ACCSCIENCE PUBLISHING

Cancer Plus

ORIGINAL RESEARCH ARTICLE

# Feasibility and acceptability of HPV DNA self-sampling in a low-resource setting

**Malvern Munjoma[1*], Stephano Gudukeya[1], Jabulani Mavudze[1], Charity Chipfumbu[1], Danai Madzivire[2], Ngonidzashe Madidi[2], Tafara Moga[1], Blessing Mutede[1], and Noah Taruberekera[1]**

[1]Population Solutions for Health, Harare, Zimbabwe

[2]Population Services International, Harare, Zimbabwe

## Abstract

Women living with human immunodeficiency virus (HIV) have up to 6 times the risk of cervical cancer compared with HIV-negative women, with more than 60% of cervical cancer cases in Southern Africa occurring among HIV-positive women. Human papillomavirus (HPV) DNA self-sampling is a World Health Organization-recommended, cost-effective screening approach suitable for low-resource settings, particularly where healthcare worker availability and client mobility are constrained. With support from the Swedish Embassy, Population Services International Zimbabwe evaluated the feasibility and acceptability of HPV DNA self-sample collection among women of reproductive age, and assessed whether self-collected vaginal swabs yielded results comparable to provider-collected cervical samples. A quantitative cross-sectional crossover trial was conducted from May 2020 to December 2022 across three high-volume healthcare facilities. Women aged 30–65 were randomized into two arms: Arm 1 (self-collection followed by provider collection) and Arm 2 (provider collection followed by self-collection). Data were collected electronically using SurveyToGo and analyzed in STATA 13. Randomization checks assessed demographic comparability between arms. HPV positivity rates and 95% confidence intervals (CIs) were also computed. Among 609 self-collected samples, 26.9% were HPV-positive (95% CI: 23.5–30.6), compared with 29.3% positivity (95% CI: 25.8–33.0) among 611 provider-collected samples, showing statistically similar outcomes. Findings were consistent across study sites and participant age groups. Self-sample collection was widely acceptable among participants and deemed feasible by service providers. The results demonstrate that women can reliably self-collect samples for HPV DNA testing. This strategy offers a scalable, resource-efficient approach to expanding cervical cancer screening coverage in high-HIV–burden, low-resource settings, such as Zimbabwe, while reducing provider workload and facilitating earlier detection.

***Keywords:*** Self-sample collection; Human papillomavirus DNA; Cancer screening; Feasibility and acceptability; Low-resource setting

***Corresponding author:**
Malvern Munjoma
(mmunjoma@psh.org.zw)

**Citation:** Munjoma M, Gudukeya S, Mavudze J, *et al*. Feasibility and acceptability of HPV DNA self-sampling in a low-resource setting. *Cancer Plus*. 2025;7(4):47-60. doi: 10.36922/CP025110016

**Received:** March 12, 2025

**Revised:** June 23, 2025

**Accepted:** July 1, 2025

**Published online:** December 4, 2025

## 1. Introduction

### 1.1. Background

Between 1990 and 2013, cancer rose from the third leading cause of death to the second, after cardiovascular diseases. While breast cancer was responsible for the highest cancer mortality in females globally, cervical cancer was the most frequently diagnosed cancer among women in developing countries.[1] Of the 6.9 million disability-adjusted life years caused by cervical cancer in 2013, 85% occurred in developing countries. According to the Global Cancer Observatory statistics for 2018, cervical cancer is the fourth most commonly diagnosed cancer in women globally and remains the leading cause of cancer deaths among women in countries with low human development indices.[2,3] Global trends show that most countries at high risk for cervical cancer are in Africa—Malawi, Mozambique, Zambia, and Zimbabwe are among the highest-risk countries.[4] In Zimbabwe, cervical cancer has the highest incidence rate among women of all ages and races, accounting for an estimated 19% of all cancers in women.

High-risk human papillomavirus (hr-HPV) causes virtually all cervical cancers.[5-7] There are 14 types (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68) of hr-HPV associated with the development of cervical cancer.[5,6] Of these, HPV types 16 and 18 account for approximately 70% of all cases. Notably, cervical cancer can be prevented in 8 out of 10 cases if early diagnosis and treatment are provided.[4] However, many women do not undergo cervical cancer screening due to fear, shame, and cultural or religious considerations, among other reasons. Limited access to healthcare services, especially in developing countries where poverty is widespread, is also a significant barrier to cervical cancer screening.[8]

The World Health Organization (WHO) recommends three procedures to screen women for cervical cancer.[9] Cervical cytology, also known as the Pap smear, examines cervical cells to check for the presence of abnormal cells. It is not frequently employed in developing countries as it is a costly procedure, requiring considerable management and effort from the many agencies involved.[10,11] Visual inspection with acetic acid (VIA) and HPV testing for hr-HPV types, such as HPV 16 and 18, are other WHO-recommended alternatives. Women who test positive for hr-HPV should follow-up with a Pap smear and/or VIA, along with cryotherapy, and additional tests can be performed to determine the exact type of HPV.[12-18] A negative test indicates that the risk of developing cervical cancer in the next few years is minimal.[10,15,19,20]

The HPV DNA testing method uses sample collection from the cervix or vagina for the identification of 14 high-risk types of HPV, including HPV 16 and 18. Sample collection, which can be performed by the individual herself, takes only a few minutes, after which a laboratory examination is performed to check for the presence of DNA of hr-HPV that causes cancer. For women who are human immunodeficiency virus (HIV)-negative and HPV DNA test-negative, the screening interval given is 5 years, while for women who are HIV-positive and HPV DNA test-negative, the screening interval is 3 years.

In resource-limited countries, HPV DNA testing involving self-sample collection by the client is a pertinent intervention, as it is cost-effective and reduces the burden on the healthcare delivery system. Although cytology requires the services of trained medical professionals, including smear takers, cytotechnologists, cytopathologists, and colposcopists, the HPV DNA test has the potential for close to complete automation, allows for self-sample collection, and has in-built quality control procedures. In a study conducted in Thailand, hr-HPV testing was shown to increase the detection rate of cervical intraepithelial neoplasia grade 2 and to reduce costs by nearly USD 1.4 million/100,000 women screened compared to HPV 16 and 18 genotyping.[21] In another cost-effectiveness study in China,[22] HPV DNA testing, which costs USD 16.30, was also shown to be cheaper than the Pap test, which costs USD 99.00 in total.

Acceptability studies have revealed that many women are more receptive to the HPV test than to the Pap smear.[23] Reasons given for preference were mainly related to issues of privacy and accessibility. Some women, however, expressed reservations due to fear of incorrect diagnosis and lack of self-confidence in following the correct procedures (in the case of self-sample collection). Studies in several countries have compared the accuracy of HPV self-collection samples with samples obtained by a physician and have assessed the acceptability of self-collection in different populations.[23] The results revealed that most healthcare providers were willing to recommend self-sample collection for HPV testing but reported that this was conditional on factors, such as patients' ability to collect adequate samples and test characteristics, including sensitivity, specificity, and cost-effectiveness. Another concern was that women performing HPV self-sample collection at home might miss the opportunity to address other health concerns during a screening visit.

### 1.2. Cervical cancer in Zimbabwe

In Zimbabwe, cervical cancer accounts for about one-third of all cancer cases, and it is the leading cause of all cancer-related deaths in the country. In 2014 alone, 2,200 women were diagnosed with cervical cancer, with a mortality rate

of 63.9%.[24] This high disease burden is closely related to the HIV epidemic that has affected the country since the late 1990s.

The 2016 Zimbabwe Demographic Health Survey reports that 97% of women have at least heard about cervical cancer, while only 13% have had a cervical examination.[25] Furthermore, among those reporting having a cervical cancer examination, 90% reported having the examination done within 3 years preceding the survey, and 66% had it within the 12 months before the study. This clearly indicates that the uptake of cervical cancer services in the country has been increasing.

An HPV vaccine program was also introduced in the country in 2014 through a collaboration between the Vaccine Alliance, the United Nations Children's Fund, the United Nations Population Fund, WHO, and the Zimbabwe Expanded Programme of Immunization. The program was piloted in Marondera and Beitbridge using a school- and community-based strategy to reach 10-year-old girls in and out of school.[4] To date, the HPV vaccine program has been successfully rolled out in all 10 provinces of Zimbabwe. HPV DNA testing in Zimbabwe was explored in 2017; however, it was noted that the method had low specificity, thereby prompting the need for co-screening using other methods, such as visual inspection with acetic acid and camera (VIAC) and Pap smear.[4] The option of co-testing is expensive for the average Zimbabwean woman. Table 1 summarizes the average costs of cervical cancer screening methods per person in public and private hospitals in Zimbabwe.

### 1.3. Study rationale

Before 2010, cervical cancer screening in Zimbabwe was mainly based on Pap smears; however, the test was relatively expensive and had a long turnaround time due to shortages of cytologists. As such, the national Pap smear screening program offered in public hospitals was discontinued due to these limitations, while the National Family Planning Council still offers the test, subject to the availability of resources. Private gynecologists offer the same service at a cost that is approximately sevenfold higher.[4] While the main challenges faced in preventing, screening, and treating cervical cancer revolve around human and material resources, the centralization of facilities to vaccinate, screen, and treat cancer also presents a barrier to access. Decentralization of these services is limited by the lack of diagnostic and treatment equipment, which is often expensive to acquire and maintain.

**Table 1. Costs of cervical cancer preventive and screening/ early detection methods in the public and private hospitals in Zimbabwe**

| Stage | Method | Cost in public hospital (USD) | Cost in private hospital (USD) |
|---|---|---|---|
| Prevention | HPV vaccine | Data not available | 180–300 |
| Screening | Pap smear | 20 | 150 |
| | VIAC | Free | 10–20 |

Abbreviations: HPV: Human papillomavirus; VIAC: Visual inspection with acetic acid and camera.

Thus, HPV DNA testing provides an innovative and cheaper screening alternative for women who do not participate in traditional cytological screening, with the goal of reducing health disparities and preventing cervical cancer. Furthermore, incorporating self-sampling strategies into cervical cancer screening programs will reduce costs and potentially increase the number of women reached by these programs.[26] The possibility of community-based self-sampling will reduce the clients' cost of accessing services, further increasing the number of women that can be screened. This innovation is necessary considering the prevailing economic conditions in the country that have, in the past, caused delays in treatment, and given that patient knowledge plays a major role in the high morbidity and mortality of cervical cancer in Zimbabwe.

In Zimbabwe, HPV testing is offered at Lancet laboratories and is not accessible to all individuals due to the high cost.[4] Free HPV DNA testing and liquid-based thin prep cytology were launched at Parirenyatwa Group of Hospitals' pathology laboratories in February 2018, and screening is in progress, albeit with low uptake due to reagent procurement challenges faced by the healthcare sector. A feasibility and acceptability study is therefore necessary to equip the cervical cancer screening program implemented in collaboration with the Ministry of Health with empirical evidence to support the program to effectively offer HPV DNA screening in an affordable and sustainable context.

### 1.4. Goal and objectives of the study

Population Services International (PSI) Zimbabwe, with support from the Swedish International Development Cooperation Agency (SIDA), sought to test the feasibility and acceptability of HPV DNA screening in the New Start Centre health service delivery network. The acceptability of HPV DNA testing will result in an increased number of women screened at a lower cost, and an improvement in the quality of health service delivery due to the reduced burden on service providers. The study findings will be used as evidence to inform decision-making on whether:

(i) There is a perceived service provision burden reduction among PSI service providers.
(ii) HPV DNA screening is acceptable and feasible among women of reproductive age.

### 1.5. Study objectives

There are several objectives of this study, including:
(i) To compare the rates of HPV detection in self-collected vaginal and provider-collected cervical swabs.
(ii) To assess provider perceptions of clients' ability to provide reliable samples and site personnel's preparedness to offer HPV DNA testing.
(iii) To develop a user-friendly instructional manual for HPV DNA self-sample collection.

While some studies have shown that the sensitivity of self-collected vaginal swabs for the detection of HPV is similar to that of provider-collected cervical swabs,[27,28] this study aims to validate these findings in the Zimbabwean context among clients served within the PSI New Start Centre network. Furthermore, this study aims to measure the difference in sensitivity between the two screening methods in the PSI New Start Centre Network and to tailor user instructions to suit the local context.

### 1.6. Research questions

There are several research questions in this study, including:
(i) What are the specificity and sensitivity of self-collected vaginal samples compared to the provider-collected cervical swabs?
(ii) Is there confidence, comfort in the procedure, and trust in the test result of clients in sample self-collection for HPV DNA screening?
(iii) What proportion of women intend to use the HPV DNA screening method in the future?
(iv) What are the attitudes toward and perceived benefits or disadvantages of HPV DNA among service providers (registered general nurses [RGNs] administering the sample collection)?

## 2. Methods

### 2.1. Study design

#### *2.1.1. Quantitative study design*

A randomized crossover controlled trial was conducted with the New Start Center clients. In a crossover design, each participant receives all treatments under investigation but at different time points. The order in which participants receive the treatments is randomized. This design was selected to increase statistical power because each patient served as their own control, thereby reducing between-subject variability and enabling the detection of smaller effect sizes with a smaller sample size. The HPV detection rates in the two study arms were compared to assess potential sequence effects. Sequence effects are confounding influences that arise in experiments where subjects are exposed to multiple conditions; they reflect interactions among conditions that may occur depending on the order in which treatments are administered.

Participants were randomly allocated to one of the following two study groups:
(i) Arm 1: HPV DNA self-sampling before a provider-collected cervical swab.
(ii) Arm 2: Provider-collected cervical swab before a self-collected vaginal swab.

After completing the two screening methods, participants in each arm took part in face-to-face interviews using a standardized, structured questionnaire. This was a client-exit interview.

#### *2.1.2. Qualitative study design*

Two sets of qualitative data were collected in this study. The first consisted of in-depth interviews with service providers (RGNs) at the New Start Center using a semi-structured interview guide to gain insights into attitudes, ease of use, and perceived benefits of the HPV DNA screening method. The second involved cognitive interviews with clients who had visited the New Start Center for cervical cancer screening and had collected vaginal cell samples themselves. A semi-structured questionnaire was used to determine whether clients understood the step-by-step HPV DNA self-sample collection instructions. This tool was used for self-sample collection among women in the study.

### 2.2. Study setting and recruitment

Interviews for both the qualitative and quantitative data collection were conducted at three New Start Centre sites providing cervical cancer screening services. These were New Africa House in Harare, Bambanani in Bulawayo, and the Chitungwiza New Start Center. In all interviews, women aged 30 and above were enrolled in the study. At present, the total PSI New Start Center network screens between 1,000 and 1,500 women/month, and among these, 70–75% are above the age of 30.

The participants were directed to a private, well-lit room. An HPV DNA self-sampling kit with written instructions and illustrative diagrams was given to each participant by the research assistant.

The participant followed the instructions independently for self-sample collection. The swab was placed in the plastic vial, which was then placed in a sealed specimen bag with the help of a service provider and sent to the New Start Molecular Laboratory at the Chitungwiza New Start Center for examination. The careHPV test, which can detect 14 high-risk HPV genotypes (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68), was used for

the HPV DNA testing. Clients were only asked to pay an administrative fee of 9 Zimbabwean dollars (equivalent to 0.25 as of November, 2025) to access this test and other services offered at the New Start Center, as these services were funded by SIDA.

### 2.3. Sampling strategy

Recruitment of study participants was conducted over a period of 2 months across the three sites. Client volume for one quarter was estimated for each site, and recruitment was performed using systematic random sampling with the following sampling interval:

$$\begin{matrix}\text{Sampling interval}\\ \text{for each site per day}\end{matrix} = \frac{\begin{matrix}\text{Average number of}\\ \text{clients per site per day}\end{matrix}}{\begin{matrix}\text{Average sample size}\\ \text{required per site per day}\end{matrix}} \quad (1)$$

For example, if the client volume at the Bambanani site per day was 25 and the required sample size per day was 5, then the sampling interval was on average 5, that is, every fifth client was selected to participate. Sampling was done without replacement, that is, if the $n$-th person refused to participate in the study, the ($n$+1)-th person who consented was enrolled in their place.

#### *2.3.1. Inclusion criteria*

Inclusion criteria were:
(i) Walk-in New Start Center clients.
(ii) Women aged between 30 and 59 years.
(iii) Willingness of participants to perform self-sample collection for HPV DNA screening.
(iv) Willingness of participants to allow a service provider to collect a cervical swab.
(v) Participants provided consent to participate in the study.

### 2.4. Sample size calculation

#### *2.4.1. Quantitative study sample size calculation*

The following parameters were used to calculate the minimum sample size for a crossover study design:
(i) Power of 90%.
(ii) 5% level of significance.
(iii) Two-sided test.
(iv) Standard deviation of the difference in the response variables = 1.
(v) Minimal detectable difference in means = 0.2.[28]

The above parameters yielded a minimum required sample size of 528 study participants, calculated using an online tool (http://hedwig.mgh.harvard.edu/sample_size/js/js_crossover_quant.html). Assuming a response rate of 78%,[22] the total sample size required was 678. This means each arm would recruit 339 participants.

Figure 1 shows the recruitment process and the distribution of the sample sizes by arm. Probability proportional to size, based on site volume, was used to allocate the required sample sizes by site. Recruitment of clients was conducted over a 2-month period. The total number of clients who consented and participated in the study was 628. However, only 614 records were used in the data analysis after data cleaning. A total of 308 participants were randomly allocated to Arm 1, and all collected swabs were used. In contrast, for Arm 2, 303 swabs were collected, but only 301 were used.

#### *2.4.2. Qualitative study sample size*

As noted earlier, two sets of qualitative components were conducted in this study: in-depth interviews with service providers and cognitive interviews with prospective clients for HPV DNA screening. A total of six in-depth interviews were conducted across the three study sites, with two service providers at each site. A service provider was defined as a site-based clinician (RGN) providing cervical cancer screening services.

For the cognitive interviews, a minimum of three cognitive interview rounds with clients were conducted in the process of developing a user-friendly instructional manual. In each round, three exit interviews per site were conducted with a different set of clients selected randomly. These data were used to improve the instruction manual.

### 2.5. Data management and data analysis

#### *2.5.1. Quantitative data*

Data were collected using SurveyToGo, an Android data collection application. Data quality in terms of completeness and consistency was ensured by pre-coding questionnaire skip instructions in the software and making sure that all questions were mandatory, unless skip instructions applied.

Data were exported into STATA version 13 (StataCorp LLC, United States) for cleaning and analysis. First, descriptive analysis was conducted to profile study participants with regard to their demographic characteristics, such as age, occupation, marital status, current method of contraception, and parity. HPV-related factors, such as age at sexual debut, sexually transmitted infection (STI) history, abortion history, and family history of cancer-related illnesses, among others, were also described. Furthermore, a descriptive comparison of the rates of HPV detection in self-collected vaginal samples

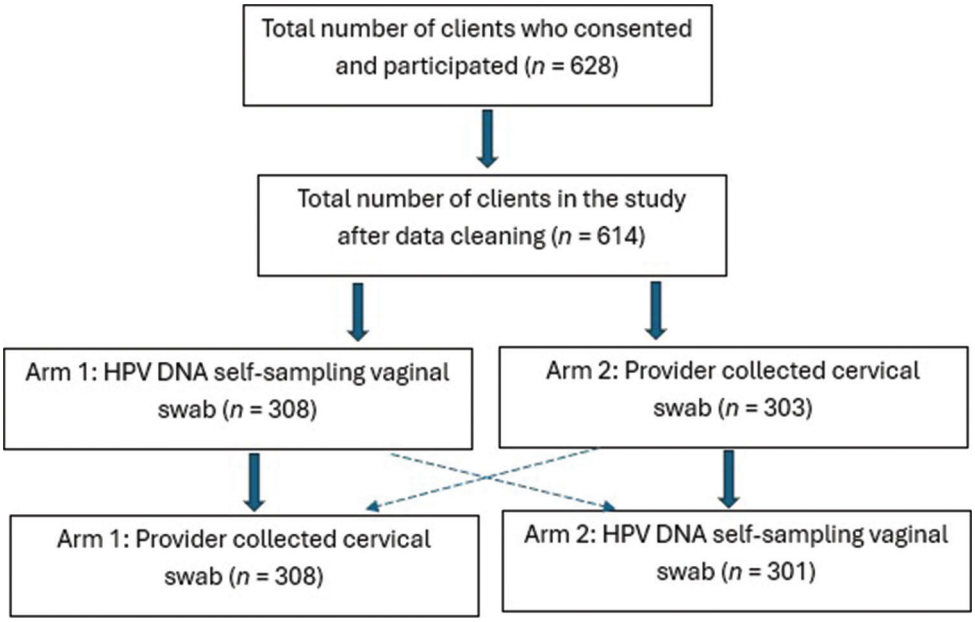


**Figure 1.** Recruitment process and distribution of the sample sizes by arm
Note: The dashlines illustrates the cross over design.
Abbreviation: HPV: Human papillomavirus.

and provider-collected cervical swabs was conducted and cross-tabulated with these demographics.

In addition, the detection rate of HPV in the two study arms was compared to determine a sequence effect. Once the sequence effect was confirmed to be minimal, data from the two arms were managed as a single dataset. Concordance of HPV DNA detection between sampling modalities was assessed using an unweighted Kappa (κ) statistic to determine the percentage agreement beyond that expected by chance. The strength of the agreement was categorized into six levels according to the κ statistic: $\kappa < 0$ = poor agreement, 0–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate, 0.61–0.80 = substantial, and 0.81–1.00 = almost perfect.

Furthermore, McNemar's tests[29] were performed for comparison of the HPV DNA tests. An adjusted McNemar test[30] was used to compare the proportions of HPV DNA-positive results between samples while accounting for the correlation of multiple samples within subjects.[31] This analytic approach has been used previously in several studies on hr-HPV research assessing concordance of self- and provider-collected swabs.[32] All variables that were potential confounders were investigated, and statistical techniques were applied to adjust for known confounders, such as HIV status, during analysis. Several studies have shown that the detection rate of all hr-HPV types, including HPV 16, is higher among HIV-positive women compared to those who are negative.[33] As such, women enrolled in this study were offered a voluntary HIV test (as per the procedure of the current New Start Center-integrated service provision). Those who decided not to get an HIV test but were willing to participate in the study were still eligible.

### *2.5.2. Qualitative data*

Qualitative data from service providers were collected using audio recorders. All audio-recorded qualitative data were transcribed and translated verbatim from the Shona language into English, where necessary. Any relevant non-verbal communications were included in the transcripts.

Content analysis was used to identify primary themes. In content analysis, researchers first conducted open coding to label emergent themes. Two researchers independently coded each transcript. Discrepancies were resolved, after which axial coding was performed to link related codes together and identify patterns in coding relationships. Finally, summary coding was used to identify the primary and secondary codes and patterns from the data. Codes were grouped, and emerging themes were identified. Themes and sub-themes were illustrated with verbatim quotes.

For the iterative cognitive interviews with clients, a series of questions on the comprehension of the step-by-step user guide for HPV DNA self-sample collection was administered. This process was performed iteratively in three rounds, incorporating suggested changes into the user guide.

### 2.6. Ethical considerations

#### *2.6.1. Informed consent*

This study was approved by the local institutional review board of the Medical Research Council of Zimbabwe (MRCZ/A/2490). Written informed consent was obtained from all study participants, in line with recommendations from the Medical Research Council of Zimbabwe. Participants were provided with a copy of their informed consent form.

#### *2.6.2. Risks*

The risks of participating in this study were minimal. Participants who felt uncomfortable with any of the questions were given the option to skip them. Participants may have experienced minor discomfort during the collection of cervical and/or vaginal specimens, while others may have had privacy concerns regarding provider-collected cervical specimens. In any case, participants could opt out or withdraw from the study at any point without any repercussions.

#### *2.6.3. Benefits*

There were no direct benefits to participants in this study.

#### *2.6.4. Confidentiality*

All study-related information was stored securely at the project office. All participants' information was stored in locked file cabinets in areas with restricted access to study staff. Records with names or other personal identifiers, such as informed consent forms, were stored separately from study records and identified by participant identification numbers (PTID). All data were collected and analyzed anonymously; there was no way of linking identifying information to PTID. All transcriptions from audio-recorded interviews and discussions were stored on password-protected computers with limited access. The cervical specimens collected were placed in careHPV collection medium and stored for 30 days from the date of collection at 2–8°C in an access-restricted laboratory. Only authorized laboratory personnel at the New Start Center and study investigators had access to the specimens. After a period of viability, the specimens were destroyed.

## 3. Results

### 3.1. Demographics

Table 2 presents demographic characteristics of respondents by study arm, where Arm 1 corresponds to HPV DNA self-sampling before a provider-collected cervical swab, and Arm 2 corresponds to a provider-collected cervical swab before a self-collected vaginal swab. There were no differences in frequency distribution across all demographics, indicating no randomization bias across the study arms.

### 3.2. Sample description: Risk assessment

Known cancer risk factors were compared between the two study arms, and the results are presented in Table 3. The frequency distributions of risk factors were comparable between the study arms, indicating a balanced randomization.

### 3.3. Test results

The findings revealed that HPV positivity was 29.4% in Arm 1 compared to 26.8% in Arm 2, with overlapping 95% confidence intervals (CIs), indicating no statistically significant difference in point estimates between the two study arms, as shown in Table 4.

Table 5 presents the test results of self- and provider-collected samples. Self-collected samples yielded a 26.9% HPV positivity compared to 29.3% positivity in provider-collected samples, and these point estimates were also statistically similar, as indicated by overlapping 95% CIs. A McNemar's test for the difference between the paired proportions for the provider-collected and self-collected samples confirmed this result, with a $p<0.1060$.

Table 6 presents HPV positivity results across different participant demographics. The purpose of this analysis was to identify factors associated with HPV positivity and assess whether these factors differed between provider-collected and client-collected samples.

The findings revealed no significant differences in HPV positivity proportions across all demographics, indicating that there were no factors associated with the outcome at 5% level of significance. This result was consistent across provider-collected cervical swabs and client-collected vaginal swabs.

Table 7 presents the results of similar analyses comparing HPV positivity outcomes across known cancer risk factors. Participants with a history of alcohol consumption had a significantly higher HPV positivity of 46.2% (95% CI: 34.5–58.3) compared to participants who reported no alcohol consumption, who had a positivity of 27.3% (95% CI: 23.8–31.2) in the provider-collected samples, and 34.8% (95% CI: 24.4–47.0) among participants who reported alcohol consumption in the client-collected samples, compared to 26.0% (95% CI: 22.5–29.9) among participants who reported no alcohol consumption.

Moreover, HIV-positive participants had a significantly higher HPV positivity in the provider-collected samples at 41.2% (95% CI: 34–48.7) compared to 24.7% (95% CI: 20.9–29.0) among HIV-negative participants. A significant

**Table 2. Demographic characteristics of women screened for HPV DNA, by study arm**

| Variable | Categories | Arm 1 (% [min–max]) | Arm 2 (% [min–max]) | Total (n [%]) |
|---|---|---|---|---|
| Age | Min–max (mean) | 30–65 (39) | 30–77 (40) | 30–77 (40) |
| Education level | None | 1.0 (0.3–3.0) | 2.0 (0.9–4.3) | 9 (1.5) |
| | Incomplete primary | 3.2 (1.7–5.9) | 3.3 (1.8–6.0) | 20 (3.3) |
| | Completed primary | 7.1 (4.7–10.6) | 8.5 (5.9–12.3) | 48 (7.7) |
| | Incomplete secondary | 19.3 (15.3–24.2) | 25.3 (20.7–30.6) | 137 (22.3) |
| | Completed secondary | 52.6 (47.0–58.1) | 48.3 (42.8–54.0) | 310 (50.5) |
| | Any tertiary | 8.1 (5.5–11.7) | 6.3 (4.0–9.6) | 44 (7.2) |
| | Completed tertiary | 8.7 (6.0–12.4) | 6.3 (4.0–9.6) | 46 (7.5) |
| Marital status | Married/cohabiting | 68.4 (63.0–3.3) | 70.0 (64.6–75.0) | 425 (69.2) |
| | Never married | 5.8 (3.7–9.0) | 4.6 (2.7–7.6) | 32 (5.2) |
| | Widowed | 8.4 (5.8–12.1) | 9.9 (7.0–13.8) | 56 (9.1) |
| | Divorced | 9.3 (6.6–13.2) | 5.6 (3.5–8.8) | 46 (7.5) |
| | Separated | 8.1 (5.5–11.7) | 9.9 (7.0–13.8) | 55 (9.0) |
| Sector | Rural | 3.5 (2.0–6.3) | 2.6 (1.3–5.2) | 19 (3.1) |
| | Urban | 91.0 (87.2–93.7) | 95.1 (92.0–97.0) | 571 (93.0) |
| | Peri-urban | 4.5 (2.7–7.5) | 1.6 (0.7–3.9) | 19 (3.1) |
| | Farming/resettlement | 1.0 (0.3–3.0) | 0.7 (0.2–2.6) | 5 (0.8) |
| Religion | Christianity | 78.4 (73.4–82.6) | 79.0 (75.0–84.1) | 486 (79.2) |
| | Apostolic | 17.7 (13.8–22.4) | 16.1 (12.4–20.7) | 104 (16.9) |
| | Muslim | 1.0 (0.3–3.0) | 2.7 (0.7–3.9) | 8 (1.3) |
| | Traditional | - | 0.2 (0.04–2.3) | 1 (0.2) |
| | None | 2.9 (1.5–5.5) | 2.0 (0.9–4.3) | 15 (2.4) |

difference was also observed in the client-collected samples, where 39.1% (95% CI 32.0–46.6) of participants tested HPV-positive compared to 22.3% (95% CI 18.6–26.4) among HIV-negative participants, as indicated by non-overlapping CIs. No statistical differences were observed across the other known cancer risk factors, as shown in Table 7.

### 3.4. User experiences on HPV DNA sample collection

Experiences with self-sample collection were documented to better understand women's experiences, as shown in Table 8. Among participants, 37% expressed concern about injuring themselves, while 39.6% were concerned about not obtaining a good sample. A small proportion (9.8%) reported feeling embarrassed during self-sample collection, and a similar proportion (10.3%) reported experiencing some pain during collection.

Over half of the respondents (54.4%) reported preferring self-sample collection. Nonetheless, 97.6% of respondents indicated they would recommend HPV DNA sample collection overall, 90.6% intended to undergo cancer screening using this method, and 88.8% trusted the HPV DNA test results.

Figure 2 shows the reported level of difficulty with self-sample collection. The modal score was 2 on a scale of 1–10, indicating relative ease of sample collection among most women.

### 3.5. Service provider perceptions

The study additionally assessed service provider perceptions of clients' ability to provide reliable samples and the preparedness of site personnel to offer HPV DNA testing. Common themes emerging from the thematic analysis indicated a high preference for HPV DNA self-sample collection with minimal supervision by skilled and semi-skilled professionals. Providers described HPV DNA self-sample collection as more suitable for younger and more literate women, who could read and follow instructions better.

Some providers preferred provider collection, stating that there were reduced chances of specimen contamination. Furthermore, provider collection offered an additional opportunity for the identification of other pathological changes and a chance for syndromic STI screening. In addition, women would have the opportunity to receive counseling and ask questions directly to the

**Table 3. Risk assessment of women screened for HPV DNA, by study arm**

| Variable | Categories | Arm 1 (% [min–max]) | Arm 2 (% [min–max]) | Total (*n* [%]) |
|---|---|---|---|---|
| History of alcohol consumption | Always | 1.6 (0.7–3.8) | 1.6 (0.7–3.9) | 10 (1.6) |
| | Sometimes | 11.9 (8.8–16.1) | 6.3 (4.0–9.6) | 56 (9.0) |
| | Rarely | 1.9 (0.9–4.3) | 1.3 (0.5–3.5) | 10 (1.5) |
| | Never | 84.3 (79.7–87.9) | 90.8 (87.0–93.6) | 537 (87.4) |
| | Missing | 0.3 (0.04–2.3) | - | 1 (0.5) |
| HIV results | Positive | 25.2 (20.6–30.3) | 30.2 (25.3–35.7) | 170 (27.7) |
| | Negative | 74.8 (69.7–79.4) | 69.7 (64.3–74.7) | 444 (72.3) |
| Family history of cervical cancer | Yes | 9.4 (6.6–13.2) | 9.9 (7.0–13.8) | 59 (9.6) |
| | No | 84.2 (79.7–87.9) | 87.2 (82.9–90.5) | 526 (85.7) |
| | Uncertain | 6.1 (3.9–9.4) | 2.6 (1.3–5.2) | 27 (4.4) |
| | Missing | 0.3 (0.04–2.3) | 0.3 (0.04–2.3) | 2 (0.3) |
| Age at sexual debut | ≤15 | 4.5 (2.7–7.5) | 4.6 (2.7–7.6) | 28 (4.6) |
| | 16–17 | 15.8 (12.1–20.3) | 14.1 (10.6–18.6) | 92 (15.0) |
| | 18–19 | 29.0 (24.2–34.4) | 32.2 (27.2–37.7) | 188 (30.6) |
| | 20–24 | 41.3 (35.9–46.9) | 43.8 (38.2–49.4) | 261 (42.5) |
| | ≥25 | 9.4 (6.6–13.2) | 5.3 (3.2–8.4) | 45 (7.3) |
| Number of lifetime sexual partners | 1–2 | 63.2 (57.7–68.4) | 64.5 (58.9–69.7) | 392 (63.8) |
| | 3–4 | 20.4 (16.2–25.2) | 19.1 (15.0–23.9) | 121 (19.7) |
| | 5–6 | 8.7 (6.0–12.4) | 6.6 (4.3–10.0) | 47 (7.7) |
| | ≥7 | 7.7 (5.2–11.3) | 9.8 (7.0–13.8) | 54 (8.8) |
| Ever had an STI | Yes | 14.2 (10.7–18.6) | 19.7 (15.6–24.6) | 104 (16.9) |
| | No | 85.8 (81.4–89.3) | 80.3 (75.4–84.4) | 510 (83.1) |

Abbreviations: HIV: Human immunodeficiency virus; STI: Sexually transmitted infection.

**Table 4. Test results for provider-collected samples, by study arm**

| Samples | Total tests | Number of HPV-positive | Percentage of HPV-positive | 95% CIs |
|---|---|---|---|---|
| Arm 1 | 616 | 181 | 29.4 | 25.8–33.2 |
| Arm 2 | 604 | 162 | 26.8 | 23.3–30.5 |

Abbreviations: CI: Confidence interval; HPV: Human papillomavirus.

**Table 5. Test results for self-collected and provider-collected samples**

| Samples | Total tests | Number of HPV-positive | Percentage of HPV-positive | 95% CIs |
|---|---|---|---|---|
| Client-collected | 609 | 164 | 26.9 | 23.5–30.6 |
| Provider-collected | 611 | 179 | 29.3 | 25.8–33.0 |

Abbreviations: CI: Confidence interval; HPV: Human papillomavirus.

service provider about cervical cancer or HPV, among other sexual and reproductive health issues. There were also concerns among a few service providers that some clients may struggle to understand instructions, which could lead to inaccurate results.

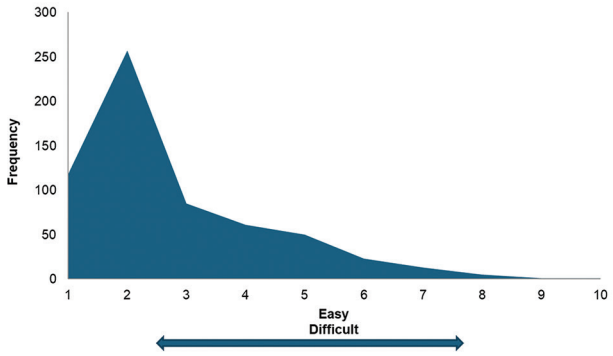


**Figure 2.** Level of difficulty of self-sample collection

Overall, there was a preference for HPV DNA testing over VIAC, as the latter may show results that are misleading and not indicative of precancerous conditions, whereas HPV DNA testing focuses solely on cancer. Furthermore, most service providers preferred self-sample collection over provider-collected samples due to the non-involvement of the speculum, which was described as "too invasive." Self-sample collection was also viewed as a

**Table 6. Results of HPV positivity by sample demographics**

| Variable | Categories | Provider-collected sample result (*n*=611) | | Client-collected sample result (*n*=609) | |
|---|---|---|---|---|---|
| | | HPV-positive (%) | 95% CIs | HPV-positive (%) | 95% CIs |
| Age | 30–39 | 30.7 | 25.9–35.8 | 27.6 | 14.4–46.3 |
| | 40–49 | 27.7 | 22–34.2 | 23.6 | 18–30.4 |
| | >50 | 27.5 | 18.3–39.2 | 27.3 | 22.6–32.5 |
| Education level | None | 27.9 | 23.8–32.4 | 27.6 | 14.4–46.3 |
| | Primary | 41.9 | 26.1–59.6 | 23.6 | 18–30.4 |
| | Secondary | 28.6 | 18.3–41.7 | 27.3 | 22.6–32.5 |
| | Tertiary | 30.4 | 18.9–45.1 | 32.2 | 23.4–42.5 |
| Marital status | Married/cohabiting | 27.9 | 23.8–32.4 | 24.9 | 21–29.2 |
| | Never married | 41.9 | 26.1–59.6 | 40.6 | 25.2–58.1 |
| | Widowed | 28.6 | 18.3–41.7 | 25.0 | 15.4–37.9 |
| | Divorced | 30.4 | 18.9–45.1 | 37.8 | 24.9–52.6 |
| | Separated | 32.7 | 21.7–46.1 | 27.8 | 17.5–41.1 |
| Sector | Rural | 21.1 | 8.1–44.6 | 21.1 | 8.1–44.6 |
| | Urban | 29.6 | 26–33.5 | 27.9 | 24.4–31.8 |
| | Peri-urban | 21.1 | 8.1–44.6 | 5.3 | 0.7–29.5 |
| | Farming/resettlement | 60.0 | 20–90 | 20.0 | 2.7–69.2 |
| Religion | Christianity | 28.9 | 26.7–34.9 | 33.1 | 25–33.1 |
| | Apostolic | 18.3 | 16–32.1 | 26.9 | 12–26.9 |
| | Muslim | 25.0 | 12.5–71.6 | 62.4 | 6.3–62.4 |
| | None | 20.0 | 10.4–53.4 | 47.0 | 6.6–47 |

Abbreviations: CI: Confidence interval; HPV: Human papillomavirus.

**Table 7. Results of HPV positivity by risk factor**

| Variable | Categories | Provider-collected sample result (*n*=611) | | Client-collected sample result (*n*=609) | |
|---|---|---|---|---|---|
| | | HPV-positive (%) | 95% CIs | HPV-positive (%) | 95% CIs |
| History of alcohol consumption | No/rarely | 27.3 | 23.8–31.2 | 26.0 | 22.5–29.9 |
| | Yes | 46.2 | 34.5–58.3 | 34.8 | 24.4–47.0 |
| HIV results | Positive | 41.2 | 34.0–48.7 | 39.1 | 32.0–46.6 |
| | Negative | 24.7 | 20.9–29.0 | 22.3 | 18.6–26.4 |
| Family history of cervical cancer | Yes | 23.7 | 14.6–36.2 | 22.0 | 13.2–34.4 |
| | No | 30.0 | 26.2–34.0 | 27.6 | 24.0–31.6 |
| | Uncertain | 23.1 | 10.7–42.8 | 22.2 | 10.3–41.5 |
| Age at sexual debut | <18 | 26.7 | 19.5–35.3 | 21.8 | 15.3–30.2 |
| | 18–24 | 29.5 | 25.5–33.9 | 27.6 | 23.7–32.0 |
| | ≥25 | 34.1 | 21.7–49.1 | 33.3 | 21.2–48.2 |
| Number of lifetime sexual partners | 1–2 | 27.3 | 23.1–31.9 | 24.4 | 20.3–28.9 |
| | 3–4 | 33.3 | 25.5–42.2 | 31.7 | 24.0–40.5 |
| | 5–6 | 26.1 | 15.4–40.6 | 32.6 | 20.7–47.3 |
| | ≥7 | 37.7 | 25.8–51.4 | 30.2 | 19.4–43.8 |
| Ever had an STI | Yes | 31.7 | 23.5–41.3 | 28.8 | 21.0–38.3 |
| | No | 28.8 | 25.0–32.9 | 26.5 | 22.9–30.6 |

Abbreviations: CI: Confidence interval; HPV: Human papillomavirus; STI: Sexually transmitted infection.

**Table 8. User experiences on HPV DNA sample collection**

| Indicator | Yes (%) | 95% CI |
|---|---|---|
| Concerned about hurting oneself | 37.0 | 33.2–40.9 |
| Concerned about not obtaining a good sample | 39.6 | 35.8–43.5 |
| Concerned about dropping the sampling equipment | 19.7 | 16.7–23.1 |
| Felt anxious during self-sample collection | 33.1 | 29.4–36.9 |
| Felt embarrassed during self-sample collection | 9.8 | 7.7–12.4 |
| Felt pain during sample collection | 10.3 | 8.1–12.9 |
| Would recommend this method | 97.6 | 96.0–98.5 |
| Preference for self-sample collection versus provider collection | 54.4 | 50.4–58.3 |
| Intention to get tested for cancer using HPV DNA in the future | 90.6 | 88.0–92.6 |
| Trusted the results of the test | 88.8 | 86.0–91.0 |

Abbreviations: CI: Confidence interval; HPV: Human papillomavirus.

panacea for reducing healthcare worker burden, especially in high-volume sites, since the kit could be issued to several women simultaneously, thereby reducing waiting time and allowing the provider to attend to other recipients of care.

## 4. Discussion

The study compared HPV DNA results between two study arms defined and differentiated by the sequence of sample collection. In the first study arm, a self-collected vaginal swab was obtained, followed by a provider-collected cervical swab, while in the second study arm, the sequence was swapped—the provider-collected cervical swab preceded the self-collected vaginal swab. First, randomization checks were conducted to evaluate possible sampling bias across the study arms. The results showed a similar distribution across all participants' demographics and potential cancer covariates, indicating that the two study arms were comparable.

HPV positivity was comparable between the two study arms, indicating that the sequence of collecting samples did not affect the outcome. Results were comparable regardless of which sample was collected first. These results are consistent with findings from a crossover trial by Wong *et al*.,[22] which compared HPV DNA and Pap smear. Furthermore, comparisons between provider- and self-collected vaginal samples were performed. The results showed no statistically significant differences in HPV positivity, confirming that self-collected samples were comparable to provider-collected samples. Although Kuguyo *et al*.[4] noted that HPV DNA screening has low specificity, these results suggest that HPV DNA screening is a feasible method that can be used with a follow-up VIAC test following a positive HPV screen.

Further analyses were conducted to evaluate whether comparisons between provider- and self-collected vaginal samples differed by specific demographic variables. Across age, level of education, marital status, religion, and type of residence, no statistically significant differences were observed, indicating that the risk factors were not associated with HPV positivity results in provider- and self-collected samples. Cancer risk factors, such as history of alcohol consumption, HIV status, family history of cancer, age at sexual debut, number of sexual partners, and STI infection history were also included to compare the outcomes. The findings reveal that there were no factors associated with inconsistent results between self- and provider-collected samples.

In the same analyses, investigators also assessed factors associated with HPV positivity. The findings reveal that there were no demographic factors associated with HPV positivity. However, further investigations on risk factors showed that both provider- and self-collected samples were more likely to show positive results among participants with a history of alcohol consumption compared to those without. HIV-positive women were also more likely to have a positive result compared to HIV-negative women in both provider- and client-collected samples.

In terms of user experiences on HPV DNA sample collection, participants responded positively, with most of them reporting that they trusted the results from the test, would recommend this method to other women, and would get tested again in the future using HPV DNA. While the results indicated that women reported relative ease in self-sample collection, some women were concerned about not getting a good sample or hurting themselves, or felt anxious, embarrassed, or experienced some pain. Sensitization campaigns and tailored instructions may be instrumental in equipping women with sufficient knowledge to improve their technique and increase their confidence.

The qualitative results showed a high preference for HPV DNA among women and service providers relative to other methods, such as VIAC. This finding is consistent with that of Senkomago and Saraiya.[23] HPV self-sample collection also offers the convenience of reducing healthcare worker burden at the service delivery point. However, women may miss an opportunity to get screened for other infections or conditions and access other available health services.

HPV DNA screening is known to be less expensive than other screening methods, as noted by Nelson *et al*.[26] The high preference for HPV DNA self-sampling in a low- and middle-income country, such as Zimbabwe becomes an important finding. Braz *et al*.[8] stated that inadequate resourced service delivery systems are a major contributor to low cervical cancer screening coverage. Self-sample

collection goes a long way in reducing healthcare worker burden in such settings.

However, several limitations remain in this study. First, all HPV-positive results should have been followed up with a VIAC test to determine eligibility for cryotherapy, thermal ablation treatment, or a loop electrosurgical excision procedure. This is the standard routine for cancer management. In addition, a full cancer screening and treatment cascade—from screening by method to treatment and tracking of treatment outcomes—could have also provided a more complete comparison of provider-collected and client-collected samples. Moreover, the study sample was largely skewed toward the urban population, which affected the generalizability of the results to the rural setting, where women are generally less educated and have less access to cancer screening and treatment services. The cost-effectiveness of provider-delivered sample collection compared to self-sample collection could have also added further insights in providing more context to the acceptability and feasibility of self-sample collection. However, evaluating cost-effectiveness was beyond the scope of this study.

## 5. Conclusion

In conclusion, self-sample collection is just as effective as provider collection in detecting HPV. HPV detection rates were not affected by the sequence used to collect the samples—regardless of whether the provider-collected sample or the self-collected sample was taken first. This demonstrates that women can collect a reliable sample for HPV testing. Furthermore, most service providers and participants viewed the screening method as highly acceptable, and both groups agreed that sample collection was easy. A few participants reported experiencing pain during sample collection, suggesting the need for further training and supervision by trained providers to ensure correct adherence to instructions. HPV DNA self-sample collection has not yet been widely implemented in Zimbabwe. The findings of this study provide insights to support the expansion of HPV DNA testing and increase cervical cancer screening coverage in the country. The scale-up process should be supported by clear communication strategies, along with a step-by-step manual for self-sample collection, translated into local languages to improve accessibility.

## Acknowledgments

We extend our heartfelt gratitude to the data collection team and service providers for their active participation in protocol training and their unwavering commitment to implementing the protocol with fidelity. Finally, we convey our utmost respect and gratitude to the study participants for voluntarily consenting to participate and allowing both self- and provider-collected samples to be used in this study.

## Funding

This study was funded by the Swedish International Development Agency (SIDA; grant number: 4697).

## Conflict of interest

The authors declare no conflicts of interest.

## Author contributions

*Conceptualization:* Malvern Munjoma, Stephano Gudukeya, Noah Taruberekera

*Data curation:* Malvern Munjoma, Danai Madzivire

*Formal analysis:* Malvern Munjoma, Jabulani Mavudze, Danai Madzivire

*Funding acquisition:* Stephano Gudukeya, Ngonidzashe Madidi, Noah Taruberekera

*Investigation:* Malvern Munjoma

*Methodology:* Malvern Munjoma, Jabulani Mavudze

*Supervision:* Charity Chipfumbu, Danai Madzivire, Ngonidzashe Madidi

*Writing–original draft:* Malvern Munjoma, Jabulani Mavudze

*Writing–review & editing:* Stephano Gudukeya, Tafara Moga, Blessing Mutede, Noah Taruberekera

## Ethics approval and consent to participate

This study was approved by the Medical Research Council of Zimbabwe (MRCZ; approval number: MRCZ/A/2490). Written consent was obtained from the participants in line with the MRCZ guidance.

## Consent for publication

Written consent was obtained to publish data (in report and aggregate format), not images or actual names.

## Availability of data

Data are available from the corresponding author upon reasonable request.

## References

1. Institute for Health Metrics and Evaluation (IHME). *Global Burden of Disease Study 2015 (GBD 2015): Cancer Results*. Seattle, WA: IHME; 2015.

2. Bray F, Ferlay J, Soerjomataram I, Siegel RL, Torre LA, Jemal A. Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*. 2018;68(6):394-424.

doi: 10.3322/caac.21492

3. Sherris J, Herdman C, Elias C. Cervical cancer in the developing world. *West J Med*. 2001;175(4):231-233.

doi: 10.1136/ewjm.175.4.231

4. Kuguyo O, Matimba A, Tsikai N, *et al*. Cervical cancer in Zimbabwe: A situation analysis. *Pan Afr Med J*. 2017;27:215.

doi: 10.11604/pamj.2017.27.215.12994

5. Walboomers JM, Jacobs MV, Manos MM, *et al*. Human papillomavirus is a necessary cause of invasive cervical cancer worldwide. *J Pathol*. 1999;189(1):12-19.

doi: 10.1002/(SICI)1096-9896(199909)189:1<12:AID-PATH431>3.0.CO;2-F

6. Luciani S, Cabanes A, Prieto-Lara E, Gawryszewski V. Cervical and female breast cancers in the Americas: Current situation and opportunities for action. *Bull World Health Organ*. 2013;91(9):640-649.

doi: 10.2471/BLT.12.116699

7. Reisner SL, Deutsch MB, Peitzmeier SM, *et al*. Test performance and acceptability of self- versus provider-collected swabs for high-risk HPV DNA testing in female-to-male trans masculine patients. *PLoS One*. 2018;13(3):e0190172.

doi: 10.1371/journal.pone.0190172

8. Braz NS, Lorenzi NP, Sorpreso IC, de Aguiar LM, Baracat EC, Soares-Júnior JM. The acceptability of vaginal smear self-collection for screening for cervical cancer: A systematic review. *Clinics (Sao Paulo)*. 2017;72(3):183-187.

doi: 10.6061/clinics/2017(03)09

9. World Health Organization. *WHO Guideline for Screening and Treatment of Cervical Pre-Cancer Lesions for Cervical Cancer Prevention*. 2nd ed. Geneva: World Health Organization; 2021.

10. Sankaranarayanan R, Budukh AM, Rajkumar R. Effective screening programmes for cervical cancer in low- and middle-income developing countries. *Bull World Health Organ*. 2001;79(10):954-962.

11. Boggan JC, Walmer DK, Henderson G, *et al*. Vaginal self-sampling for human papillomavirus infection as a primary cervical cancer screening tool in a Haitian population. *Sex Transm Dis*. 2015;42(11):655-659.

doi: 10.1097/OLQ.0000000000000345

12. Valdez M, Jeronimo J, Bansil P, *et al*. Effectiveness of novel, lower cost molecular human papillomavirus-based tests for cervical cancer screening in rural China. *Int J Cancer*. 2016;138(6):1453-1461.

doi: 10.1002/ijc.29877

13. Penaranda E, Molokwu J, Flores S, Byrd T, Brown L, Shokar N. Women's attitudes toward cervicovaginal self-sampling for high-risk HPV infection on the US-Mexico border. *J Low Genit Tract Dis*. 2015;19(4):323-328.

doi: 10.1097/LGT.0000000000000134

14. Adamson PC, Huchko MJ, Moss AM, Kinkel HF, Medina-Marino A. Acceptability and accuracy of cervical cancer screening using a self-collected tampon for HPV mRNA testing among HIV-infected women in South Africa. *PLoS One*. 2015;10(9):e0137299.

doi: 10.1371/journal.pone.0137299

15. Moses E, Pedersen H, Mitchell S. 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*. 2015;20(10):1355-1367.

doi: 10.1111/tmi.12549

16. Crosby RA, Hagensee ME, Vanderpool R, *et al*. Community-based screening for cervical cancer: A feasibility study of rural Appalachian women. *Sex Transm Dis*. 2015;42(11):607-611.

doi: 10.1097/OLQ.0000000000000365

17. Rositch AF, Gatuguta A, Choi R. Knowledge and acceptability of pap smears, self-sampling and HPV vaccination among adult women in Kenya. *PLoS One*. 2012;7:e40766.

doi: 10.1371/journal.pone.0040766

18. Bansil P, Wittet S, Lim JL, Winkler JL, Paul P, Jeronimo J. Acceptability of self-collection sampling for HPV-DNA testing in low-resource settings: A mixed methods approach. *BMC Public Health*. 2014;14:596.

doi: 10.1186/1471-2458-14-596

19. World Health Organization. *WHO Guidelines for Screening and Treatment of Precancerous Lesions for Cervical Cancer Prevention*. Geneva: WHO; 2013.

20. Gage JC, Schiffman M, Katki HA, Castle PE, *et al*. Reassurance against future risk of precancer and cancer conferred by a negative human papillomavirus test. *J Natl Cancer Inst*. 2014;106(8):dju153.

doi: 10.1093/jnci/dju153

21. Termrungruanglert W, Khemapech N, Tantitamit T, Sangrajrang S, Havanond P, Laowahutanont P. Cost-effectiveness analysis study of HPV testing as a primary cervical cancer screening in Thailand. *Gynecol Oncol Rep*. 2017;22:58-63.

doi: 10.1016/j.gore.2017.09.007

22. Wong EL, Chan PK, Chor JS, Cheung AW, Huang F, Wong SY. Evaluation of the impact of human papillomavirus DNA self-sampling on the uptake of cervical cancer screening. *Cancer Nurs*. 2016;39(1):E1-E11.

doi: 10.1097/NCC.0000000000000241

23. Senkomago V, Saraiya M. Examining acceptability of self-

collection for human papillomavirus testing among women and healthcare providers with a broader lens. *J Womens Health (Larchmt)*. 2017;26(6):597-599.

doi: 10.1089/jwh.2017.6384

24. Tachiwenyika E, Dhodho M, Muchedzi A, *et al*. Prevalence of cervical cancer and clinical management among women screened positive using visual inspection with acetic acid and cervicography in Zimbabwe. *PLoS One*. 2023;18(11):e0294115.

doi: 10.1371/journal.pone.0294115

25. Zimbabwe National Statistics Agency (ZIMSTAT), ICF International. *Zimbabwe Demographic and Health Survey 2015: Key Indicators*. Zimbabwe: ZIMSTAT and ICF; 2016.

26. Nelson EJ, Maynard BR, Loux T, Fatla J, Gordon R, Arnoldet LD. The acceptability of self-sampled screening for HPV DNA: A systematic review and meta-analysis. *Sex Transm Infect*. 2017;93:56-61.

doi: 10.1136/sextrans-2016-052609

27. Stanczuk G, Baxter G, Currie H, *et al*. Clinical validation of hrHPV testing on vaginal and urine self-samples in primary cervical screening. *BMJ Open*. 2016;6(4): e010660.

doi: 10.1136/bmjopen-2015-010660

28. Gravitt PE, Paul P, Katki HA, *et al*. Effectiveness of VIA, Pap, and HPV DNA testing in a cervical cancer screening program in a Peri-urban community in Andhra Pradesh, India. *PLoS One*. 2010;5(10):e13711.

doi: 10.1371/journal.pone.0013711

29. Rosner B. *Fundamentals of Biostatistics*. 6th ed. Belmont, CA: Thomson Higher Education; 2006.

30. McNemar Q. Note on the sampling error of the difference between correlated proportions or percentages. *Psychometrika*. 1947;12(2):153-157.

doi: 10.1007/BF02295996

31. Durkalski V, Palesch Y, Lipsitz S, Rust P. Analysis of clustered matched pair data. *Stat Med*. 2003;22(15):2417-2428.

doi: 10.1002/sim.1438

32. Winer RL, Lee SK, Fontenot AB, *et al*. Concordance of self-collected and clinician-collected swab samples for detecting HPV DNA. *J Clin Microbiol*. 2007;45(6):1966-1969.

33. Clifford GM, de Vuyst H, Tenet V, Plummer M, Tully S, Franceschi S. Effect of HIV infection on Human Papillomavirus types causing invasive cervical cancer in Africa. *J Acquir Immune Defic Syndr*. 2016;73(3):332-339.

doi: 10.1097/QAI.0000000000001113