, beyond the scope of this study) (Table 6.2.7).

The proportion of women who rescreened within 15 months was higher in older women than in younger women (Table 6.2.7), and clearly decreased with increasing remoteness, and decreased with increasing socioeconomic disadvantage (Table 6.2.8).

Table 6.2.7: Proportion of women who rescreened after a possible or definite LSIL on cytology, by age, women aged 20–69, 2007–2011

	Rescreened within 15 months		Rescreened between 15 and 27 months		Rescreened between 27 and 36 months		Rescreened more than 36 months		Did not rescreen	
	Number	%	Number	%	Number	%	Number	%	Number	%
20–24	40,920	58.7	17,381	24.9	3,057	4.4	3,797	5.4	4,581	6.6
25–29	30,260	61.8	11,381	23.2	1,925	3.9	2,257	4.6	3,148	6.4
30–34	17,203	69.7	4,979	20.2	670	2.7	796	3.2	1,042	4.2
35–39	15,653	71.8	4,262	19.6	496	2.3	541	2.5	847	3.9
40–44	13,484	73.4	3,450	18.8	366	2.0	356	1.9	708	3.9
45–49	12,001	75.5	2,789	17.5	279	1.8	281	1.8	549	3.5
50–54	7,564	76.9	1,657	16.8	136	1.4	126	1.3	352	3.6
55–59	4,273	78.1	869	15.9	77	1.4	64	1.2	191	3.5
60–64	2,654	79.7	480	14.4	29	0.9	30	0.9	137	4.1
65–69	1,316	72.6	153	8.4	8	0.4	3	0.2	332	6.6
20–69	**145,328**	**66.1**	**47,401**	**21.6**	**7,043**	**3.2**	**8,251**	**3.8**	**11,887**	**5.4**

Source: AIHW analysis of linked state and territory cervical screening register data.

Table 6.2.8: Proportion of women who rescreened after a possible or definite LSIL on cytology, by remoteness area, socioeconomic area, state and territory at first Pap test, women aged 20–69, 2000–2014

	Rescreened within 15 months		Rescreened between 15 and 27 months		Rescreened between 27 and 36 months		Rescreened more than 36 months		Did not rescreen	
	Number	%	Number	%	Number	%	Number	%	Number	%
Remoteness area										
Major cities	107,884	67.0	33,558	20.8	4,977	3.1	5,829	3.6	8,757	5.4
Inner regional	22,964	64.9	8,236	23.3	1,141	3.2	1,399	4.0	1,668	4.7
Outer regional	11,580	63.7	4,188	23.0	625	3.4	742	4.1	1,040	5.7
Remote	1,746	55.8	842	26.9	149	4.8	146	4.7	245	7.8
Very remote	1,000	52.3	535	28.0	137	7.2	116	6.1	125	6.5
Socioeconomic area										
1 (most disadvantage)	22,270	62.9	7,924	22.4	1,335	3.8	1,599	4.5	2,274	6.4
2	25,301	64.4	8,837	22.5	1,318	3.4	1,574	4.0	2,271	5.8
3	28,731	66.4	9,207	21.3	1,422	3.3	1,684	3.9	2,250	5.2
4	32,095	66.9	10,190	21.2	1,395	2.9	1,719	3.6	2,571	5.4
5 (least disadvantage)	35,851	68.7	10,863	20.8	1,515	2.9	1,607	3.1	2,360	4.5
State or territory										
NSW	39,073	65.2	12,847	21.4	2,058	3.4	2,484	4.1	3,500	5.8
Vic	42,421	68.6	12,603	20.4	1,736	2.8	2,068	3.3	3,037	4.9
Qld	30,274	68.6	8,388	19.0	1,373	3.1	1,700	3.9	2,371	5.4
WA	16,876	59.8	7,487	26.5	1,055	3.7	1,121	4.0	1,697	6.0
SA	9,546	66.8	3,210	22.5	400	2.8	432	3.0	692	4.8
Tas	2,958	60.4	1,317	26.9	175	3.6	203	4.1	242	4.9
ACT	2,632	68.3	849	22.0	108	2.8	108	2.8	156	4.0
NT	1,548	57.1	700	25.8	138	5.1	135	5.0	192	7.1

Source: AIHW analysis of linked state and territory cervical screening register data.

6.3 Effect of HPV vaccination on participation in cervical screening

Analysis design

Participation in cervical screening was measured as the proportion of the population that had at least one Pap test over 2 calendar years to align with the 2-year screening interval of the National Cervical Screening Program prior to 1 December 2017. The calendar years 2013 and 2014 were used, as these were the latest available on the linked data set, and would therefore provide the greatest amount of information about women who were vaccinated from 2007 onwards.

Because only women up to the age of 26 were eligible for the catch-up vaccination program (aged around 32 in 2013–2014), women aged 20–24 and 25–29 are the focus of these analyses, since they were eligible for both HPV vaccination through the catch-up vaccination program and cervical screening. Single year of age analyses are also presented to age 32.

Participants were assigned a vaccination status as at the beginning of the 2-year reporting period. The number of women vaccinated at the beginning of the 2-year period was used as the vaccinated population and the remainder used as the unvaccinated population. The population was not adjusted to remove the estimated number of women who had had a hysterectomy because of the very low rates of hysterectomy in women younger than 30.

Analysis results

Participation in cervical screening by HPV vaccination status

In 2013–2014, participation in cervical screening was higher in vaccinated women than in unvaccinated women aged 20–24 and 25–29 (Table 6.3.1). The difference for women aged 20–24 was 12.4 percentage points (45.5% compared with 33.1%) and the difference for women aged 25–29 was 12.2 percentage points (56.5% compared with 44.3%).

The participation rate for 2013–2014 was also calculated for all women using the linked data set for ages 20–24 and 25–29. This was 41.6% and 50.4%, respectively (Table 6.3.1).

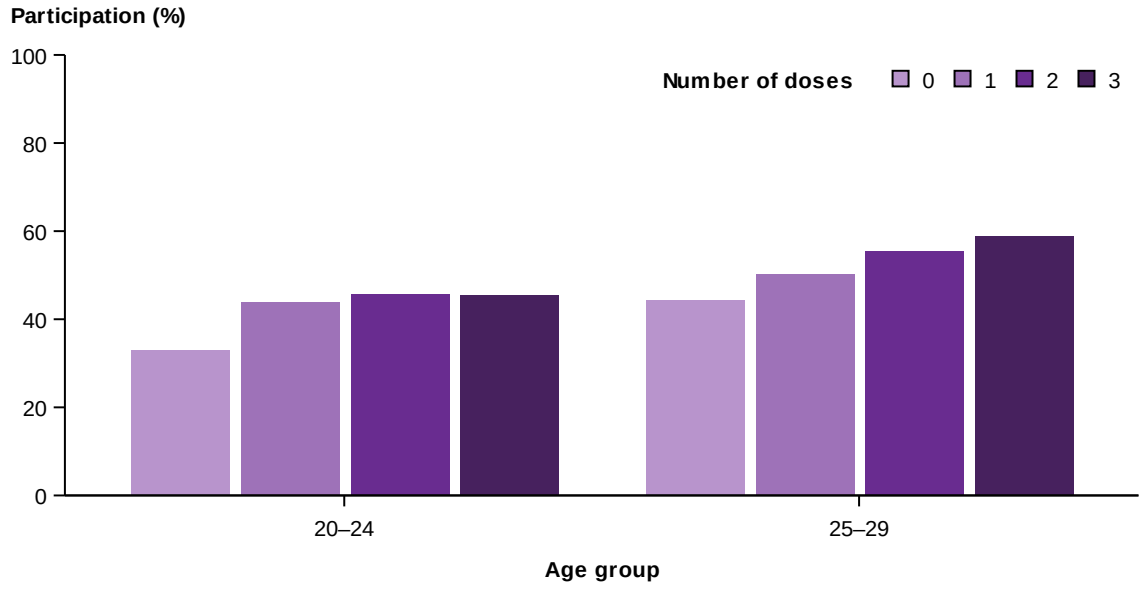
Table 6.3.1: Participation in cervical screening, by HPV vaccination status, women aged 20–24 2013–2014

	Unvaccinated		Vaccinated		Australia	
Age group	Number	Participation (%)	Number	Participation (%)	Number	Participation (%)
20–24	82,826	33.1	255,445	45.5	338,271	41.6
25–29	194,291	44.3	242,691	56.5	436,982	50.4

Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

Participation in cervical screening by vaccination status in 2013–2014 was further analysed by number of doses. Women aged 20–24 who received 1, 2 or 3 doses of HPV vaccine had similar levels of participation, at 43.8%, 45.7% and 45.6%, respectively (Figure 6.3.1). Conversely, there was a positive association between number of HPV vaccine doses and participation in cervical screening for women aged 25–29, increasing from 50.3% for women who received 1 dose, to 55.5% for women who received 2 doses, and 58.9% for women who received 3 doses of HPV vaccine (Figure 6.3.1).

Figure 6.3.1: Participation in cervical screening, by number of doses of HPV vaccine received, women aged 20–24 and 25–29, 2013–2014



Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

Participation in cervical screening in 2013–2014 by HPV vaccination status was further examined by single year of age for women aged 20 to 32 (see Table 6.3.2). Participation in cervical screening was higher in vaccinated women than in unvaccinated women for all ages Notably, this difference was at or above 10 percentage points for all ages within the 5-year age groups of 20–24 and 25–29 analysed above. Women aged 22, 23, 25 and 26 had the largest differences of around 15 percentage points. For women aged 32 there was only 1 percentage point between vaccinated and unvaccinated women.

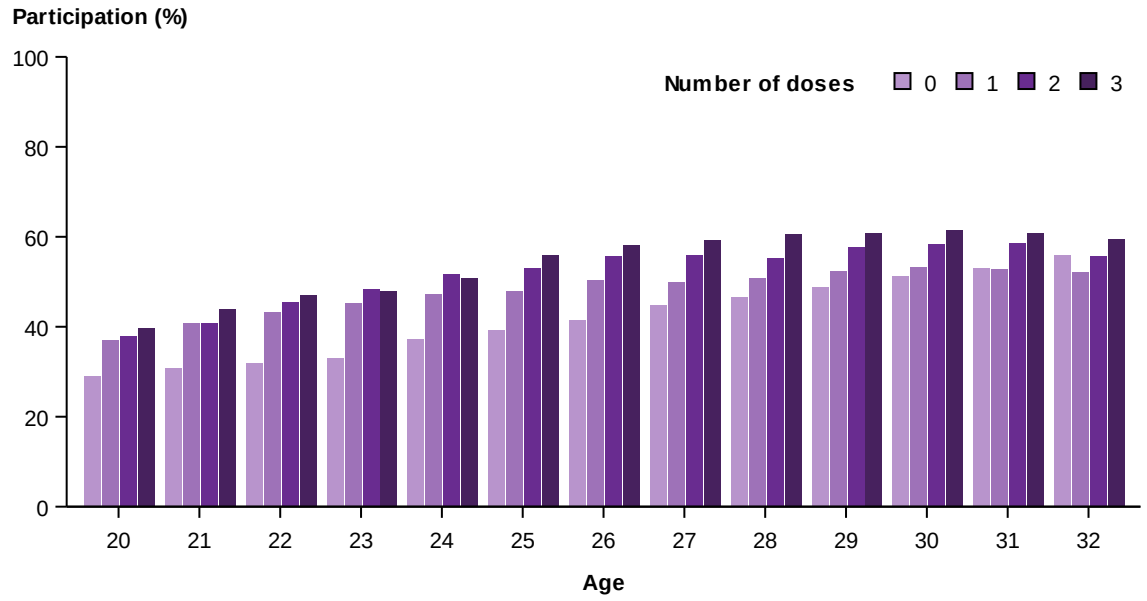
Table 6.3.2: Participation in cervical screening, by HPV vaccination status and single year of age, 2013–2014

	Unvaccinated		Vaccinated			Australia	
Age	Number	Participation (%)	Number	Participation (%)	Difference	Number	Participation (%)
20	11,082	29.0	45,376	39.5	*10.5*	56,458	36.9
21	12,420	30.8	50,311	43.4	*12.5*	62,731	40.2
22	14,590	32.0	54,151	46.7	*14.7*	68,741	42.5
23	18,599	33.1	54,301	47.9	*14.8*	72,900	43.0
24	26,135	37.3	51,306	50.5	*13.3*	77,441	45.1
25	32,311	39.3	48,055	54.0	*14.7*	80,366	46.9
26	35,863	41.5	48,050	56.2	*14.7*	83,913	48.8
27	39,669	44.7	48,231	56.8	*12.1*	87,900	50.6
28	42,284	46.6	48,830	57.4	*10.8*	91,114	51.9
29	44,164	48.7	49,525	58.4	*9.7*	93,689	53.4
30	46,943	51.2	49,416	59.2	*7.9*	96,359	55.0
31	50,284	53.0	45,405	58.9	*5.9*	95,689	55.6
32	61,968	56.0	32,788	57.3	*1.3*	94,756	56.4

Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

Examining the number of doses received for women aged between 20 and 32 illustrates trends that are not visible when the different doses are combined into a single vaccinated category (Figure 6.3.2). For instance, while participation was highest for those aged 20, 21 and 22 who received 3 doses, there was very little difference between participation in those who received 2 or 3 doses for women aged 23 and 24. In contrast, women aged 25, 26, 27, 28 and 29 all showed similar patterns of participation by HPV vaccination dose received, which is reflected in the overall participation by vaccination status seen in Figure 6.3.1.

Figure 6.3.2: Participation in cervical screening, by number of doses of HPV vaccine received and single year of age, 2013–2014



Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

Opportunistic cervical screening due to HPV vaccination

Of women aged 18–26 who had their first Pap test on or after 1 April 2007, 8.2% had their first Pap test either on the same day as their first dose of vaccine (2.9%) or between their first and last vaccine doses (5.2%).

Comparison of results previously reported

The findings from this project differed from a previous project conducted jointly by the AIHW and the VCS Foundation in 2012 (Budd et al. 2014), which found that participation was lower in vaccinated women. Further analyses were performed to try to reconcile this difference.

The first option explored was that the difference was due to a shift in participation by vaccination status over time, since the 2012 AIHW-VCS project reported participation for the 2-year period 2010–2011. Data in this study were therefore also analysed for 2010–2011. It was found that higher participation in cervical screening in vaccinated compared with unvaccinated women was also true in 2010–2011, indicating that there has been no apparent shift in participation by vaccination status over time.

The second option explored was that the difference was due to differences between states and territories, since the 2012 AIHW-VCS project included only Victorian women. Data in this study were therefore also analysed for Victoria only for the 2-year period 2010–2011. It was found that the trends in participation in cervical screening by HPV vaccination status

determined using data from the current project for Victoria mirrored those for Australia, indicating that the difference is not unique to Victoria (Table 6.3.3).

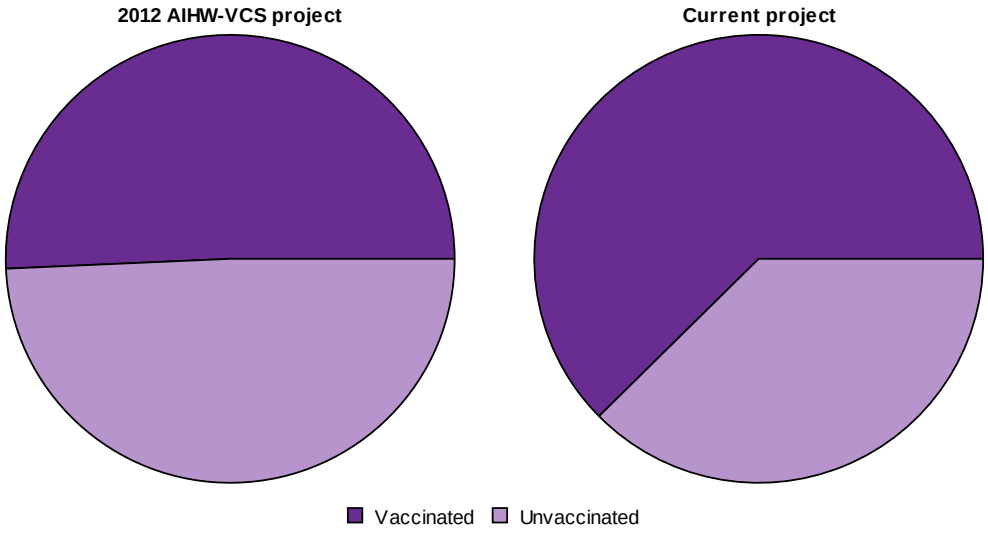
Table 6.3.3: Participation in cervical screening by HPV vaccination status, 2012 AIHW-VCS project and current project, 2010–2011

	2012 AIHW-VCS project		Current project	
Age group	Unvaccinated	Vaccinated	Unvaccinated	Vaccinated
20–24	47.7%	37.6%	33.4%	48.1%
25–29	58.7%	45.2%	46.4%	56.4%

Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

In comparing the data for Victoria from the 2 projects, it was noted that, while the overall numbers were very similar, the proportion of women identified as vaccinated was larger in the current project than in the 2012 AIHW-VCS project, as demonstrated in Figure 6.3.3.

Figure 6.3.3: Proportion of women aged 20–29 participating in cervical screening identified as vaccinated, 2012 AIHW-VCS project and current project, 2010–2011



Source: AIHW analysis of linked state and territory cervical screening register data and NHVPR data.

This means that more women who had participated in cervical screening were classified as vaccinated through being positively linked with records on the NHVPR in the current project than in the 2012 AIHW-VCS project, pointing to a difference in the data linkage process itself being responsible for the greatly differing results.

The main difference between the data linkage for the 2012 AIHW-VCS project and the current project of most relevance is that, in the current project, all data were first linked to Medicare data, which allowed personal identifiers to be updated, thereby improving the ability of the data linkage process to make positive links. This is particularly important for this age group, for which changes in surname and postcode are common. Therefore it appears that the different result is primarily due to a different method of data linkage, one which incorporates Medicare data resulting in a greater number of positive links with the NHVPR.

This is an important finding, as one of the secondary objectives of this project was to determine whether prior linkage of the NHVPR with Medicare data to update the details of girls and women vaccinated against HPV could improve the data linkage between cervical screening and NHVPR. This has been proved true by these analyses.

7 Discussion

This is the third in a series of reports to present results from a major data linkage project that linked data from the eight state and territory BreastScreen registers, the eight state and territory cervical screening registers, the National Bowel Cancer Screening Program Register, the Australian Cancer Database, the National Death Index, and the National HPV Vaccination Program Register.

The project had three main objectives, these being to:

1. determine key cancer outcomes in screening and non-screening individuals to determine whether screen-detected cancers are less likely to result in death than cancers detected outside screening programs
2. gain an understanding of the screening behaviour of participants, such as who screens, in which programs, and whether this is influenced by common factors such as socioeconomic area of residence, history of positive test results, or other events
3. use the linked data to enhance currently available screening data, such as analysis of linked cervical screening and HPV vaccination data to look at the effect of HPV vaccination on cervical abnormalities, cancers and participation in cervical screening.

The first report (AIHW 2018a) presented outcomes for breast, cervical and bowel cancers, as well as examining screening behaviour across the three cancer screening programs.

The second report, which had breast cancer and BreastScreen Australia as its focus, expanded on these findings to provide a more comprehensive picture of the survival from breast cancer detected through BreastScreen Australia, and the screening behaviour of women who participated in BreastScreen Australia.

This third report, which has cervical cancer and cervical screening as its focus, expands on, and adds substantially to, the results of the first report, providing the results of analyses on cervical cancer outcomes, cervical abnormality outcomes and cervical screening behaviour. This report also greatly enhances these analyses by investigating the effectiveness of HPV vaccination on preventing the former two, and the effects of HPV vaccination on the latter.

This report uses data collected under the previous Pap test-based National Cervical Screening Program that recommended 2-yearly Pap tests to women aged 20–69.

7.1 Objective 1: Cancer outcomes

Screen detection status and screening history were allocated to all cervical cancers in the Australian Cancer Database diagnosed in women aged 20–69 in the period 2002–2012 using Pap test data from state and territory cervical screening registers. Data from the National Death Index to the end of 2015 were used to determine if death (due to cervical cancer, or to any cause) followed these cervical cancer diagnoses.

Survival outcomes of cervical cancers diagnosed at different ages within the broad age group of 20–69 were determined according to screen detection status and screening history.

Survival from cervical cancer by screen detection status

Screen detection status categories for cervical cancer were ‘screen-detected cancers’ (a screening Pap test led directly to the detection of the cervical cancer), ‘non-screen-detected cancers in screened women’ (had previously screened, but the cancer was not detected by a screening Pap test), ‘interval cancers’ (the cancer was detected within

2.5 years of a negative screening Pap test—sometimes referred to as false negative screen), and ‘non-screen-detected cancers in never-screened women’ (no screening Pap test occurred prior to cervical cancer diagnosis).

Note that unlike the previously reported data (AIHW 2018a) that had separate categories for ‘non-screen-detected cancers after a diagnostic test’ (only Pap test prior to cancer diagnosis was less than 6 months before diagnosis) and ‘non-screen-detected cancers in never-screened women’ (no Pap test recorded prior to cancer diagnosis), data in this report use a single ‘non-screen-detected cancers in never-screened women’ category, that combines the two, since they both indicate that no screening Pap test occurred prior to diagnosis.

It was found that screen-detected cervical cancers had a 77% lower risk of causing death than non-screen-detected cervical cancers in never-screened women. Non-screen-detected cervical cancers in screened women had a 56% lower risk of cervical cancer death, and interval cancers had a 51% lower risk of cervical cancer death than non-screen-detected cervical cancers in never-screened women, consistent with these women having screened previously, even though their cancer was not screen-detected.

These figures are lower than those reported previously, that showed that screen-detected cervical cancers had an 87% lower risk of causing death than cervical cancers diagnosed in never-screened women (AIHW 2018a). This is due to the use of a different ‘never-screened’ reference group—the previous report used only women who had never had a Pap test as the reference group, while, as described above, this report combined this never-screened group with the other never-screened group of women whose only Pap test prior to diagnosis was in the 6 months preceding it (considered part of diagnosis rather than screening).

A Swedish study has also shown that screen-detected cervical cancers have a better prognosis, using cervical cancer detected due to symptoms as the comparator, and assessing survival outcomes using ‘cure proportions’, which are measures of survival that are independent of lead-time bias (Andrae et al. 2012). The study was further able to show that improved cure in screen-detected cervical cancers was largely due to these cancers being detected at an earlier stage.

Although stage data were not available in the Australian Cancer Database, it is reasonable to assume that the Swedish findings would apply for these data, and that the lower risk of death for screen-detected cervical cancers demonstrated here is due to these cervical cancers being detected at an earlier stage (also called ‘down-staging’).

Histological type of cervical cancers diagnosed may also play a role in the worse survival observed for women who have never screened, as never-screened women had a higher proportion of cervical cancers that were ‘Other or unspecified carcinomas’, and ‘Other or unspecified cancers’ (that is, not of epithelial origin), and it has been shown that women with small cell or neuroendocrine carcinomas have poorer survival (Andrae et al. 2012).

Survival from cervical cancer by screening history

Screening history categories for cervical cancer were ‘recently screened’ (indicating the last Pap test prior to diagnosis was within 2.5 years, considered within the recommended screening interval of 2 years), ‘lapsed for 2.5–3.5 years’ (indicating the last Pap test prior to diagnosis was only a little outside the recommended screening interval, so would be considered a minor lapse in cervical screening), ‘lapsed for 3.5–5.5 years’ (a medium lapse in cervical screening), and ‘lapsed for 5.5+ years’ (a major lapse in cervical screening).

It was found that cervical cancers diagnosed in recently screened women had a 60% lower risk of causing death than cervical cancers diagnosed in never-screened women, and that

women who had only a minor lapse in screening of between 2.5 and 3.5 years prior to diagnosis had a 61% lower risk. These results indicate that screening according to the recommended screening interval, or having a minor lapse in cervical screening, resulted in the lowest risk of cervical cancer death in those who were diagnosed with the disease.

Several studies have demonstrated that cervical cancers diagnosed in women who have recently screened are at an earlier stage. Andrae and others (2008) found that 50% of their case subjects who had not had a Pap test within the recommended screening interval were diagnosed with advanced cervical cancer (FIGO stage II or higher), compared with less than 19% of their case subjects who had had a Pap test within the recommended interval. Subramaniam and others (2011) found that, of women diagnosed with cervical cancer who had had a Pap test within the previous 2 years, 84% had Stage I cervical cancer, 9% had Stage II, 2% were Stage III and 4% were Stage IV. Therefore, it is likely that there is down-staging of cervical cancers diagnosed in women who have recently screened, leading to better survival.

Although younger women retained survival benefits of around 50% lower risk of death even when their Pap test prior to screening represented a medium or even a major lapse in cervical screening, this was not true for women aged 40–69, and so should not be considered an outcome for all women aged 20–69 (data showing this are due to women aged 20–39 comprising 38% of the cervical cancers diagnosed in women aged 20–69, and so results for these younger women are able to influence overall results).

These results point to a cervical cancer diagnosis in women with a recent cervical screen, particularly within the 3.5 years prior to diagnosis, resulting in a much higher likelihood of survival than for women diagnosed with cervical cancer who had never had a cervical screen, or who were lapsed screeners (especially where the last screen was more than 5.5 years prior to diagnosis).

Comparing screen detection status and screening history

While cervical cancers diagnosed in recently screened women had a 60% lower risk of causing death than those diagnosed in never-screened women, this lower risk was not as low as that found for screen-detected cancers, which had a 77% lower risk of causing death than cervical cancers diagnosed in never-screened women.

‘Recently screened women’ comprise women with screen-detected cancers, women with a low-grade Pap test within the 6 months to 2.5 years before diagnosis (a subset of the non-screen-detected cancer in screened women category), and interval cancers. Earlier it was noted that the first two of these groups have a very low rate of death from cervical cancer, at 5.9% and 5.7%, respectively, but that interval cancers have a much higher cervical cancer death rate of 12.8%. There were 1,312 interval cancers diagnosed in women aged 20–69 compared with just 354 screen-detected cancers and 297 cancers in the subset of the non-screen-detected cancer in screened women category described. With interval cancers comprising 67% of the recently screened category, the poorer outcomes for interval cancers have resulted in a comparative risk of cervical cancer death for recently screened cervical cancers that is higher than that for screen-detected cancers. To illustrate, when interval cancers were removed from the recently screened category, it was found that cervical cancers diagnosed in recently screened women had a 78% lower risk of causing death than cervical cancers diagnosed in never-screened women, while it remained the same for women who had a minor lapse of 2.5–3.5 years, at a 62% lower risk compared with never-screened women.

Around 75% of screen-detected and never-screened cervical cancers are *Squamous cell carcinomas*. In contrast, only 45.9% of interval cervical cancers are *Squamous cell*

carcinomas, with these cancers instead comprising higher proportions of *Adenocarcinomas* (40.2%), *Other and unspecified carcinomas* (6.2%) and *Other and unspecified cancers* (4.1%) than other screen detection status categories.

Interval cervical cancers by definition are diagnosed after a negative Pap test—if an abnormality was there to be seen, this is considered a false negative Pap test (a true negative Pap test would occur if there was no abnormality present at the time of the Pap test, after which a fast-growing cervical cancer developed). The high proportion of interval cancers that were adenocarcinoma (and other non-squamous cell carcinomas) is a reflection of the challenges in sampling and interpreting glandular cervical cancers and their precursors. For example, glandular cells are more difficult to sample (Sasieni et al. 2009), cervical cytology is less effective at identifying glandular abnormalities (Blomfield & Saville 2008), the cytological interpretation of abnormal glandular cells sampled (which occur much less frequently than squamous abnormalities) is more difficult, and the progression from glandular abnormality to adenocarcinoma is not well characterised (Sasieni et al. 2009; Wang et al. 2006).

As a result of these challenges, while squamous cell carcinomas have been reduced from their historical 95% (Blomfield & Saville 2008) to their current 68% of cervical cancers (AIHW 2019) as a result of cervical screening detecting high-grade squamous abnormalities before the development of squamous cell carcinomas, adenocarcinomas have not been reduced by cervical screening to the same degree. Due to this, adenocarcinomas—previously proportionately a rarer disease—now comprise 24% of cervical cancers in Australia (AIHW 2019).

In addition to adenocarcinomas being more difficult to detect through cervical screening and thus able to occur more frequently in recently screened women, the poorer survival of interval cancers compared to screen-detected cancers may be due, at least in part, to adenocarcinomas (and other non-squamous cervical cancers) having a poorer survival outcome than squamous cell carcinomas. A study by Intaraphet and others (2013) found that, regardless of stage, while small cell neuroendocrine carcinoma had poorer survival than both adenocarcinoma and squamous cell carcinoma, women diagnosed with adenocarcinoma had poorer survival than women diagnosed with squamous cell carcinoma.

These findings are consistent with cervical cancers detected through the National Cervical Screening Program leading to better survival outcomes, with good survival outcomes for women who have recently screened, even if their cancer was not screen-detected. The worst outcomes were for women who had not screened prior to being diagnosed with cancer, and it is likely that this is due to the cancer being detected at a later stage, which is associated with poorer survival outcomes.

Consistent with this, it has been found here and previously (VCS Foundation 2017) that most cervical cancers occur in women who have never screened or who are lapsed screeners. In this study it was found that, of the cervical cancers diagnosed in women aged 20–69, 51% were in women who had never screened, and 72% occurred in women who had never screened or were lapsed screeners (that is, not recently screened women).

This is more pronounced in older women—of the cervical cancers diagnosed in women aged 60–69, 68% occurred in women who had never screened and 80% occurred in women who had never screened or were lapsed screeners.

Of the cervical cancers that did occur in recently screened women, nearly half (46%) were either adenocarcinomas or other non-squamous cell carcinomas which are harder to detect through cervical screening.

Overall, these findings (by screen detection status and screening history methods) align with the recognised benefits of cervical screening in greatly reducing the incidence and mortality of cervical cancer, particularly in countries with an organised cervical screening program,

which are known to have much lower cervical cancer incidence and mortality rates than countries that do not (Bray et al. 2018).

7.2 Objective 2: Screening behaviour

Screening behaviour is determined by two factors—initiation of screening (women screening for the first time) and rescreening (women screening again). Both are required to acheive adequate levels of participation in the National Cervical Screening Program, for the greatest reductions in cervical cancer incidence, morbidity and mortality to be realised.

This report used linked cervical screening data and BreastScreen Australia to determine if there was an association between participation in BreastScreen Australia and the initiation of cervical screening in previously unscreened women, and used the linked national cervical screening data set to better understand patterns of screening and rescreening in cervical screening participants.

Analyses of linked cervical screening and BreastScreen Australia data demonstrated that women who had never had a Pap test prior to participating in BreastScreen Australia were more likely to become regular cervical screeners once they commenced screening through BreastScreen Australia. While it is beneficial that once women screen in one screening program they are more likely to then screen in another program, the differing target age groups of these programs (commencing at 20 for cervical screening and at 50 for BreastScreen Australia) means that these women who only participate in cervical screening after they participate in BreastScreen Australia have their first cervical screen far later than recommended.

An opportune and unexpected finding during this research was that many women had their cervical screening Pap test and their screening mammogram through BreastScreen on the same date, which may provide insight into ways in which screening could be made more accessible or more convenient, and possibly increase participation across all cancer screening programs (for instance a ‘One Stop’ Cancer Screening Shop has been proposed as a way to increase participation—Bobridge et al. 2017).

Earlier in this report is was demonstrated that most cervical cancers occur in women who have never screened or who are lapsed screeners. Further, even if a cervical cancer is diagnosed in screened women, the survival benefits are greatest for those in whom the cancer was screen-detected, and/or who had had a Pap test in the previous 2.5 or 3.5 years, which is likely due to the cervical cancer being diagnosed at an earlier stage than it would have been had the woman never screened, or not screened for a much longer time. This finding places emphasis on the importance of cervical screening either to prevent cervical cancers from developing, or to ensure they are diagnosed at an early stage.

While we are unable to know why women do not screen for the first time, this study was able to show that after their first Pap test, 81% of women aged 20–69 returned for a second Pap test. However it is not just important that women rescreen, but that they do so according to the recommended screening interval. After a negative Pap test, 43% of women aged 20–69 rescreened within 27 months, with a further 27% rescreening between 27 and 36 months. This latter group may represent women who rescreened only after being reminded to do so by the cervical screening register that operated in their state or territory, since reminder letters were sent only 27 months after a previously negative Pap test if no further Pap tests had been received by the register.

Remoteness area and socioeconomic area of residence are both predictors of whether a woman rescreens within 27 months—43% of women residing in *Major cities* rescreened within 27 months compared with 37% of women residing in *Very remote* areas. Similarly 46%

of women residing in areas of least disadvantage rescreened within 27 months compared with 40% in areas of most disadvantage. The proportion of women rescreening within 27 months is consistent with participation in cervical screening, measured over 24 months, being lower in areas of greater degrees of remoteness and socioeconomic disadvantage (AIHW 2019). These differences were no longer present for the proportion of women who rescreened between 27 and 36 months across these groups, except for women residing in Very remote areas, for whom rescreening remained a little lower than for women residing in other remoteness areas.

7.3 Objective 3: Enhancing screening data

This project has also allowed an investigation of the effects and effectiveness of the HPV vaccine in Australia, from participation in cervical screening, through to the detection of high-grade abnormalities, and ultimately to the development of cervical cancer.

The introduction of HPV vaccination in 2007 brought a new issue to cervical screening—a concern that girls and women, once vaccinated, would then either not commence cervical screening, or (if they had commenced cervical screening prior to vaccination) would cease cervical screening, thinking they were protected from cervical cancer.

This concern was quelled by the finding that, in the cohorts examined, participation in cervical screening was in fact higher in vaccinated women than in unvaccinated women by around 12 percentage points in the age groups of 20–24 and 25–29 examined. It was further shown that participation increased with increasing number of vaccine doses received, which provides further support for the finding that women vaccinated against HPV are more likely to participate in cervical screening.

This finding aligns with a Swedish study that also found that HPV-vaccinated women were more likely to participate in cervical screening (86% in vaccinated women compared with 75% in unvaccinated women) (Herweijer et al. 2015), and may indicate that vaccinated women are either more aware of the need to participate in cervical screening, or are more likely to take part in healthy behaviours overall. There may also be a correlation between access to HPV vaccination and access to cervical screening, since this study has revealed some barriers to cervical screening that may also exist for HPV vaccination.

Although the findings here oppose results of a similar study of Victorian data that showed that participation was lower in HPV-vaccinated women than in unvaccinated women (Budd et al. 2014), investigations revealed that the different result was due to an improved data linkage process, which included first linking HPV vaccination data to Medicare data, allowing personal identifiers to be updated with other information on Medicare, thereby improving the ability of the data linkage process to make positive links.

While it is unfortunate that what is now recognised to be an incorrect trend was published, it was nonetheless highly valuable to demonstrate the role of improving the quality of these data through prior linkage to Medicare data before data linkage to improve accuracy of positive links across cohorts such as these, in which surname and address changes are quite likely between HPV vaccination and later screening episodes. In Australia, this was achieved through prior linkage to Medicare data.

With both vaccinated and unvaccinated women now present in cervical screening data, it is possible to determine if there are any differences in the detection of high-grade abnormalities between vaccinated and unvaccinated women. This provides some insight into progression towards the long-term aim of preventing cervical cancer.

Results from these analyses indicate that women vaccinated with quadrivalent HPV vaccine have a lower incidence of high-grade abnormalities than women who have never received

the vaccine. Compared with unvaccinated women, women vaccinated with 3 doses of HPV vaccine had a 41% lower risk of any high-grade abnormality and a 57% lower risk of the precancerous abnormality of CIN3 and/or adenocarcinoma in situ.

These data are extremely promising and confirm that HPV-vaccinated women develop fewer cervical high-grade abnormalities, which aligns with previous findings (Brotherton et al. 2011; Gertig et al. 2013; Crowe et al. 2014; Palmer et al. 2019). This indicates that HPV vaccination in sexually naïve girls is able to prevent many of the HPV infections that lead to high-grade abnormalities—a requirement for the development of most cervical cancers.

It has also recently been shown that even 1 dose of HPV is able to offer some protection from high-grade abnormalities (Brotherton et al. 2019b). This result has particular relevance for developing countries that may only be able to administer 1 dose to young girls, and in this setting it is promising that HPV vaccination outside the recommended schedule may ultimately prove to be sufficient, greatly improving global reach. This is therefore an early but potentially important contribution towards the emerging evidence regarding reduced dose vaccination strategies to support the global elimination of cervical cancer (Brotherton et al. 2019b).

Analyses of linked HPV vaccination and cervical screening data in Australia have limitations that can be alleviated only by more time passing before repeating these analyses. The main issue is that there is still limited overlap between the vaccination cohort (at least of girls likely to be sexually naïve at the time of their vaccination) and the cervical screening cohort, to allow assessment of the primary measure by HPV vaccination status. In order to include sufficient women for statistically significant results, women born in 1992 or later were included. However in order to have a truly naïve cohort, these analyses ideally would have included only women born in 1994 or later; however, too few of these women had commenced screening in the years of data included in this study.

The above results from analyses of linked HPV vaccination and cervical screening data are extremely important in their own right. However, it is also very important that plans are made to enable the effectiveness of HPV vaccination in preventing high-grade abnormalities to be analysed and reported repeatedly in the future, when there is increasing overlap between females vaccinated routinely at age 12–13 and cervical screening cohorts.

Although it was expected to be too early to see an effect of HPV vaccination on cervical cancer incidence, the demonstrated reduction in precancerous abnormalities indicates that future reductions in cervical cancer are expected once more time has passed. However, this project provided an opportunity to investigate cervical cancer in HPV-vaccinated and unvaccinated females either to provide evidence that it is still too early, or to show an outcome.

Incidence rates of cervical, breast and thyroid cancer were similar between HPV-vaccinated and unvaccinated women, confirming that there are not yet sufficient data to assess this. It will be very important and highly valuable to repeat these analyses when more data are available, and ideally with HPV genotyping routinely available and recorded for all cervical cancers, given the long-term aim of the HPV vaccine to reduce cervical cancer.

These analyses, and future analyses of this type, are expected to provide valuable data on the effectiveness of HPV vaccination in the primary prevention of cervical cancer, as well as providing valuable contextual information about the environment in which cervical screening currently operates, allowing this secondary prevention strategy to change and adapt to ensure that Australian women are optimally protected from cervical cancer.

7.4 Project limitations and areas for improvement

This project had several limitations and areas where additional or improved data would provide more enriched outcome data

- Cancer outcomes and screening behaviour were not explored for Aboriginal and Torres Strait Islander people. This is a major omission, given that it is known that Aboriginal and Torres Strait Islander people have poorer outcomes and lower participation in cervical screening. Indigenous status is available on the cancer data included in this study, and it is a priority to include specific analyses by Indigenous status for this project in future if the opportunity arises.
- The Australian Cancer Database, the source of cancer data for this project, does not currently include data on cancer stage or spread. Staging data would greatly enhance this project, as it would allow the lower mortality of screen-detected cancers and recently screened cancers to be better understood and explored.
- For screening behaviour analyses, only women who appeared on a cervical screening register could be included. Women who have never screened were invisible in these analyses, which limits our understanding of why these women choose not to screen.
- The data collected and analysed were specific to the Pap test-based cervical screening program that recommended 2-yearly Pap tests for women aged 20–69. This program was renewed in December 2017, and now recommends 5-yearly HPV tests for women aged 25–74; outcomes for this renewed program will require investigation.

7.5 Where to from here?

While this report completes this data linkage project, it would be extremely valuable to repeat the key analyses from this report in the future to continue to monitor outcomes as more data become available. Importantly, this will occur within the context of a renewed National Cervical Screening Program. These include the following.

- Participation in cervical screening by HPV vaccination status to ensure that both vaccinated and unvaccinated women continue to participate in cervical screening
- Effectiveness of HPV vaccination to prevent high-grade abnormalities as more women who were vaccinated as 12 and 13 year old girls commence cervical screening, thereby producing larger cohorts for more robust analyses
- Effectiveness of HPV vaccination to prevent cervical cancer. Not yet apparent in these data, continued monitoring—ideally with HPV typing routinely available and recorded for all cervical cancers—will allow this to be reported when sufficient time has passed for the cervical cancers that would have occurred to be prevented by HPV vaccination.

These analyses would allow key aspects of the National Cervical Screening Program to be assessed to ensure that all Australian women, both HPV-vaccinated and unvaccinated, have access to a high performing, high quality and safe cervical screening program.

Appendix A: Additional data tables

Table A1: Cervical cancer mortality by screen detection status, 2002–2012

Screen detection status	HR	95% CI	*P* value
Cervical cancer mortality, unadjusted			
Screen-detected	1.0	. .	. .
Non-screen-detected in screened	1.91	1.22–3.01	0.0048
Interval cancer	2.23	1.42–3.51	0.0005
Never-screened	5.32	3.45–8.19	<0.0001
Cervical cancer mortality, adjusted			
Screen-detected	1.0	. .	. .
Non-screen-detected in screened	1.96	1.25–3.08	0.0035
Interval cancer	2.18	1.38–3.44	0.0008
Never-screened	4.42	2.87–6.82	<0.0001

Table A2: Cervical cancer mortality by screening history, 2002–2012

Screen detection status	HR	95% CI	*P* value
Cervical cancer mortality, unadjusted			
Recently screened	1.0	. .	. .
Lapsed (2.5–3.5 years)	0.94	0.69–1.27	0.6769
Lapsed (3.5–5.5 years)	1.13	0.83–1.53	0.4483
Lapsed (5.5+ years)	1.55	1.18–2.04	0.0019
Never-screened	2.95	2.53–3.43	<0.0001
Cervical cancer mortality, adjusted			
Recently screened	1.0	. .	. .
Lapsed (2.5–3.5 years)	0.97	0.71–1.32	0.8306
Lapsed (3.5–5.5 years)	1.19	0.87–1.62	0.2698
Lapsed (5.5+ years)	1.58	1.20–2.08	0.0012
Never-screened	2.50	2.14–2.92	<0.0001

Table A3: Deaths in cervical cancers by screen detection status, by age group, 2002–2012

	Screen-detected	Interval cancer	Non-screen-detected in screened	Non-screen-detected in never-screened	Total
20–39					
Diagnoses	184	550	918	946	2,598
Cervical deaths	6	48	71	165	290
Cervical deaths (%)	3.3	8.7	7.7	17.4	11.2
All deaths	7	55	84	188	334
All deaths (%)	3.8	10	9.2	19.9	12.9
40–49					
Diagnoses	87	357	423	1,021	1,888
Cervical deaths	7	32	55	253	347
Cervical deaths (%)	8	9	13	24.8	18.4
All deaths	8	40	71	308	427
All deaths (%)	9.2	11.2	16.8	30.2	22.6
50–59					
Diagnoses	52	250	241	843	1,386
Cervical deaths	3	50	39	276	368
Cervical deaths (%)	5.8	20	16.2	32.7	26.6
All deaths	6	71	57	362	496
All deaths (%)	11.5	28.4	23.7	42.9	35.8
60–69					
Diagnoses	31	155	138	701	1,025
Cervical deaths	5	38	21	265	329
Cervical deaths (%)	16.1	24.5	15.2	37.8	32.1
All deaths	10	69	37	387	503
All deaths (%)	32.3	44.5	26.8	55.2	49.1
20–69					
Diagnoses	354	1,312	1,720	3,511	6,897
Cervical deaths	21	168	186	959	1334
Cervical deaths (%)	5.9	12.8	10.8	27.3	19.3
All deaths	31	235	249	1245	1760
All deaths (%)	8.8	17.9	14.5	35.5	25.5

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Table A4: Deaths in cervical cancers by screening history, by age group, 2002–2012

	Recently screened	Lapsed (2.5–3.5 years)	Lapsed (3.5–5.5 years)	Lapsed (5.5+ years)	Never-screened	Total
20–39						
Diagnoses	904	279	258	211	946	2,598
Cervical deaths	63	21	23	18	165	290
Cervical deaths (%)	7.0	7.5	8.9	8.5	17.4	11.2
All deaths	75	25	26	20	188	334
All deaths (%)	8.3	9.0	10.1	9.5	19.9	12.9
40–49						
Diagnoses	512	130	92	133	1,021	1,888
Cervical deaths	43	18	11	22	253	347
Cervical deaths (%)	8.4	13.8	12.0	16.5	24.8	18.4
All deaths	57	21	14	27	308	427
All deaths (%)	11.1	16.2	15.2	20.3	30.2	22.6
50–59						
Diagnoses	339	66	59	79	843	1,386
Cervical deaths	56	8	12	16	276	368
Cervical deaths (%)	16.5	12.1	20.3	20.3	32.7	26.6
All deaths	82	13	16	23	362	496
All deaths (%)	24.2	19.7	27.1	29.1	42.9	35.8
60–69						
Diagnoses	208	48	36	32	701	1,025
Cervical deaths	44	4	5	11	265	329
Cervical deaths (%)	21.2	8.3	13.9	34.4	37.8	32.1
All deaths	81	12	10	13	387	503
All deaths (%)	38.9	25.0	27.8	40.6	55.2	49.1
20–69						
Diagnoses	1,963	523	445	455	3,511	6,897
Cervical deaths	206	51	51	67	959	1334
Cervical deaths (%)	10.5	9.8	11.5	14.7	27.3	19.3
All deaths	295	71	66	83	1,245	1,760
All deaths (%)	15.0	13.6	14.8	18.2	35.5	25.5

Source: AIHW analysis of linked state and territory cervical screening register data, ACD data and NDI data.

Appendix B: Positive predictive values of screening tests

The screening tests used in BreastScreen Australia, the National Cervical Screening Program and the National Bowel Cancer Screening Program, like other screening tests, are not intended to be diagnostic, but aim to identify individuals who are more likely to have cancer (or a precursor to cancer), and therefore require further investigation from diagnostic tests. The positive predictive value (PPV) of a screening test is the probability that individuals with a positive screening test have cancer (or a precursor to cancer).

For the National Cervical Screening Program, for which the screening test aims to detect precursors to cervical cancer, the PPV is calculated as the proportion of screening tests with a high-grade abnormality result that were found to be a high-grade abnormality or invasive cancer.

The screening test of the National Cervical Screening Program until 1 December 2017 was the Pap test, whereby a sample of cells collected from the cervix was examined and the result determined by a pathology laboratory. The result could range from negative, to a low-grade abnormality, high-grade abnormality or cervical cancer. Because the aim of the screening program was to identify correctly high-grade abnormalities so these could be treated prior to possible progression to cervical cancer, the PPV is the proportion of high-grade abnormalities predicted by cytology that were found on histology (in this case on histology performed within 6 months) to be a high-grade abnormality or cancer.

The PPV has been calculated for each year from 2000 to 2013. Further, because there are differences between squamous abnormalities and endocervical (glandular) abnormalities of the cervix, the PPVs of these are reported separately. These are shown in Table B1.

Table B1: Positive predictive value of a high-grade Pap test for women aged 20–69, most serious histology within 6 months of cytology performed in 2000 to 2013

Year	High-grade squamous abnormalities PPV (%)	High-grade endocervical abnormalities PPV (%)
2000	63.8	60.8
2001	65.1	56.3
2002	61.7	59.4
2003	61.3	63.4
2004	65.9	67.2
2005	63.7	68.3
2006	65.1	69.4
2007	64.2	67.1
2008	63.8	69.5
2009	66.0	74.4
2010	65.4	79.8
2011	64.6	76.4
2012	64.9	73.4
2013	64.3	73.4

Appendix C: Classifications

Classification of population groups

Cancer and screening data were analysed by remoteness area and socioeconomic area of residence. Remoteness area was classified into areas according to the 2011 Australian Bureau of Statistics (ABS) Australian Statistical Geography Standard, while socioeconomic area fifths were classified using the 2011 ABS Index of Relative Socioeconomic Disadvantage.

Geographical classification

The ability to access and provide a wide range of services is influenced by the distance between clients and providers, be it for the clients to travel to the service providers or for the providers to travel to deliver services close to a person's home. The geographical location of areas is therefore an important concept in planning and analysing the provision of services.

As already stated, geographical location was classified according to the ABS Australian Statistical Geography Standard Remoteness Structure (ABS 2011), which groups geographical areas into 6 remoteness categories, using the Accessibility/Remoteness Index for Australia. This index is a measure of the remoteness of a location from the services provided by large towns or cities. Accessibility is judged purely on distance to one of the metropolitan centres. A higher score on this index denotes a more remote location. Further information is available on the ABS website at http://www.abs.gov.au/websitedbs/D3310114.nsf/home/geography.

Residential address postcodes at time of screen for cervical screening participants were mapped to the 2011 Remoteness Structure, classified to 5 main areas: *Major cities*, *Inner regional*, *Outer regional*, *Remote* and *Very remote*. The sixth area, *Migratory*, is not used in this project. The category *Major cities* includes Australia's capital cities, except Hobart and Darwin which are classified as *Inner regional*. Participants whose postcodes were not available in the remoteness correspondence were included in an 'Unknown' geographical location grouping.

Socioeconomic classification

Socioeconomic classifications were based on the 2011 ABS Index of Relative Socioeconomic Disadvantage (IRSD) (ABS 2013). The IRSD is one of 4 Socioeconomic Indexes for Areas developed by the ABS and is based on factors such as average household income, education levels and unemployment rates. The IRSD is not a person-based measure; rather, it is an area-based measure in which small areas of Australia are classified on a continuum from most disadvantaged to least disadvantaged. This information is used as a proxy for the socioeconomic status of people living in those areas and may not be correct for each person in that area.

People were assigned to socioeconomic areas according to the IRSD of their residential postcode as per geographical classification. Socioeconomic areas (based on IRSD rankings) were calculated with a 2011 Census postal area correspondence (previously called a concordance) using a population-based method at the Australia-wide level.

The first socioeconomic area (labelled '1') corresponds to geographical areas containing the 20% of the population with the most disadvantage according to the IRSD, and the fifth group (labelled '5') corresponds to the 20% of the population with the least disadvantage.

Classification of cancer groups

Morphology refers to the histological characteristics of tumours, defined by the type of cell they involve. A tumour that involves skin cells, internal organ tissue, or lining cells is called a carcinoma, and a tumour that involves connective or supportive tissue (muscle cells, bone cells) is called a sarcoma. Each of these broad cellular types can be categorised further by their microscopic properties. The histological type of cancer is associated with different risk factors, natural behaviour history and responsiveness to therapeutic interventions.

Histological types of cervical cancer are shown in Table C1. In this project, cervical cancers were grouped further to support comparisons—the 5 groups used were *Squamous cell carcinoma*, *Adenocarcinoma*, *Adenosquamous carcinoma*, *Other specified and unspecified carcinoma*, and cervical cancers not of epithelial origin (*Other and unspecified cervical cancer*).

Table C1: Cervical cancer histology groupings

Type of cervical cancer	ICD-O-3 codes
1: Carcinoma	8010–8380, 8382–8576
1.1: Squamous cell carcinoma	8050–8078, 8083–8084
1.2: Adenocarcinoma	8140–8141, 8190–8211, 8230–8231, 8260–8263, 8382–8384, 8440–8490, 8570–8574, 8310, 8380, 8576
1.3: Adenosquamous carcinoma	8560
1.4: Other specified and unspecified carcinoma	ICD-O-3 codes for carcinoma excluding those for squamous cell carcinoma, adenocarcinoma and adenosquamous carcinoma
2: Sarcoma	8800–8811, 8840–8921, 8990–8991, 9040–9044, 9120–9133, 9540–9581, 8830, 9150
3: Other specified and unspecified malignant neoplasm	ICD-O-3 codes for cervical cancer, excluding those for carcinoma and sarcoma

Source: Based on classifications in Cancer incidence in five continents: vol. IX (Curado et al. 2007).

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Abbreviations

ABS	Australian Bureau of Statistics
ACD	Australian Cancer Database
ACT	Australian Capital Territory
AIHW	Australian Institute of Health and Welfare
AIS	adenocarcinoma in situ
CI	confidence interval
CIN	cervical intraepithelial neoplasia
CIN2	cervical intraepithelial neoplasia grade 2
CIN3	cervical intraepithelial neoplasia grade 3
HPV	human papillomavirus
HR	hazard ratio
HSIL	high-grade squamous intraepithelial lesion
IARC	International Agency for Research on Cancer
ICD-10	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision
ICD-O-3	International Classification of Diseases for Oncology, Third Edition
LSIL	low-grade squamous intraepithelial lesion
NCSP	National Cervical Screening Program
NDI	National Death Index
NHVPR	National HPV Vaccination Program Register
NSW	New South Wales
NT	Northern Territory
PPV	positive predictive value
Qld	Queensland
SA	South Australia
Tas	Tasmania
Vic	Victoria
WA	Western Australia
WHO	World Health Organization

Symbols

χ^2	chi-square statistic
—	nil or rounded to zero
. .	not applicable
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
%	per cent
±	plus or minus
p	The probability that the observed difference or association could have occurred by chance alone. If that probability is less than 5% (0.05), it is conventionally held that the observed difference is unlikely enough to be due to chance that it is evidence of a true difference or association.

Glossary

Aboriginal or Torres Strait Islander: A person of Aboriginal and/or Torres Strait Islander descent who identifies as an Aboriginal and/or Torres Strait Islander. See also **Indigenous**.

adenocarcinoma: The malignant progression of a benign **adenoma**.

asymptomatic: Describes the situation where a person has a particular disease but experiences no symptoms of it.

Australian Statistical Geography Standard (ASGS): Common framework defined by the Australian Bureau of Statistics for collection and dissemination of geographically classified statistics. The ASGS replaced the Australian Standard Geographical Classification (ASGC) in July 2011.

benign: Not malignant.

biopsy: Small sample of tissue that is taken to obtain a definitive diagnosis of an abnormality.

bowel cancer: Comprises cancer of the **colon** and cancer of the rectum, collectively known as colorectal cancer.

breast cancer: Cancer most commonly originating in the ducts of the breast (which carry milk from the lobules to the nipple) but can also originate in the lobules (small lobes of the breast that produce milk), or more rarely in the connective tissue of the breast.

BreastScreen assessment: Further investigation of a mammographic abnormality or symptom reported at screening at a BreastScreen service.

cancer: Cancer, also called malignancy, is a term for diseases in which abnormal cells divide without control and can invade nearby tissues. Cancer cells can also spread to other parts of the body through the blood and lymph systems.

cervical cancer: Cancer affecting the cells of the uterine cervix, which is the lower part (or 'neck') of the uterus where it joins the upper end of the vagina.

cervical cytology test: Cytology means 'study of cells' and, in the context of cervical screening, refers to cells from the cervix that are collected and examined for abnormalities. Cervical cytology using the Pap test was the primary screening tool of the National Cervical Screening Program prior to 1 December 2017.

cervical histology test: Examination of tissue from the cervix through a microscope, collected by a biopsy, which was the primary screening tool of the National Cervical Screening Program prior to 1 December 2017.

cervical HPV test: Assessment of the presence of oncogenic HPV types in a sample, which was used as part of 'test of cure' under the National Cervical Screening Program prior to 1 December 2017, although was also used by some practitioners where it was not indicated.

cervix: The uterine cervix is the 'neck' of the uterus, connecting the vagina to the uterus.

colon (also called large intestine)**:** Lower part of the digestive system that reabsorbs water, salt and some nutrients from digested food, forming faeces that are later passed out of the body. In this report, the bowel consists of the colon and rectum.

confidence interval: A range determined by variability in data, within which there is a specified (usually 95%) chance that the true value of a calculated parameter lies.

cytology: Cytology means ‘study of cells’ and, in the context of cervical screening, refers to cells from the cervix that are collected and examined for abnormalities.

ductal carcinoma in situ (DCIS): A non-invasive tumour of the mammary gland (breast) arising from cells lining the ducts.

eligible population: People who are eligible to participate in a cancer screening program—for bowel this comprises people registered as Australian citizens or migrants in the Medicare enrolment file, or registered with a Department of Veterans’ Affairs gold card, who reach one of the target ages; for BreastScreen Australia this comprises Australian women aged 40 and over; for cervical screening this comprises sexually active women with an intact cervix.

endocervical: Glandular.

false negative: A test that has incorrectly indicated that the disease is not present.

false positive: A test that has incorrectly indicated that the disease is present.

hazard ratio: Generated from Cox proportional hazards regression, which is used for person-time multivariable modelling, a hazard ratio is essentially the same as a rate ratio. A hazard ratio indicates how many times as high the probability of an event is in one group of people with a particular characteristic as in another group of people without that characteristic, after adjusting for other factors in the model.

histology: histology is the examination of tissue in situ (usually collected by a biopsy) through a microscope and, in the context of cervical screening, refers to tissue from the cervix. Histology is more accurate than cytology because it allows the examination of cells and other structures as they would appear in situ.

HPV: Human papillomavirus, a virus that affects both males and females. There are around 100 types of HPV, with around 40 types known as ‘genital HPV’, which are contracted through sexual contact. Persistent infection with oncogenic HPV types can lead to cervical cancer, whereas infection with non-oncogenic types of HPV can cause genital warts.

iFOBT: Immunochemical faecal occult blood test—specific type of FOBT test that requires no dietary or medicinal changes before the test. FOBTs are used to detect tiny traces of blood in a person’s faeces that may be a sign of **bowel cancer**. The immunochemical FOBT is a central part of Australia’s National Bowel Cancer Screening Program.

iFOBT result: The iFOBT results are classified by pathologists as:

- positive (blood is detected in at least 1 of 2 samples)
- negative (blood is not detected)
- inconclusive (the participant is asked to complete another kit).

incidence: The number of new cases (of an illness or event, and so on) occurring during a given period.

Indigenous: A person of Aboriginal and/or Torres Strait Islander descent who identifies as an Aboriginal and/or Torres Strait Islander. See also **Aboriginal or Torres Strait Islander**.

in situ: A Latin term meaning ‘in place or position’; undisturbed.

interval cancer: Defined in this report as a cancer diagnosed after a negative screening test. Refer to Methods for definitions for breast, cervical and bowel cancers used in this report.

invasive cancer: A **tumour** whose cells have spread locally and have the potential to spread to nearby healthy or normal tissue or to more distant parts of the body.

invitee: A person who has been invited to participate in the National Bowel Cancer Screening Program.

lead-time bias: Involves the amount of time a diagnosis of **asymptomatic** cancer is brought forward by screening. A concern with some cancers diagnosed earlier through screening is that this earlier diagnosis may make no difference to the outcome of the disease (that is, the date of death). The earlier diagnosis could therefore artificially increase (bias) survival time from that if the cancer were detected symptomatically later.

malignant: Abnormal changes consistent with **cancer**.

mammogram: A radiographic depiction of the breast.

metastasis: The process by which cancerous cells are transferred from one part of the body to another to form a secondary cancer; for example, via the lymphatic system or the bloodstream.

morbidity: Illness.

mortality: The number of deaths occurring during a given period.

National HPV Vaccination Program: This program was first introduced on 1 April 2007 as a program for females. At its inception, it comprised an ongoing vaccination program for females aged 12–13, administered through schools, and a catch-up program for females aged 13–26 between 2007 and 2009, with females aged 13–17 vaccinated through schools and females aged 18–26 vaccinated through the community. From February 2013, the current school-based program for females aged 12–13 was extended to males aged 12–13, with a catch-up program in 2013 and 2014 for males aged 14–15.

negative cytology: A satisfactory cervical cytology test in which no abnormal cells are found.

neoplasm: An abnormal ('neo', new) growth of tissue. Can be benign (not a **cancer**) or malignant (a cancer). Same as **tumour**.

non-responder: A person who was sent an invitation from the National Bowel Cancer Screening Program but did not return their screening kit for analysis.

oncogenic: Cancer-causing.

Pap test: Papanicolaou smear, a procedure to detect cancer and precancerous conditions of the female genital tract, which was the screening test of the National Cervical Screening Program until 1 December 2017. During a Pap test, cells are collected from the transformation zone of the cervix, the area of the cervix where the squamous cells from the outer opening of the cervix and glandular cells from the endocervical canal meet. This is the site where most cervical abnormalities and cancers are detected. For conventional cytology, these cells are transferred onto a slide, and sent to a pathology laboratory for assessment. Collected cells are then examined under a microscope to look for abnormalities.

participant: A person who participated in 1 of the 3 national cancer screening programs.

positive predictive value: The probability that individuals with a positive screening test have cancer (or a precursor to cancer).

positive screening test: In this project defined as a screening test that triggers diagnostic assessment—for bowel screening this is the presence of blood (even microscopic amounts) in a completed screening kit; for BreastScreen this is the identification of a suspicious area on a screening mammogram;, for cervical screening this is a Pap test result of possible or definite high-grade abnormality or cervical cancer.

screen-detected cancer: Defined in this report as a cancer diagnosed as a result of a **positive screening test**. Refer to Methods for definitions for cervical cancers used in this report.

screening: The application of a test to a population which has no overt signs or symptoms of the disease in question, to detect disease at a stage when treatment is more effective. The screening test is used to identify people who require further investigation to determine the presence or absence of disease, and is not primarily a diagnostic test.

sensitivity: A measure of how good a screening test is in identifying people with **cancer**.

socioeconomic status: A measure of socioeconomic status in which small areas of Australia are classified on a continuum from disadvantaged to affluent. See Appendix C for details.

specificity: A measure of how good a screening test is in correctly identifying those who do not have **cancer**.

tumour: See **neoplasm**.

underlying cause of death: The disease or injury that initiated the train of events leading directly to death, or the circumstances of the accident or violence that produced the fatal injury.

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Related publications

The following AIHW publications provide further information and data from the National Cervical Screening Program, and cervical cancer more broadly, and may be of interest:

- AIHW 2019. Cervical screening in Australia 2019. Cancer series no. 123. Cat. no. CAN 124. Canberra: AIHW.
- AIHW 2018. Analysis of cancer outcomes and screening behaviour for national cancer screening programs in Australia. Cancer series no. 111. Cat. no. CAN 115. Canberra: AIHW.
- AIHW 2014. National cervical cancer prevention data dictionary version 1: working paper. Cancer series no. 88. Cat. no. CAN 85. Canberra: AIHW.
- AIHW 2013. Report on monitoring activities of the National Cervical Screening Program Safety Monitoring Committee. Cancer series 80. Cat. no. CAN 77. Canberra: AIHW.

This is the third report from an Australian-first project, combining screening, cancer, death, and HPV vaccination data to demonstrate the effects of screening and HPV vaccination on cervical cancer, precancerous abnormalities and cervical screening behaviour.

Screen-detected cervical cancers were less likely to cause death than those diagnosed in never-screened women, and HPV-vaccinated women were more likely to participate in cervical screening, and less likely to have a high-grade abnormality.

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