Cervical cancer screening programme in Limpopo province: January 2007 to December 2010

Mamahlodi MT, BScMedSci
Project Manager: HIV/AIDS, National Institute for Communicable Disease; National Health Laboratory Services; School of Health Systems and Public Health, University of Pretoria
Kuonza LR, MBChB, MPH
Medical Epidemiologist, National Institute for Communicable Diseases, South Africa
Lecturer, School of Health Systems and Public Health, University of Pretoria
Candy S, BSc
Information Manager, Corporate Data Warehouse; National Health Laboratory Services
Correspondence to: Tebogo Mamahlodi, e-mail: tebogom@nicd.ac.za
Keywords: cancer, cervical smears, screening, screening coverage, Pap smear, South Africa

Abstract

Objective: South Africa launched a cervical screening policy in 2001 and aimed to screen 70% of women aged 30 years and older by the year 2010. The current study describes the performance of the cervical cancer screening programme that was implemented in the Limpopo province between 2007 and 2010.

Design: A retrospective descriptive analysis of data on cervical smears that were collected and evaluated by the National Health Laboratory Services in the Limpopo province from 2007 to 2010.

Outcome measures: Screening coverage, smear adequacy, appropriate age for screening and prevalence of pre-malignancy were calculated.

Results: Overall, 202 251 cervical smears were submitted in the Limpopo province between 2007 and 2010. The number of smears increased from 39 029 in 2007 to 63 512 in 2010. Of the 202 251 women screened, 130 911 (72.7%) were within the recommended screening age (30 years and older). Annual screening coverage rates ranged from 2.9-4.2% of the population of women aged 30 years and older. The cumulative screening coverage during the four years was 13.7%. The mean smear adequacy rate during this time was 98.5%. Of the 202 251 smears, 5 237 (2.5%) reflected high-grade squamous intraepithelial lesions, while 238 (0.2%) contained malignant lesions.

Conclusion: The cervical cancer screening programme in Limpopo improved during the study period, but still fell short of national goals. Key areas that require strengthening include low screening coverage and the screening of young women who are at less risk of acquiring cervical cancer.

Ⓟ Peer reviewed. (Submitted: 2012-10-02. Accepted: 2012-11-30.) © SASGO South Afr J Gynaecol Oncol 2013;5(1):4-10

Introduction

Cervical cancer is a public health problem globally, especially in developing countries, where 80% of cases occur.[1] While most developed countries have experienced a significant decrease in the incidence of cervical cancer over the years, the disease has become the most common cancer and the leading cancer-related cause of death among women in sub-Saharan Africa countries.[2] The majority of women who develop the disease in these countries seek treatment at advanced stages, when treatment is no longer effective.[1,2] It is estimated that at least 3 000 women die of cervical cancer in South Africa annually.[1,2]

Cervical cancer is detectable in the early stages through screening for precancerous cervical lesions using the safe and cost-effective cytology-based Papanicolaou test (commonly referred to as the Pap smear).[3] If detected in the early stages, cervical cancer is preventable or curable by surgical removal of the precancerous lesions. Population-wide cervical cancer screening programmes have been effective in reducing the incidence of the disease in developed and industrialised countries.[4] However, in most sub-Saharan African countries, cervical cancer prevention and screening programmes are either nonexistent or rudimentary.[4] Where screening programmes exist, coverage is often suboptimal because of a poorly

developed health infrastructure and inadequate health resources, as well as the existence of competing health priority programmes for human immunodeficiency virus/acquired immune deficiency syndrome and tuberculosis.[4] Because of such challenges, the majority of women in these countries do not have access to cervical cancer screening services.

South Africa launched a population-wide national cervical cancer control programme in 2001.[5] The goal of the programme was to screen at least 70% of women in the target age group (30 years of age and older) within the first 10 years of implementing the programme, and to provide at least three free Pap smears in a woman's lifetime at 10-year intervals.[5] In line with this national policy, the Limpopo Provincial Department of Health commenced a provincial cervical cancer screening programme in 2001.[6] The current article describes the performance of the cervical cancer screening programme in the Limpopo province between 2007 and 2010, with an emphasis on distribution, screening coverage, adequacy of smears and reported cytological abnormalities, using data routinely collected by the National Health Laboratory Services (NHLS).

Method

Study setting and design

The Limpopo province is located in the northern part of South Africa and is divided into five administrative districts: Waterberg, Sekhukhune, Vhembe, Mopani and Capricorn. The province has a total population of approximately 5.8 million people. Women contribute an estimated 53%.[7]

The Limpopo province implemented the cervical cancer screening programme in 2001, in line with the national cervical screening policy. The current study uses a retrospective descriptive analytic approach for data that were collected from the cervical cancer screening programme in the Limpopo province through the NHLS.

Cervical cancer screening in the Limpopo province

In line with the national cervical screening policy,[5-7] the Limpopo province offers cervical screening for free to women aged 30 years and older who access primary healthcare services in the province. After collection of the cervical smear, the women are asked to return after a period of three weeks for the cytology results. When an abnormal smear is detected, the woman is referred to an appropriate health facility for colposcopy services and further treatment.

A facility-based data-collection tool (the Pap smear register) captures the identifying and demographic information, the Pap smear results and relevant follow-up information for each screened woman. Aggregated monthly summaries are submitted to the next health unit level through the local health information system. Collected smears are sent to the local NHLS laboratory for analysis. Smears are evaluated in the laboratory by trained cytotechnicians and pathologists using the 2001 Bethesda System to report cervical cytology results.[8] All clinical specimens that are analysed within the NHLS laboratory network in South Africa are captured electronically through a real-time laboratory information system onto a centralised data repository, called the Central Data Warehouse (CDW). The data on the CDW include all the demographical information and results that are captured on the laboratory information system.

Data on smears submitted for cytology from the Limpopo province between 2007 and 2010 were extracted from the CDW database for this study. The data variables include date of smear collection, the women's ages at smear collection, the district of residence, smear adequacy and smear cytology results. Data for the period 2001- 2006 were not available for this study.

Data management and analysis

The study population comprised women with Pap smears that were submitted to the NHLS for evaluation between January 2007 and December 2010. Data were analysed using the Stata® statistical software (Release 11, StataCorp, 2009, College Station, Texas). Categorical variables were summarised using proportions (percentages). The chi-square test for trend was used for statistical significance of observed trends. A p-value of less than 0.05 (p-value < 0.05) was considered to be statistically significant. The data variables were also used to describe or evaluate various components of the cervical cancer screening programme in the Limpopo province.

The following programme indicators were evaluated:

- Appropriate age for screening was calculated as the proportion of examined smears that were collected from women over the age of 30 years.
- Smear adequacy was calculated as the proportion of submitted smears that were classified as adequate for cytological examination in the laboratory.
- The proportion of abnormal smears was calculated as the percentage of examined smears that were detected containing cytological abnormalities according to the Bethesda System.
- Smear coverage was calculated as the proportion of the targeted population for which smears were submitted for cytology. The target population was the total number of women aged 30 years and older, residing in the Limpopo province for each year.

Ethics considerations

Permission to conduct the study was obtained from the management of CDW of the NHLS. Ethics clearance was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (protocol number S184/2011).

Results

During the period under study, a total of 202 251 cervical smears were submitted to the NHLS for cytological examination through the provincial cervical screening programme in the Limpopo province. The number of submitted cervical smears increased by 60% from 39 029 in 2007 to 63 517 in 2010 (Table I). An overall increasing trend was observed across all five health districts in the Limpopo province for the observed years, except in 2009 when there was a notable decrease in all five health districts in the number of cervical smears that were submitted for examination.

Table I: Number of cervical smears submitted to the National Health Laboratory Services for cytology according to the year in the Limpopo province from 2007-2010

Year	Number of smears submitted
2007	39 029
2008	54 573
2009	45 137
2010	63 512
Total	**202 251**

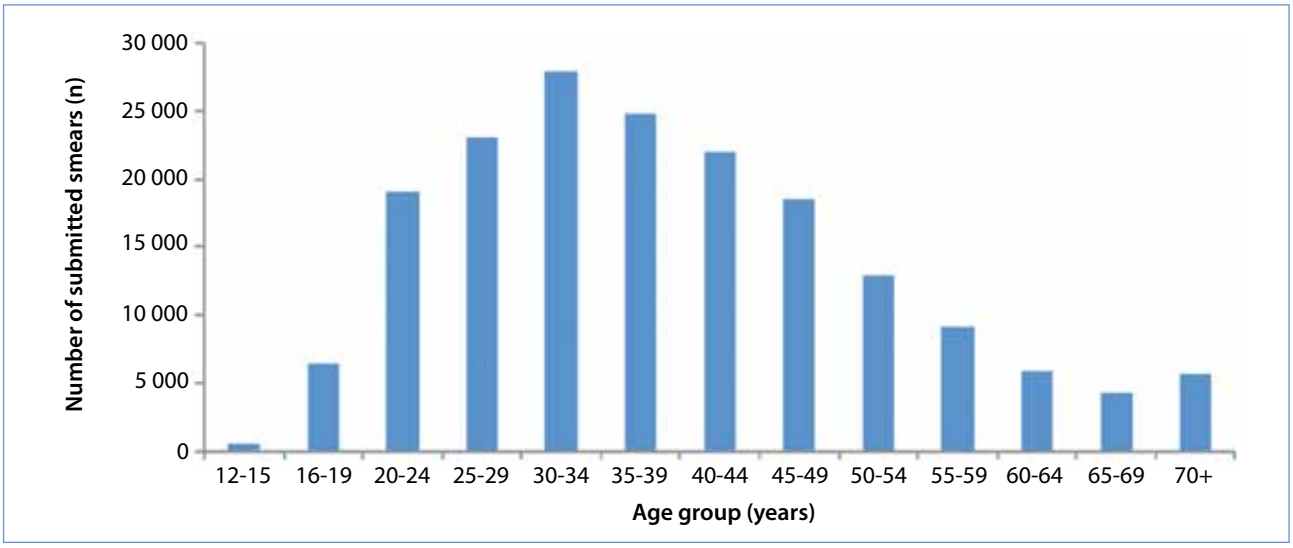
Figure 1 shows the age distribution of the women enrolled into the screening programme during the four-year period. Of the 202 251 smears, the age of the screened women had not been recorded for 22 235 (10.9%). Of the 180 016 smears where the age was captured, 116 184 (64.5%) of the women were aged between 25 and 49 years. However, the data also show that nearly a third (49 105, 27.3%) of the smears were collected from women who were below the minimum recommended age at which cervical cancer screening in South Africa is started (30 years). The proportion of collected smears from the women within the appropriate age for screening ranged from 70.9-78.6% during the four-year period (Table II).

The annual cervical screening coverage ranged from 2.9-4.2 per 100 women between 2007 and 2010 (Table III). During the four-year period, the province achieved

Table II: Proportion of smears carried out on women aged 30 years and older according to the year in the Limpopo province from 2007-2010

Year	Total smears	Smears from women older than 30 years	
		n	%
2007	33 907	26 659	78.6
2008	48 286	34 769	72.0
2009	40 153	28 466	70.9
2010	57 670	41 017	71.1
Total	**180 016**	**130 911**	**73.2**

Excludes 22 235 smears for which no age was recorded



Excludes 22 235 smears for which no age was recorded

Figure 1: Distribution of submitted Papanicolaou smears to the National Health Laboratory Services for cytology according to age group in the Limpopo province from 2007-2010

Table III: Cervical screening coverage rates among women aged 30 years and older in the Limpopo province from 2007-2010

Year	Number of cervical smears from women ≥ 30 years	Annual screening coverage per 100 women ≥ 30 years	Cumulative coverage among women ≥ 30 years from 2007 (%)
2007	26 659	2.9	2.9
2008	34 769	3.7	6.6
2009	28 466	2.9	9.5
2010	41 017	4.2	13.7

Screening coverage rates were calculated using mid-year population estimates for women aged 30 years and older, as enumerated by Statistics South Africa. They exclude 22 235 smears (10.9%) for which no age was recorded

a cumulative coverage of approximately 13.7% among women who were 30 years and older.

Table IV shows the mean smear adequacy rates for each year. During the four-year study period, the Limpopo province achieved a mean smear adequacy rate of 98.5%, well above the national minimum performance target of 70%. All five districts maintained very high smear adequacy rates.

Table IV: Adequacy rates for cervical smears submitted for cytology from each district in the Limpopo province from 2007-2010

Years	Total submitted smears	Adequate cervical smears	
		n	%
2007	39 029	38 415	98.4
2008	54 573	54 131	99.2
2009	45 137	44 799	99.3
2010	63 512	61 659	97.1
Total	**202 251**	**199 004**	**98.5**

Of the 202 251 cervical smears submitted to the NHLS for an examination during the four years, 1 806 (0.9%) were unsuitable for examination, and another 952 (0.5%) had an inconclusive morphological appearance. Table V shows the distribution of cytological diagnoses according to age category for the 199 491 smears that were successfully examined. Overall, 238 (0.2%) of the smears had malignant cells. Of 238 smears with malignant cells, 177 (74.4%) were squamous cell carcinoma, 45 (18.9%) were adenocarcinoma, and the rest (40, 16.8%) were other types of cancers.

The prevalence of malignant cells enhanced with increasing age, from 0% in women below 16 years,

Table V: Distribution of cytological diagnoses (number and percentage) according to age category among smears submitted to the NHLS from the Limpopo province from 2007-2010

Age group	Normal	AGUS	ASC-H	AIS	ASC-US	Atypia	Benign changes	HSIL	LSIL	Malignant	Total
12-15	492 (97)	0 (0)	0 (0)	0 (0)	4 (0.8)	0 (0)	0 (0)	2 (0.4)	9 (1.8)	0 (0)	507
16-19	6 153 (96.2)	1 (0)	2 (0)	0 (0)	76 (1.2)	2 (0)	0 (0)	16 (0.3)	149 (2.3)	0 (0)	6 399
20-24	17 869 (94.7)	1 (0)	3 (0)	0 (0)	213 (1.1)	1 (0)	0 (0)	107 (0.6)	670 (3.6)	1 (0)	18 865
25-29	20 839 (91.5)	1 (0)	12 (0.1)	0 (0)	279 (1.2)	2 (0)	0 (0)	393 (1.7)	1 246 (5.5)	1 (0)	22 773
30-34	24 591 (89.3)	3 (0)	25 (0.1)	0 (0)	408 (1.5)	7 (0)	1 (0)	850 (3.1)	1 644 (6.0)	7 (0)	27 536
35-39	21 818 (89.1)	4 (0)	32 (0.1)	0 (0)	303 (1.2)	7 (0)	0 (0)	858 (3.5)	1 446 (5.9)	14 (0.1)	24 482
40-44	19 525 (90.2)	5 (0)	36 (0.2)	1 (0)	254 (1.2)	7 (0)	0 (0)	709 (3.3)	1 087 (5)	17 (0.1)	21 641
45-49	16 680 (91.6)	3 (0)	37 (0.2)	0 (0)	198 (1.1)	2 (0)	1 (0)	609 (3.3)	653 (3.6)	26 (0.1)	18 209
50-54	11 811 (92.9)	4 (0)	41 (0.3)	0 (0)	114 (0.9)	6 (0)	0 (0)	396 (3.1)	316 (2.5)	24 (0.2)	12 712
55-59	8 449 (93.8)	5 (0.1)	24 (0.3)	2 (0)	89 (1.0)	4 (0)	1 (0)	249 (2.8)	164 (1.8)	23 (0.3)	9 010
60-64	5 392 (93.6)	5 (0.1)	22 (0.4)	0 (0)	53 (0.9)	7 (0.1)	1 (0)	179 (3.1)	78 (1.4)	22 (0.4)	5 759
65-69	3 889 (92.8)	5 (0.1)	13 (0.3)	0 (0)	36 (0.9)	7 (0.2)	0 (0)	148 (3.5)	64 (1.5)	30 (0.7)	4 192
70+	5 097 (92.3)	1 (0)	29 (0.5)	0 (0)	46 (0.8)	5 (0.1)	0 (0)	233 (4.2)	58 (1)	55 (1.0)	5 524
Unknown	20 373 (93.1)	1 (0)	36 (0.2)	0 (0)	179 (0.8)	3 (0)	0 (0)	488 (2.2)	784 (3.6)	18 (0.1)	21 882
Total	**182 978 (91.7)**	**39 (0)**	**312 (0.2)**	**3 (0)**	**2 252 (1.0)**	**60 (0)**	**4 (0**	**5 237 (2.5)**	**8 368 (3.2)**	**238 (0.2)**	**199 491**

AGUS: Atypical glandular cells of undetermined significance, ASC-H: atypical squamous cells (cannot exclude high-grade squamous intraepithelial lesion, ASC-US: atypical squamous cells of undetermined significance, HSIL: high-grade squamous intraepithelial lesion, LSIL: low-grade intraepithelial lesion

to 1% in women older than 70 years of age (p-value < 0.001). Similarly, the prevalence of high-grade squamous intraepithelial lesions (HSIL) increased with the advancing age of the women (p-value < 0.001). By contrast, the rate of low-grade squamous intraepithelial lesions (LSIL) decreased with increasing age (p-value < 0.001). However, 18 (7.6%) of the 238 smears with malignant cells and 488 (9.3%) of the 5 237 smears with HSIL showed no record of the age of the screened woman.

Discussion

The findings show a steady increase in the number of cervical smears that were submitted for cytology between 2007 and 2010 in the Limpopo province. At the launch of the national cervical cancer control programme in 2001, the goal was to incrementally increase coverage, and ultimately to screen at least 70% of women in the target age group within 10 years of initiation of the programme.[5,9] In order to achieve this goal, health departments and partner organisations made some effort at community level, for example, through regular media campaigns, to educate, inform and invite women for screening. In addition, the number of health professionals who were trained in the collection and evaluation of smears also increased.[5,9,10] Possibly, these efforts contributed to the increase in the number of women who presented for cervical screening.

Almost a third of the smears were collected from women below the age of 30 years. In South Africa, the national cervical cancer screening policy recommends screening from the age of 30 years. Some previous studies that were carried out in South Africa also reported that screening was generally performed in younger women.[11] Currently, most parts of the country do not offer population-wide cervical screening. Health facilities conduct opportunistic screening that mainly targets women seeking postnatal care and family planning services. Women seeking such services are generally younger, which partly explains why a higher proportion of the smears were carried out in these younger women.

Over the past decade, epidemiological evidence has shown that HIV-positive women have a higher prevalence of human papilloma virus infection (a precursor of cervical cancer) and are at higher risk of fast progression to cervical cancer.[12] Although the national guidelines did not specify the appropriate age for cervical screening in HIV-positive women until recently, in 2010, it is possible that some of the screening that was carried out on younger women was performed as routine screening on HIV-positive women. In addition, poor knowledge and awareness of the appropriate age for screening among staff conducting the cervical screening possibly contributed to screening of women below the recommended age.[5,9,10,13] Performing smears on women who fall outside the population targeted by the screening programme diverts much-needed resources from the population at highest risk of the disease, and thus undermines the screening programme.

Our findings show that LSIL were more prevalent in younger women and the prevalence decreased with advancing age. According to the Bethesda System for reporting cervical cytological diagnoses, the LSIL category includes changes that are consistent with the human papillomavirus (HPV) infection, mild dysplasias and Grade 1 cervical intraepithelial neoplasias.[14] Epidemiological data show that the incidence of HPV infection increases after the onset of sexual activity, peaks around the age of 30 years, and then declines with increasing age.[15,16] This is because the majority of HPV infections regress to normal within a few months following the infection,[16,17] thus explaining the inverse relationship between the prevalence of LSIL and increasing age. Similar patterns have been reported in studies that have been conducted in other parts of the country.[17-19]

The data also show that the prevalence of HSIL and malignant lesions increased with advancing age from the age of 30 years approximately. These findings seem to support the current national cervical screening policy, which recommends the screening of women who are 30 years and older. Screening women above the age of 30 years has been found to be more effective in preventing stage 1B or even more advanced cervical cancer in older, rather than younger women.[19] However, our findings also show that 0.7% of the smears that were carried out in women younger than the age of 20 years reflected HSIL. This seems to pose a challenging question about when it is ideal to commence cervical screening. Some recent literature has suggested that the incidence of cervical dysplasia among adolescents has been on the increase.[20] Mostly, this has been attributed to early onset and increased sexual activity among young women, leading to increased exposure to HPV infection and resultant cervical abnormalities.[19,20] Nonetheless, a number of studies have also shown that the majority of these preinvasive cervical lesions in adolescents will regress to normal without any intervention.[20] Screening programmes in developed countries have recommended the commencement of cervical screening from as early as 20 years old.[14,20]

Attaining high coverage rates in the target population is crucial for the success of any screening programme. The screening programme in Limpopo achieved a cumulative screening coverage of approximately 13.7% during the four years of study. South Africa, like most other developing countries, is characterised by a low coverage of cytology-based cancer screening programmes.[18,21] When the screening programme was

launched in 2001, the target was to screen at least 70% of women aged 30 years old and older by 2010. Although screening coverage rates for the period 2001-2006 could not be obtained, our findings suggest that the province may have failed to meet these targets. To achieve the 70% coverage target, the province needed to achieve annual coverage rates in excess of 7% for the 10 years. Other provinces in the country have also failed to meet this target.[21-23] Although there were notable increases in screening coverage rates across all the provinces between 2007 and 2010, none of the provinces achieved the target of 70%.[24]

Several issues have been cited to explain the low coverage rates, including lack of awareness among the target population; inadequate trained personnel to perform the screening tests, read smears and interpret the results; poor communication between the screening sites and laboratories; and inaccessibility of the facilities to diagnose and treat patients who have been detected through the screening process.[25,26] In addition, population-based surveys, conducted in settings similar to those in South Africa, have reported gross inequalities in screening coverage.[27] The women who are at highest risk of developing cervical cancer are among the least likely to be screened.[28] However, it is encouraging to note the gradual increase in screening coverage that occurred annually between 2007 and 2010.

Evaluation of smear specimen adequacy is considered to be an important quality assurance procedure in the laboratory in increasing the possibility of intraepithelial lesion detection and minimising the risk of false negative reporting.[29] This is especially important in resource-limited settings, such as South Africa, where a woman may undergo screening only once in her lifetime.[29,30] Conventionally, a cervical smear is considered to be satisfactory for evaluation if it has an estimated minimum of 8 000-12 000 clearly displayed squamous epithelial cells.[29,30] The Limpopo province recorded high smear adequacy rates throughout the study period.

Recent scientific evidence has shown that a visual inspection of the cervix with acetic acid, and oncogenic HPV testing, are effective alternatives to the traditional cytology-based Pap smear test.[31,32] Scientists have suggested that these new screening methods may well be more cost-effective and useful in countries with limited resources where the majority of the existing screening programmes have not shown clinically significant reductions in the incidence of cervical cancer.[26,31,33] Recently, the American Cancer Society released new guidelines for the early detection of cervical precancerous lesions and cancer, recommending concurrent screening using both the Pap smear and the HPV test.[34] However, in South Africa, even if the government does incorporate new screening methods into the national cervical screening policy, the existing low screening coverage rates will remain a considerable hindrance to the success of the screening programme.

Our study has some limitations that should be taken into consideration when interpreting the findings. Firstly, it relied on secondary data that had limited data elements. The success of a screening programme hinges upon the availability and accessibility of follow-up treatments for patients who are detected through screening. Our analysis could not evaluate the performance of the screening programme in terms of the follow-up treatments of patients who were detected through the provincial screening programme. Secondly, patients screened in the provincial screening programme were not allocated the same laboratory identification number during follow-up visits. Therefore, it is possible that some women could have presented for screening more than once during the four-year study period, and were captured more than once in the CDW database. Thirdly, 10.9% of the entries in the database had a missing date of birth, mainly owing to incompleteness of information during data collection and capturing of data in the main data warehouse. This could have resulted in underestimation of the appropriate age of screening and coverage. Fourthly, the analysed data in this study excluded women for whom cervical smears had been collected in private healthcare facilities and sent to private laboratories for analysis. This could also have resulted in underestimation of true screening coverage in the province. Despite these limitations, we believe that these findings provide a good account of the performance of the cervical cancer screening programme in the Limpopo province during the period.

Conclusion

The cervical cancer screening programme in Limpopo showed some improvement during the four-year study period, but still fell short of the national goals. The key areas that require strengthening include increasing the screening coverage among women at higher risk (30 years and older), and reducing the screening of younger women who are at a lower risk of cervical cancer. Future studies should explore the factors that contribute to the low coverage rates, and also examine the availability and uptake of follow-up treatments for women with abnormal diagnoses that are detected through the screening programme.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

The authors are grateful to staff from the South

African Field Epidemiology and Laboratory Training Programme, the School of Health Systems and Public Health at the University of Pretoria, and the National Institute for Communicable Diseases for valuable technical contributions in terms of the analysis and interpretation of data. The authors also acknowledge the staff from the Limpopo Department of Health who participated in the cervical screening programme, and the staff from the NHLS for reading the smears and capturing all the relevant data.

References

1. WHO/ICO Information Centre on HPV and Cervical Cancer (HPV Information Centre). Human papillomavirus and related cancers world report. World Health Organization [homepage on the Internet]. 2010. c2011. Available from: http://apps.who.int/hpvcentre/statistics/dynamic/ico/country_pdf/GBR.pdf
2. WHO/ICO Information Centre on HPV and Cervical Cancer (HPV Information Centre). Human papillomavirus and related cancers in South Africa. World Health Organization. 2010. c2011. Available from: http://apps.who.int/hpvcentre/statistics/dynamic/ico/country_pdf/ZAF.pdf
3. Koss LG. The Papanicolaou test for cervical cancer detection: A triumph and a tragedy. JAMA. 1989;261(5):737-743.
4. Sherris J, Herdman C, Elias C. Beyond our borders: cervical cancer in the developing world. West J Med. 2001;175(4):231-233.
5. National guidelines on cervical cancer screening programme. South African Department of Health [homepage on the Internet]. 2000. c2011. Available from: http//www.doh.gov.za/docs/index.html
6. National Health Laboratory Services, South Africa. Monthly collated data (2001) from cytology coordinator.
7. Statistics South Africa. Mid-year population estimates. Pretoria: Statistics South Africa; 2007.
8. Fidda N, Miron J, Rodgers WH, Rader A. Impact of the new Bethesda system 2001 on specimen adequacy of conventional cervicovaginal smears. Diagn Cytopathol. 2004;30(4):235-239.
9. Pillay AL. Rural and urban South African women's awareness of cancers of the breast and cervix. Ethn Health. 2002;7(2):103-114.
10. Ndlovu BH. Awareness, knowledge and experiences of women regarding cervical cancer in rural Kwazulu-Natal, South Africa. Unpublished master's thesis. Stellenbosch University, Stellenbosch; 2011.
11. Jassat W. An evaluation of the cervical screening programme in Johannesburg metro district, Gauteng province. Unpublished research report. University of the Witwatersrand, Johannesburg; 2010.
12. Cronje HS, Trumpelmann MD, Divall PD, et al. Cervical cytological services in the Orange Free State: demographic characteristics. S Afr Med J. 1989;76(11):615-618.
13. Preventing cervical cancer worldwide. Alliance for Cervical Cancer Prevention [homepage on the Internet]. 2005. c2012. Available from: http://www.alliance-cxca.org/documents/PRBPolicybriefPreventCervCancerPB_Eng.pdf
14. Saslow D, Solomon D, Lawson HW, et al. American Cancer Society, American Society for Colposcopy and Cervical Pathology, and American Society for Clinical Pathology screening guidelines for the prevention and early detection of cervical cancer. Am J Clinic Pathol. 2002;137(4):516-542.
15. Franco EL, Rohan TE, Villa LL. Epidemiologic evidence and human papilloma virus infection as a necessary cause of cervical cancer. J Natl Cancer Inst. 1998;91(6):506-511.
16. Bosch FX, De Silva S. Chapter 1: human papilloma virus and cervical cancer: burden and assessment of causality. J Natl Cancer Instit Monogr. 2003;(31):3-13.
17. Denny L. Prevention of cervical cancer. Reprod Health Matters. 2008;16(32):18-31.
18. Denny L. Cervical cancer in South Africa: an overview of current status and prevention strategies. CME. 2010;28(2):70-73.
19. Van Boegaert LJ, Knapp DC. Opportunistic testing of medically underserved women for cervical cancer in South Africa. Acta Cytol. 2001;45(3):313-316.
20. The impact of cervical screening on young women: a critical review of the literature 2002-2009. NHSCSP [homepage on the Internet]. 2010. c2012. Available from: http://www.cancerscreening.nhs.uk/cervical/publications/nhscsp31.pdf
21. Fonn S, Bloch B, Mabina M, et al. Prevalence of pre-cancerous lesions and cervical cancer in South Africa: A multi-centre study. S Afr Med J. 2002;92(2):148-156.
22. Cronje HS. Screening for cervical cancer in the developing world. Best Pract Res Clin Obstet Gynaecol. 2005;19(4):517-529.
23. Cervical cancer screening in developing countries: report of a WHO consultation. Geneva: World Health Organization; 2002.
24. Cervical cancer screening coverage. Health statistics/health status/chronic diseases. Health Systems Trust [homepage on the Internet] 2010/2011. c2012. Available from: http://indicators.hst.org.za/healthstats/263/data
25. Sankaranarayanan R, Gaffikin L, Jacob M, et al. A critical assessment of screening methods for cervical neoplasia. Int J Gynaecol Obstet. 2005;89(Suppl 2):S4-S12.
26. Denny L, Quinn M, Sankaranarayanan R. Chapter 8: screening for cervical cancer in developing countries. Vaccine. 2006;24 Suppl 3:S3/S71-S77.
27. Kawonga M, Fonn S. Achieving effective cervical screening coverage in South Africa through human resources and health systems development. Repord Health Matters 2008;16(32):32-40.
28. Denny L. Cervical cancer: prevention and treatment. Disco Med. 2012;14(75):125-131.
29. Sheffield MV, Simsir A, Talley L, et al. Interobserver variability in assessing adequacy of the squamous component in conventional cervicovaginal smears. Am J Clin Pathol. 2003;119(3):367-373.
30. Kawonga M, Moodley J, Bradley J, Hoffmann M. Volume I: a guide for programme managers. Cervical health implementation project: implementation of cervical screening in South Africa. University of Cape Town, Witwatersrand University Engender Health; 2004.
31. Denny L. The prevention of cervical cancer in developing countries. BJOG. 2005;112(9):1204-1212.
32. Sankaranarayanan R, Nene BM, Shastri SS, et al. HPV screening for cervical cancer in rural India. N Engl J Med. 2009;360(14):1385-1394.
33. Sankaranarayanan R, Budukh A, Rajkumar R. Effective screening programs for cervical cancer in low- and middle-income developing countries. Bull World Health Organ. 2001;79(10):954-962.
34. Cervical cancer: prevention and early detection. American Cancer Society [homepage on the Internet]. c2012. Available from: http://www.cancer.org/acs/groups/cid/documents/webcontent/003167-pdf.pdf