Scientific African 21 (2023) e01889

Contents lists available at ScienceDirect

Scientific African

journal homepage: www.elsevier.com/locate/sciaf

Implementing HPV-DNA screening as primary cervical cancer screening modality in Zimbabwe: Challenges and recommendations

Grant Murewanhema [a], Mathias Dzobo [b], Enos Moyo [c], Perseverance Moyo [b], Tasimba Mhizha [d], Tafadzwa Dzinamarira [b,e,*]

[a] Unit of Obstetrics and Gynaecology, University of Zimbabwe, Harare, Zimbabwe
[b] Department of Public Health, University of Pretoria, Pretoria, South Africa
[c] Department of Public Health, Oshakati Medical Centre, Oshakati, Namibia
[d] Clinton Health Access Initiative, Harare, Zimbabwe
[e] ICAP at Columbia University, Harare, Zimbabwe

ARTICLE INFO

Editor: DR B Gyampoh

Keywords:
Cervical cancer
Screening
Human papillomavirus
HPV-DNA
Zimbabwe

ABSTRACT

The World Health Organisation's 90–70–90 cancer strategy is premised upon the implementation of human papillomavirus deoxyribonucleic acid (HPV-DNA) testing as the primary cervical cancer screening modality. The ultimate aim is to reduce the age-standardized incidence of cervical cancer to less than 4 per 100 000 by the end of the 21st century and eliminate the disease as a significant global health concern. Zimbabwe, like other countries in sub-Saharan Africa, has a high burden of cervical cancer, with data from the Zimbabwe National Cancer Registry showing that cervical cancer is the leading cause of cancer deaths among women. This is despite visual inspection of the cervix with acetic acid (VIA) and cytology being available as screening modalities. These programs have suffered several implementation challenges, and the success of implementing HPV-DNA screening programs will depend partly on addressing the challenges that have been faced by these pre-existing programs. Additionally, other challenges unique to HPV-DNA testing must be anticipated with adequate measures put in place to avert these potential challenges. This calls for a close collaboration between academia, clinicians, public health stakeholders, policymakers, and implementing partners to ensure the success of the program and avert cervical cancer deaths.

Introduction

Cervical cancer remains a leading gynecological malignancy. In 2018, 570 000 new cases of cancer were diagnosed globally, and an estimated 311 000 women died from the disease [1]. Cervical cancer accounts for considerable morbidity and is a leading cause of cancer deaths among women in sub-Saharan Africa (SSA). Nineteen of the top 20 countries with the highest cervical cancer globally are in SSA [2]. Yet, this is one of the most well-understood and preventable cancers. Zimbabwe is one of the high-burden countries. According to GLOBOCAN estimates, the age-standardized incidence of cervical cancer in the country is 61.7 per 100 000 women [3].

* Corresponding author.
E-mail address: u19395419@up.ac.za (T. Dzinamarira).

https://doi.org/10.1016/j.sciaf.2023.e01889
Received 6 January 2023; Received in revised form 11 August 2023; Accepted 5 September 2023
Available online 6 September 2023

The Zimbabwe National Cancer Registry (ZNCR) shows that in the country, the incidence has risen gradually from 2005 to 2018, with cervical cancer emerging as the leading malignancy among women in Zimbabwe [4]. In 2020, cervical cancer accounted for 29.4% of all new cancer cases diagnosed among females in the country [5].

Ninety-nine percent of all cervical cancers are caused by high-risk human papillomavirus (HPV) genotypes [1]. However, HPV is a necessary but not sufficient cause of cervical cancer. There are several known high-risk HPV genotypes, but types 16 and 18 cause at least 70% of cervical cancers. Other high-risk HPV genotypes of considerable clinical and public health significance include 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, and 68 [6]. HPV is ubiquitous and highly transmissible at sexual contact, with evidence pointing towards high levels of exposure during the early years of sexual life [6]. Immunocompetent persons will clear the virus spontaneously, with up to 90% of individuals having achieved clearance by 24 months. Repeated exposures, especially among immunocompromised individuals confer chances of persistence of cervical HPV infection, the risk factor for cervical carcinogenesis [7].

Decades of research have led to an advanced understanding of the natural history of the development of invasive cervical cancer from the time of initial HPV infection. It is established that in general, the process of carcinogenesis takes place over a period of time spanning over a decade or more [7]. This has provided public health with unique opportunities to detect changes that lead to cancer and provide curative treatment modalities before the development of invasive cancer [8]. This secondary prevention through screening modalities including cytology and visual inspection methods has been utilized globally and led to marked reductions in the burden of cervical cancer in countries with advanced screening programs [8]. However, in resource-limited countries in sub-Saharan Africa, the implementation of comprehensive screening programs has faced several challenges and barriers, limiting their effectiveness at a public health level [9]. Hence, in Zimbabwe, despite the availability of screening programs, the burden of cervical cancer has continued to increase [4].

The development of safe and effective HPV vaccines represents a welcome development in the prevention of cervical cancer. Bivalent, quadrivalent, and nonavalent HPV vaccines are available and utilized to different extents in different countries depending on resource availability [10]. Zimbabwe has a national HPV vaccination program for adolescent girls rolled out in 2018 after a pilot demonstration project in Beitbridge and Marondera in 2014 that achieved greater than 80% coverage of the target population [11]. The combination of primary prevention through HPV vaccination and secondary prevention through screening with a high-performance test is projected to eventually lead to the elimination of cervical cancer. These prevention measures are significant public health measures that will result in a reduction of age-standardized incidence rates to less than 4 per 100 000 by the end of the 21st century [12].

HPV-DNA testing is a high-performance cervical cancer screening modality that is now recommended by the World Health organisation (WHO) as a primary screening modality, with several advantages over VIA methods and cytology methods. As part of moving towards achieving the WHO 90–70–90 strategy for the elimination of cervical cancer, it is highly recommended that countries move to HPV-DNA-based screening, with VIA and colposcopy as triaging methods for HPV-DNA positive individuals and treat and see strategies with thermal ablation [13]. In line with WHO recommendations, the Ministry of Health and Child Care (MoHCC) of Zimbabwe is planning a shift towards the implementation of nationwide HPV-DNA testing as the primary cervical cancer screening modality. In this article, we discuss why VIA and cytology have faced implementation challenges in Zimbabwe and other low-resource settings. We discuss the advantages of HPV-DNA testing over the traditional screening modalities, the challenges the country is likely to face in the implementation of HPV-DNA testing and offer recommendations to advance the use of HPV-DNA screening.

Methodology

For this article, we conducted a literature review on available cervical cancer screening programs, the challenges of implementing these programs in low-resourced countries, the advantages of HPV-DNA screening over traditional screening modalities, HPV-DNA implementation challenges, and the recommendations to address the challenges, with special focus on Zimbabwe. We searched for articles published in English from the WHO website, and peer-reviewed articles from ScienceDirect, Google Scholar, SCOPUS, MEDLINE, Africa Journals Online (AJOL), and PubMed databases. The keywords that were used in the literature search were 'cervical cancer', 'screening modalities', 'screening programs', 'implementation challenges', 'HPV-DNA screening advantages', 'recommendations', 'low-resourced countries', and 'Zimbabwe'. Boolean operators 'AND' and 'OR' were used to retrieve articles that have both terms or either term, thereby delimiting the search. We used wildcard and truncation symbols to expand a search term to include all forms of the root word.

Current cervical cancer screening programs

Visual inspection with acetic acid (VIA) and conventional cytology (Papanicolaou smears) are the most commonly utilized cervical cancer screening modalities in SSA [9]. Only 20% of African nations had nationwide cervical cancer screening programs as of 2019, including South Africa, Botswana, Rwanda, and Zimbabwe [9]. The majority of these had screening coverage of less than 10% [12].

Visual inspection with acetic acid

VIA is straightforward, cheap, easy, and relatively effective and has helped increase access to screening in low-resource settings like Zimbabwe. The process involves swabbing acetic acid on the cervix and then visually observing for areas that change color (aceto-whitening). Abnormal tissues like those found in pre-cancerous lesions turn white [14]. The healthcare worker (HCW) then removes these tissues using ablative methods such as thermal ablation or cryotherapy or refers for more complicated observations [14]. VIA

offers a single-visit screen-and-treat approach which has helped increase screening coverage, reaching traditionally underserved clients that may have had difficulty coming for multiple visits for follow-up care [14]. VIA has been the backbone of cervical cancer screening in Zimbabwe, but it is offered only up to the district level. The VIA program in Zimbabwe was set up coupled with cryotherapy to facilitate a one-day see-and-treat approach [15]. Regular screening intervals with VIA are quite frequent, at 3–5 years for HIV-negative women and yearly for women living with HIV [13].

Cervical cytology

Cervical cytology has been the gold standard for detecting cervical malignancy in women since the 20th century [16]. In conventional cytology, commonly referred to as the Pap smear, HCWs scrape cells from the surface of the cervix for analysis under a microscope, checking for abnormal cells in the cervix that could lead to cervical cancer if left untreated [16]. Liquid-based cytology has also been introduced but has not gained popularity in public health sector settings, despite the advantage of offering reflex HPV-DNA testing [16].

Implementation challenges of the current screening programs in resource-limited settings

Whilst there are challenges applicable to both VIA and cytology, some are specific to each procedure. We categorized the implementation challenges into client-related and health system-related factors to facilitate discussion. These are summarised in Fig. 1.

Client factors

The utilization of VIA and cytology for cervical cancer screening (CCS) by women in SSA remains low [9]. Only 13.4% of participants in a Zimbabwean study said they had ever undergone a cervical cancer screening [17]. Several studies in SSA associated the poor uptake of these screening services with poor knowledge of cervical cancer and screening. Forty-one percent of the participants in a study in a rural area of Zimbabwe had inadequate awareness of screening, negatively affecting the utilization of these services [18]. Some women have a low-risk perception of cancer, leading to less likelihood of utilizing screening services. Additionally, some women choose not to use the services due to shame about the intimate nature of these screening techniques, particularly in cases when male HCWs performed the procedures [19]. Some women were afraid of the procedures, worried about the pain, or believed certain myths about them, including the idea that they might induce cancer or expand the vagina. Due to the fear, some women have with cancer diagnoses, they choose not to be screened. Poor use of CCS services has been linked to a lack of financial and emotional support from a spouse or family [20]. Point-of-care payment for the procedures has also been associated with low utilization [21].

Health system / institutional factors

Health system challenges include human resources, equipment, and the infrastructure required to carry out the procedures [20]. CCS cannot always be conducted at some healthcare facilities due to staffing deficits. Furthermore, there may not be any HCWs trained to carry out the procedures at some facilities [21]. Not all healthcare facilities offer these procedures, making it difficult for women, especially those in rural areas to access the services. Some of the women may not have enough money to pay for transport to go to the nearest healthcare facility where the procedures are offered [18]. Lengthy waiting times, the attitude of HCWs, or the procedures only being performed at specific hours or days of the week can be significant barriers to access [19].

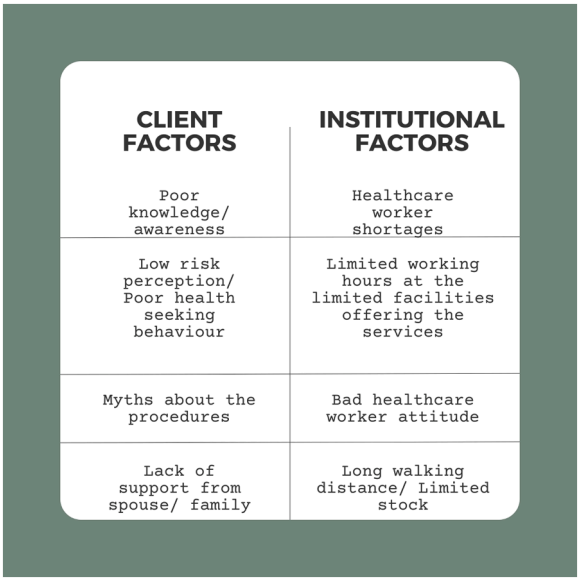

Fig. 1. Implementation challenges of the current screening methods.

Countries in SSA, including Zimbabwe, have a shortage of cytopathologists and pathologists required to process the Pap smear samples [21]. The national Pap smear screening program in Zimbabwe was stopped due to limitations in manpower and infrastructure. Even where women had a Pap smear performed, some did not return for their results due to long turnaround times, especially in public healthcare facilities, or the lack of money for transport. There is also a shortage of equipment required to perform the procedures [21]. In addition, the evaluation of cytology specimens is a visual process that may be more prone to inaccuracies, especially when being performed by unskilled HCWs [16].

A study conducted in Zimbabwe revealed that VIA is manpower intensive and there was no evidence of commodity and equipment supply in the public sector between 2016 and 2019 [22]. VIA is rarely available at primary healthcare facilities, especially in rural areas, yet about 68% of the population resides in rural areas [23]. The relatively low sensitivity and specificity of 60 and 79%, respectively, are a cause for concern. VIA is subjective, not reproducible, and highly dependent on the provider's level of skill [24]. In Zimbabwe, there was an occasional failure by healthcare facilities to provide VIA due to the unavailability of sterile packs, which demotivated clients. Some healthcare institutions frequently ran out of crucial VIA supplies such as acetic acid, camera batteries, and cryoprobes. This was attributed to ineffective or non-existent stock management systems at the healthcare facility level [22]. The commodity supply chain for VIA commodities was reported to be inefficient and not integrated with other health commodities which are distributed quarterly from the National Pharmaceutical Company [22]. There was also a lack of clarity on the commodity backup system in the event of stockouts as VIA managers were not clear about whose responsibility it was, whether government, non-governmental organizations, or healthcare facilities [22].

Advantages of HPV-DNA screening over traditional screening modalities

The HPV-DNA test is a laboratory-based nucleic acid test that can be used for cervical cancer screening. The basis of this screen is the aetiological relationship between HPV infection and cervical carcinogenesis [25]. As highlighted earlier, nearly 100% of cervical cancers are due to high-risk HPV infection. The HPV-DNA assay detects the presence of genetic material unique to the high-risk strains from a sample of cervical cells. A positive result requires triage for cervical abnormalities with either VIA or colposcopy and treatment of precancerous lesions with appropriate available methods [16].

The adoption of HPV-DNA testing or primary cervical cancer screening offers several advantages over traditional cytology-based methods and visual methods of screening. Compared to cytology and visual-based methods, HPV-DNA testing is more sensitive to detecting cervical precancer and cancer [25]. With HPV testing there is an option for self-collection since it has been proven that the self-collected samples' sensitivity and specificity are comparable to clinician-collected samples [26]. Some HPV testing technologies can be used at the point-of-care allowing same-day treatment which is a key aspect of cervical cancer prevention and treatment. Studies in both resource-limited and high-income countries have confirmed the superior sensitivity of HPV testing compared to cytology and VIA. In one systematic review, it was revealed that HPV testing is more sensitive than cytology and VIA in detecting CIN2+/CIN3+ [25]. HPV testing has a considerably higher sensitivity (98%) when compared to Cytology (70%) and VIA (60%). In addition to its sensitivity, HPV testing has a high negative predictive value, allowing for longer intervals before the next screening [27]. Studies demonstrate that two rounds of HPV screening may be enough to protect against cervical cancer in the lifetime of a woman. In the general population, HPV-DNA testing should be repeated after 5–10 years. Exceptions are among women who are HIV positive and require 3–5 years intervals for HPV-DNA testing [28]. However, because most HPV infections are transient, there is a need to triage a positive HPV-DNA result with an additional test such as VIA [29], which is widely available in most countries including Zimbabwe [9].

Self-collection of samples for HPV testing has been reported to be acceptable to women, giving them body autonomy, convenience, and privacy. Additionally, HPV testing on self-collected specimens has been useful in reaching previously unscreened populations who lacked access to screening services [30]. The criteria for a good quality sample are less strict with HPV testing compared with cytology and studies have proved that self-collected specimens are as accurate as clinician-collected specimens in detecting CIN2+/CIN3+ [26]. Self-collection is seen as an innovative tool that overcomes several of the barriers that discourage women from participating in cervical cancer screening [31]. At a public health level, self-sampling allows task shifting, as clinicians can concentrate on other duties whilst women perform self-collection. The self-collected specimen can be used for multiple screening for other sexually transmitted infections allowing for the saving of resources and timely diagnosis and treatment of these [32].

When used at the point of care HPV testing allows for a screen-and-treat or a screen, triage and treat approach that benefits women by the provision of early treatment services and saving them time and costs associated with having to return to a healthcare facility [13]. A screen-and-treat approach minimizes loss to follow up which is a setback of current cervical cancer screening programs. For low-resource settings, the WHO recommends HPV testing with treatment for women with positive test results, with or without intermediate triage using available triage options such as VIA, cytology, or HPV genotyping for women who are at least 30 years old in the general population [13]. Special consideration is given to women living with HIV who have an increased risk of HPV infection and development of cervical cancer [13]. When the HPV test is used as a primary screening tool it is necessary to use a triage tool such as VIA to reduce the proportion of women who test HPV-positive needing referral and treatment [16].

Available point-of-care machines are easy to operate, needing less sophisticated operators and infrastructure requirements. An example is a GeneXpert platform from Cepheid which can be successfully used in remote and distant parts of the country. A study conducted in Zimbabwe demonstrated the utility of a near-point-of-care GeneXpert HPV for detecting high-risk HPV within a relatively under-screened rural population [33].

HPV-DNA testing implementation challenges

Following WHO recommendations, Zimbabwe is preparing to implement nationwide HPV DNA screening as the primary cervical cancer screening modality. While HPV-DNA testing confers several advantages over the traditional screening strategies of VIA and cytology, it is important for public health stakeholders and implementation partners to anticipate challenges and adequately prepare for them in order to avoid chances of program failure. Fig. 2 summarises the possible implementation challenges.

Laboratory capacity and logistical considerations

Considering that HPV DNA testing is still limited in Zimbabwe, there is a need for the scale-up and decentralization of testing and this requires the purchase of laboratory equipment including molecular analyzers. Since laboratory personnel may not have the skills to carry out the test, they should be trained in conducting HPV-DNA testing as this will ensure quality results and optimal use of resources [34]. Different laboratories are likely to use different methods for performing the test. A laboratory handbook containing the necessary standard operating procedures should therefore be developed to ensure that standardized methods are used at all the laboratories [34]. There should also be an improvement in laboratory capacity to ensure that laboratories providing HPV-DNA testing meet the eligibility requirements specified by international and national bodies [35]. In addition, internal and external quality assessment systems should be implemented and performed to ensure that the results are reliable and of good quality [35]. Furthermore, a regular supply of laboratory commodities required for the test should be guaranteed to ensure the smooth running of the screening program. In the long run, this can be achieved through local production of the commodities since supply will be less affected by global disruptions in the supply chain [35].

Cost and cost-effectiveness of HPV-DNA testing

A huge initial investment is expected for the national implementation of HPV-DNA testing. This will cover the personnel training costs, laboratory equipment, and supplies, and pay for the expected increase in follow-up activities since HPV-DNA testing is more sensitive than the previously used VIA [36]. These costs may be increased by the need to import equipment, sample media, brushes, and HPV-DNA test kits. The cost-effectiveness of HPV-DNA testing depends on the perspective used in the calculations. If the assumption is that the testing will be carried out in public healthcare facilities, only direct costs are used. Although previous studies in low-to-middle-income countries showed that HPV-DNA testing was cost-effective, most of the studies performed modeling [37,38]. Therefore, the cost-effectiveness of implementing HPV-DNA screening programs is not well explored. The cost-effectiveness of HPV-DNA testing for Zimbabwe is likely to be influenced by several factors noted in previous cost-effectiveness studies, such as the percentage of screening coverage, the rate of compliance with the recommended follow-up by women, the prevalence of HPV in the population, and the direct medical costs of implementing the program [36,39,40]. Previous cost-effective studies revealed that HPV-DNA testing was cost-effective when there was a high percentage of coverage and compliance with follow-up visits [41]. This is likely to be challenging considering that the Pap smear screening method in the country failed partly because of the need for follow-up visits and the manpower requirement [22]. Of concern to Zimbabwe will be whether HPV-DNA testing is affordable since no budget impact analysis has yet been performed. Considering that the program may require a huge initial investment, the country may not have enough resources to implement the program.

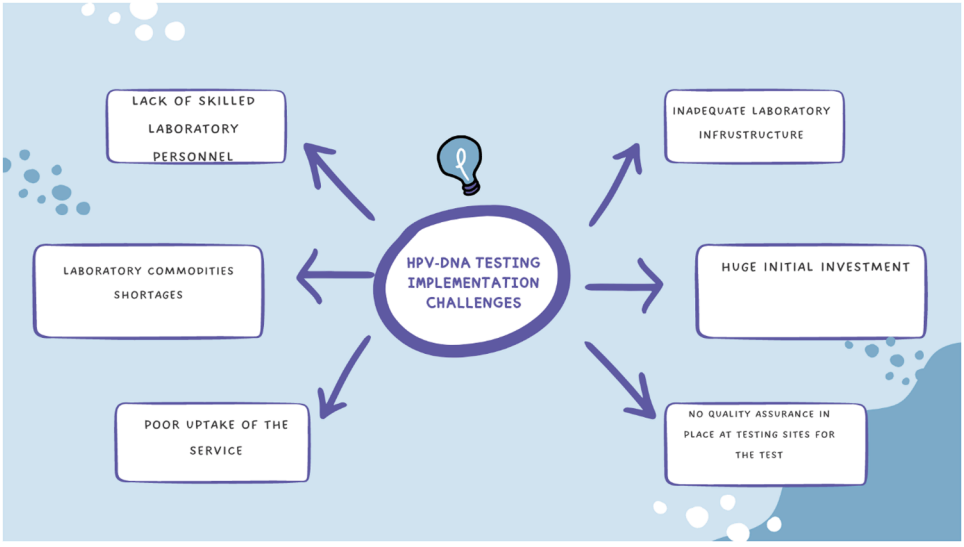

Fig. 2. HPV-DNA testing implementation challenges.

Recommendations

The implementation success of nationwide HPV-DNA testing as a primary cervical cancer screening modality in the country is highly dependent on adequately addressing the anticipated challenges as well as the challenges faced by the current screening programs. Close collaboration between clinicians, public health stakeholders, the MoHCC, other relevant government departments, academia, and implementation partners is required to ensure the maximum success of the program and drive the country towards achieving the WHO's 90–70–90 strategy. Zimbabwe has a track record of performing well in adequately supported public health programs, including achieving the UNAIDS 95–95–95 targets for HIV control [42]. Decentralization of HPV-DNA must leverage lessons learned from the COVID-19 pandemic to take testing services to where people live instead of people having to travel long distances to access these.

To improve the uptake of cervical cancer screening in Zimbabwe, there is a need to educate women and communities, and also to involve men in cervical cancer disease and available prevention methods such as screening. Educational interventions are important to raise awareness and reduce the low-risk perception among women, and also to dispel mind formation and stigma. The use of community health workers has demonstrated success in increasing awareness of cervical cancer and creating demand for screening [43]. Utilizing modern media of communication such as social media, radio, and mobile text-based messaging can help disseminate important information to all women.

Community-based self-sampling initiatives are more suitable for implementing cervical cancer screening in low-resource settings to overcome the issue of accessibility and also bring convenience to women when using point-of-care technologies for testing women can be screened and linked to care or triage methods without losing them to follow-up thus increasing the impact and effectiveness of the screening program. In Cameroon, campaigns for HPV self-sampling in the community have proven feasible and cost-effective in increasing screening coverage, as demonstrated by same-day screen-and-treat initiatives [44].

Considering the imminent shift to HPV-based primary cervical cancer screening from VIA-based screening, there is a need to develop guideline including algorithms that speak to the Zimbabwean context and considers available financial and human resources to ensure the success of an HPV-based screening program. There is a need for different stakeholders to co-create feasible, acceptable, and effective interventions to ensure demand and uptake of the screening program and ensure linkage to the care of women who screen positive. One study has demonstrated the utility of consensus-generating methods such as the nominal group technique to co-create important health interventions in SSA [45]. Future qualitative research in the country should be conducted to determine women's perceptions about cervical cancer and factors that influence their willingness to utilize cervical cancer screening services. Recommendations are summarised in Table 1.

Conclusion

Ensuring the smooth implementation of HPV-DNA screening and early treatment of precancerous lesions, improving HPV vaccination, and providing adequate and appropriate treatment for early-stage disease is critical for reducing the burden, morbidity, and mortality associated with cervical cancer in Zimbabwe and SSA. This will ensure sufficient progress towards the WHO's 90–70–90 cervical cancer strategy and reduce, by the end of the 21st century, the age-standardized incidence rate of cervical cancer to less than 4 per 100 000. It is important to leverage lessons learned from the current cervical cancer strategies to ensure smooth and successful implementation of HPV-DNA screening as the primary cervical cancer screening modality in high-burden settings such as Zimbabwe. Additionally, providing adequate thermal ablation facilities to ensure a screen-and-treat approach will be critical for ensuring success. Academia, clinicians, public health stakeholders, the MoHCC, implementation partners, and other relevant stakeholders must collaborate closely to work toward the ultimate goal of eliminating cervical cancer as a significant global health concern.

Table 1
Recommendations.

Client Level Factors	Health System Factors
1 Improve the public's cervical cancer awareness (information education and communication).	1 Ensure availability of testing at the primary care level, including point-of-care testing to reduce long turnaround times and losses to follow-up.
2 Improve availability and accessibility of self-collected vaginal swabs.	2 Ensure the immediate availability of triaging (VIA) and treatment services (thermal ablation) to ensure a test-and-treat approach.
3 Adequately address issues of low-risk perception.	3 Ensure the placement of adequate logistics/supply-chain mechanisms for supplies of all consumables to avoid periods of stockouts.
	4 Close collaboration between MoHCC and implementation partners to ensure uniform, non-segregation practices.
	5 Rapid and widespread dissemination of new cervical cancer screening guidelines to ensure all service providers are aware of the new guidelines.
	6 Training of more laboratory scientists.
	7 Improving laboratory infrastructure to accommodate diagnostic equipment.
	8 Decentralization of HPV-DNA testing centres.
	9 Provision of HPV-DNA testing at an affordable cost.

Funding

The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

CRediT authorship contribution statement

Grant Murewanhema: Conceptualization, Methodology, Writing – original draft. **Mathias Dzobo:** Writing – review & editing. **Enos Moyo:** Writing – review & editing. **Perseverance Moyo:** Writing – review & editing. **Tasimba Mhizha:** Writing – review & editing. **Tafadzwa Dzinamarira:** Conceptualization, Supervision, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] WHO. Cervical cancer. 2022. Available at: https://www.who.int/health-topics/cervical-cancer#tab=tab_1.
[2] WHO. Cervical cancer. 2021. Available at: https://www.afro.who.int/health-topics/cervical-cancer.
[3] The Global Cancer Observatory. Cervix uteri factsheets. 2021. Available at: https://gco.iarc.fr/today/data/factsheets/cancers/23-Cervix-uteri-fact-sheet.pdf.
[4] Chokunonga E., Borok M.Z., Chingonzoh T., Chirenje Z.M., Makunike-Mutasa R. Manangazira, P.; et al. Pattern of Cancer in Zimbabwe in 2017, Harare: zimbabwe National Cancer Registry. 2020.
[5] The Global Cancer Observatory, Zimbabwe factsheets (2021). Available at, https://gco.iarc.fr/today/data/factsheets/populations/716-zimbabwe-fact-sheets.pdf.
[6] K. Okunade, Human papillomavirus and cervical cancer, J. Obstet. Gynaecol. 40 (5) (2020) 602–608.
[7] L. Wójcik, D. Samulak, M. Makowska, H. Romanowicz, Z. Kojs, B. Smolarz, et al., The Role of Human Papillomavirus in Cervical Cancer, Int. J. Cancer Clin. Res. 6 (125) (2019), https://doi.org/10.23937/2378-3419/1410125.
[8] WHO. Assessing national capacity for the prevention and control of noncommunicable diseases: report of the 2019 global survey. 2020. Available at: https://www.who.int/publications/i/item/9789240002319.
[9] Union of International Cancer Control. Cervical cancer elimination in Africa: where are we now and where do we need to be? 2022. Available at: https://www.uicc.org/sites/main/files/atoms/files/UICC-Cervical_Cancer_in_Africa_FA_Single.pdf.
[10] S. Finocchano-Kessler, C. Wexler, M. Maloba, N. Mabachi, F. Ndikum-Moffor, E. Bukusi, et al., Cervical cancer prevention and treatment research in Africa: a systematic review from a public health perspective, BMC Women's Health 16 (29) (2016), https://doi.org/10.1186/s1, 2016.
[11] D.S. LaMontagne, P. Manangazira, J. Marembo, C. Chigodo, C. Zvamashakwe, E. Tshuma, et al., HPV vaccination coverage in three districts in Zimbabwe following national introduction of 0,12 month schedule among 10 to 14 year old girls, Vaccine 40 (S1) (2022) A58–A66.
[12] WHO. Global strategy to accelerate the elimination of cervical cancer as a public health problem. 2020. Available at: https://www.who.int/publications/i/item/9789240014107.
[13] WHO. WHO guideline for screening and treatment of cervical pre-cancer lesions for cervical cancer prevention. 2021. Available at: https://www.who.int/publications/i/item/9789240030824.
[14] M. Ardahan, A. Temel, Visual inspection with acetic acid in cervical cancer screening, Cancer Nurs. 34 (2) (2011) 158–163.
[15] M. Fallala, R. Mash, Cervical cancer screening: safety, acceptability, and feasibility of a single-visit approach in Bulawayo, Zimbabwe, Afr. J. Prim. Health Care Fam. Med. 7 (1) (2015) a742, https://doi.org/10.4102/phcfm.v7i1.742.
[16] V. Bouvard, N. Wentzensen, A. Mackie, J. Berkhof, J. Brotherton, R. Giorgi-Rossi, et al., The IARC perspective on cervical cancer screening, N. Engl. J. Med. 385 (2021) 1908–1918, 2021.
[17] A. Isabirye, B. Elwange, K. Singh, M. De Allegri, Individual and community-level determinants of cervical cancer screening in Zimbabwe: a multi-level analyses of a nationwide survey, BMC Womens Health 22 (309) (2022), https://doi.org/10.1186/s12905-022-01881-0.
[18] E. Nyamambi, C. Murendo, N. Sibanda, S. Mazinyane, Knowledge, attitudes and barriers of cervical cancer screening among women in Chegutu rural district of Zimbabwe, Cogent. Soc. Sci. 6 (1) (2020), https://doi.org/10.1080/23311886.2020.1766784.
[19] J. Lim, A. Ojo, Barriers to utilisation of cervical cancer screening in Sub Sahara Africa: a systematic review, Eur. J. Cancer Care 26 (1) (2017) e12444, https://doi.org/10.1111/ecc.12444.
[20] E. Black, F. Hyslop, R. Richmond, Barriers and facilitators to uptake of cervical cancer screening among women in Uganda: a systematic review, BMC Womens Health 19 (108) (2019), https://doi.org/10.1186/s12905-019-0809-z.
[21] S. Mkhonta, J. Shirinde, Registered nurses' perspectives on barriers of cervical cancer screening in Swaziland: a qualitative study, Pan. Afr. Med. J. 38 (295) (2021), https://doi.org/10.11604/pamj.2021.38.295.22431.
[22] O. Tapera, A.M. Nyakabau, N. Simango, B.T. Guzha, S. Jombo-Nyakuwa, E. Takawira, et al., Gaps and opportunities for cervical cancer prevention, diagnosis, treatment and care: evidence from midterm review of the Zimbabwe cervical Cancer prevention and control strategy (2016–2020), BMC Public Health 21 (1478) (2021), https://doi.org/10.1186/s12889-021-11532-y.
[23] The World Bank. Rural population (% of total population)-Zimbabwe. 2022. Available at: https://data.worldbank.org/indicator/SP.RUR.TOTL.ZS?locations=ZW.
[24] E. Moses, H.N. Pedersen, S.M. Mitchell, M. Sekikubo, D. Mwesigwa, J. Singer, et al., Uptake of community-based, self-collected HPV testing vs. visual inspection with acetic acid for cervical cancer screening in Kampala, Uganda: preliminary results of a randomised controlled trial, Trop. Med. Int. Health 20 (10) (2015) 1355–1367.
[25] H. Kelly, I. Jaafar, M. Chung, P. Michelow, S. Greene, H. Strickler, et al., Diagnostic accuracy of cervical cancer screening strategies for high-grade cervical intraepithelial neoplasia (CIN2+/CIN3+) among women living with HIV: a systematic review and meta-analysis, eClinicalMedicine 53 (2022), 101645, https://doi.org/10.1016/j.eclinm.2022.101645.
[26] J. Joseph, P. Mangwendeza, T. Maparo, T. Mhizha, O. Demke, S. Murwira, et al., Comparative analysis between self-collected and clinician-collected samples for HPV testing in public health facilities in Zimbabwe, J. Clin. Virol. 145 (2021), https://doi.org/10.1016/j.jcv.2021.105017.
[27] G. Hoste, K. Vossaert, W. Poppe, The clinical role of HPV testing in primary and secondary cervical cancer screening, Obstet. Gynecol. Int. 2013 (2013), https://doi.org/10.1155/2013/610373.
[28] WHO. WHO recommends DNA testing as a first-choice screening method for cervical cancer prevention. 2021. Available at: https://www.who.int/europe/news/item/11-09-2021-who-recommends-dna-testing-as-a-first-choice-screening-method-for-cervical-cancer-prevention.
[29] N. Gami, G. Gandhi, S. Batra, V. Zutshi, B.C. Das, S. Bhambhani, et al., Role of visual inspection of cervix with acetic acid and high risk human papilloma virus DNA testing in screening for cervical cancer, Int. J. Reprod. Contracept. Obstet. Gynecol. 2 (2) (2013) 152–156.

[30] C. Styffe, E. Tratt, M.E. Macdonald, P. Brassard, HPV self-sampling in indigenous communities: a scoping review, J. Immigr. Minor Health 22 (4) (2020) 852–859.
[31] Z.A. Nodjikouambaye, C. Adawaye, R.S. Mboumba Bouassa, D. Sadjoli, L Bélec, A systematic review of self-sampling for HPV testing in Africa, Int. J. Gynaecol. Obstet. 149 (2) (2020) 123–129.
[32] A.C. Des Marais, Y. Zhao, M.M. Hobbs, V. Sivaraman, L. Barclay, N.T. Brewer, et al., Home Self-Collection by Mail to Test for Human Papillomavirus and Sexually Transmitted Infections, Obstet. Gynecol. 132 (6) (2018) 1412–1420.
[33] M.B. Fitzpatrick, R.S. Dube-Mandishora, D.A. Katzenstein, K. McCarty, J. Weber, M.K. Sahoo, et al., hrHPV prevalence and type distribution in rural Zimbabwe: a community-based self-collection study using near-point-of-care GeneXpert HPV testing, Int. J. Infect. Dis. 82 (2019) 21–29.
[34] F.M. Carozzi, A. De Mistro, K. Cuschieri, H. Frayle, C. Sani, E. Burroni, et al., HPV testing for primary cervical screening: laboratory issues and evolving requirements for robust quality assurance, J. Clin. Virol. 76 (Suppl 1) (2016) S22–S28.
[35] B. Engesæter, B. van Diermen Hidle, M. Hansen, P. Moltu, K.M. Staby, S. Borchgrevink-Persen, et al., Quality assurance of human papillomavirus (HPV) testing in the implementation of HPV primary screening in Norway: an inter-laboratory reproducibility study, BMC Infect. Dis. 16 (698) (2016), https://doi.org/10.1186/s12879-016-2028-7.
[36] N. Lince-Deroche, J. Phiri, P. Michelow, J.S. Smith, C. Firnhaber, Costs and cost effectiveness of three approaches for cervical cancer screening among HIV-positive women in Johannesburg, South Africa, PLoS ONE 10 (11) (2015), e0141969, https://doi.org/10.1371/journal.pone.0141969.
[37] T. Sefuthi, L. Nkonki, A systematic review of economic evaluations of cervical cancer screening methods, Syst. Rev. 11 (162) (2022), https://doi.org/10.1186/s13643-022-02017-z.
[38] N.G. Campos, N. Lince-Deroche, C.J. Chibwesha, C. Firnhaber, J.S. Smith, P. Michelow, et al., Cost-effectiveness of cervical cancer screening in women living with hiv in south africa: a mathematical modeling study, J. Acquir. Immune Defic. Syndr. 79 (2) (2018) 195–205.
[39] S.J. Goldie, L. Gaffikin, J.D. Goldhaber-Fiebert, A. Gordillo-Tobar, C. Levi, C. Mahe, et al., Cost-effectiveness of cervical-cancer screening in five developing countries, N. Engl. J. Med. 353 (2005) 2158–2168.
[40] A. Devine, A. Vahanian, B. Sawadogo, S. Zan, F.Y. Bocoum, H. Kelly, et al., Costs and cost-effectiveness of cervical cancer screening strategies in women living with HIV in Burkina Faso: the HPV in Africa Research Partnership (HARP) study, PLoS ONE 16 (3) (2021), e0248832, https://doi.org/10.1371/journal.pone.0248832.
[41] A.K. Mezei, H.L. Armstrong, H.N. Pedersen, N.G. Campos, S.M. Mitchell, M. Sekikubo, et al., Cost-effectiveness of cervical cancer screening methods in low- and middle-income countries: a systematic review, Int. J. Cancer 141 (2017) 437–446.
[42] Pembere K. Milestone: zim attains 95-95-95 HIV targets. 2022. Available at: https://healthtimes.co.zw/2022/10/31/milestone-zim-attains-95-95-95-hiv-targets/#:~:text=ZIMBABWE%20has%20reached%20the%20UNAIDS,that%20have%20attained%20the%20 goal.&text=The%20Joint%20United%20Nations%20Programme,%25%E2%80%9395%25%20by%202025.
[43] J. O'Donovan, C. O'Donovan, S Nagraj, The role of community health workers in cervical cancer screening in low-income and middle-income countries: a systematic scoping review of the literature, BMJ Glob. Health 13 (3) (2019), e001452, https://doi.org/10.1136/bmjgh-2019-001452, 4.
[44] J.F. Domgu, B. Futuh, C. Ngalla, P. Kakute, F. Manjuh, S. Manga, et al., Feasibility of a community-based cervical cancer screening with "test and treat" strategy using self-sample for an HPV test: experience from rural Cameroon, Africa, Int. J. Cancer. 147 (1) (2020) 128–138, https://doi.org/10.1002/ijc.32746.
[45] T. Dzinamarira, A. Mulindabigwi, T.P. Mashamba-Thompson, Co-creation of a health education program for improving the uptake of HIV self-testing among men in Rwanda: nominal group technique, Heliyon 6 (10) (2020) e05378, https://doi.org/10.1016/j.heliyon.2020.e05378.