

RESEARCH ARTICLE

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## HPV Self-Sampling for Cervical Cancer Screening in Morocco: A Cross-Sectional Study

Fatima Zahra Chellat<sup>1\*</sup>, Nassiba Bahra<sup>2</sup>, Youssef Chami Khazraji<sup>3</sup>, Rachid Bekkali<sup>3</sup>, Maria Bennani<sup>3</sup>, Zineb Gaizi<sup>3</sup>, Nabil Tachfouti<sup>2</sup>, Samira EL Fakir<sup>2</sup>, Anasse Ben Abdellah<sup>2</sup>, Mohammed EL Mzibri<sup>4</sup>, Mohamed Berraho<sup>1</sup>

### Abstract

**Objective:** Morocco is currently planning to introduce HPV testing as the primary screening method in routine cervical cancer screening. Accordingly, HPV self-sampling offers a potential solution to increase participation rates, particularly in underserved regions. Therefore, this study was designed to assess the feasibility and acceptability of HPV self-sampling using the GeneXpert assay as an alternative to clinician-administered screenings in Morocco. **Methods:** A cross-sectional study was conducted among 997 women aged 30 or 40 years from four Moroccan provinces. Participants were offered the choice of clinician-collected sampling, supervised self-sampling, or unsupervised self-sampling. Socioeconomic and clinical data were collected using structured questionnaires, and HPV detection and genotyping were performed using the GeneXpert HPV assay. **Results:** Overall, 13% of participants opted for self-sampling, including 4.8% who chose unsupervised, and 8.2% supervised self-sampling. Women living in urban areas, younger participants (30 years old), and those with higher education and income levels were more likely to select self-sampling. Satisfaction was high: 92.2% found the procedure easy to perform, all participants reported comfort using the cytobrush, and all indicated willingness to recommend the test to relatives or friends. Additionally, the diagnostic performance of high-risk HPV (hrHPV) testing was comparable between self-collected and clinician-collected samples, demonstrating no effect of sampling method on HPV detection. **Conclusion:** HPV self-sampling is feasible and highly acceptable among Moroccan women. However, the low uptake, particularly in rural settings, highlights the need for targeted education and awareness efforts. Integrating self-sampling into national screening programs may improve participation and contribute to reducing cervical cancer incidence in Morocco.

**Keywords:** Human papillomavirus (HPV)- HPV testing- self-sampling- Morocco

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### Introduction

Cervical cancer remains a significant global public health concern, ranking as the eighth most common cancer and the ninth leading cause of cancer-related mortality among women. In 2022, an estimated 662,301 new cases and 348,874 deaths were reported worldwide, with approximately 85% occurring in low- and middle-income countries (LMICs) [1]. In the same year, Morocco ranked fourth in incidence and second in mortality in the region, with 2,644 new cases and 1,468 deaths, corresponding to an incidence rate of 8.7 per 100,000 women [2].

Despite its substantial burden, cervical cancer is largely preventable through HPV vaccination, early diagnosis, and timely treatment [3]. In 2020, the World Health Organization (WHO) launched a global

initiative to eliminate cervical cancer by increasing HPV vaccination coverage, expanding screening programs, and improving access to treatment. Although HPV vaccination significantly reduces infection rates, access remains limited in many settings, including Morocco, leaving many women at continued risk [4]. Secondary prevention strategies focused on the early detection and treatment of precancerous lesions have been shown to reduce incidence and mortality, particularly in high-income countries with well-established screening programs [5]. However, screening coverage remains inadequate globally due to barriers such as limited healthcare access, lack of medical insurance, discomfort, embarrassment, and fear of cancer [6].

The WHO recently recommended HPV testing as the primary method for cervical cancer screening because of

<sup>1</sup>Institute of Cancer Research (IRC), Fez, Morocco. <sup>2</sup>Laboratory of Epidemiology, Clinical Research and Community Health, Faculty of Medicine, Pharmacy and Dentistry, Sidi Mohammed Ben Abdellah University, 30000, Fez, Morocco. <sup>3</sup>Foundation Lalla Salma Cancer prevention and treatment, 10000, Rabat, Morocco. <sup>4</sup>National Centre for Nuclear Energy, Science and Technology, Rabat, Morocco. \*For Correspondence: fatimazahra.chellat@usmba.ac.ma

its high sensitivity and specificity. Primary HPV testing offers several advantages: (a) it is based on recent advances in molecular diagnostics; (b) most HPV tests have been approved by the U.S. Food and Drug Administration (FDA) [7]; (c) it enables longer screening intervals; and (d) it can be performed using self-collected vaginal samples [8, 9]. In this context, the key factor influencing the successful implementation of HPV-based screening is the acceptability of self-sampling among women.

Self-collection allows women to obtain samples independently, reducing dependence on healthcare providers and offering particular benefits in low-resource settings [10, 11]. Globally, self-sampling for HPV testing has consistently been shown to increase screening coverage among underscreened populations, and several studies have reported high acceptability due to its simplicity, convenience, and privacy [3, 12].

In Morocco, despite the presence of a national early detection program using visual inspection with acetic acid (VIA), screening coverage remains insufficient, particularly in rural areas [13]. To strengthen early detection efforts, Morocco is integrating molecular HPV testing and genotyping into its screening strategy addressing the limitations of cytology-based approaches [14].

Self-sampling represents a promising strategy to improve participation, especially in underserved regions. This study assesses its feasibility and acceptability using the GeneXpert technique. Integrating self-sampling into the national screening program has the potential to expand access and substantially reduce cervical cancer incidence and mortality.

## Materials and Methods

### *Study Area and Population*

This cross-sectional study was conducted across four Moroccan provinces: Tangier, Béni Mellal, Taroudant, and Inezgane; strategically selected based on demographic and epidemiological factors, including the prevalence of HPV and other sexually transmitted infections [15, 16]. A total of 997 women aged 30 or 40 years were recruited from rural and urban settings. Pregnant women and those with diagnosed uterine disease, a history of cervical cancer, or debilitating conditions such as miliary tuberculosis, congestive heart failure, renal failure, uncontrolled hypertension or diabetes, or cognitive impairments were excluded.

### *Sample Size and Distribution*

The sample size was determined using a confidence level of  $\alpha = 0.05$ , a precision of 0.03, a cluster effect of 3, and an estimated prevalence of HPV types 16 and 18 ranging from 2% to 8% [17, 18], ensuring sufficient precision and statistical power. The final sample included 997 women from both urban and rural areas, allowing comparative analyses between geographic settings.

### *Study Variables*

Before data collection, collaborators from all provinces received standardized training led by the research team,

covering data management, self-sampling procedures, and HPV testing using the GeneXpert platform [19]. At enrollment, all participants completed socioeconomic and medical questionnaires capturing age, place of residence, marital status, education level, employment status, and monthly household income. Medical and gynecological histories were also collected, including comorbidities, cervical symptoms, age at first sexual intercourse, contraceptive use, and pregnancy history.

For HPV testing, participants selected their preferred sampling method: self-sampling, assisted self-sampling at health centers, or clinician-collected sampling. Women who chose self-sampling completed an additional questionnaire assessing comfort and acceptability. Responses were recorded on Likert scales measuring: ease of sample collection using a cytobrush (“Very easy” to “Very difficult”), preferred screening frequency if self-sampling was considered as effective as clinician-collection (“More often” to “Less often”), comfort level (“Very comfortable” to “Very uncomfortable,” including “Not applicable”), and willingness to recommend the test (“Strongly disagree” to “Strongly agree,” with options for “Not applicable” and “No opinion”).

### *Self-Sampling Procedure*

Participants were instructed on HPV self-collection using a cytobrush either at health centers or at home, with remote guidance from providers. Samples were analyzed in designated laboratories to compare diagnostic performance with clinician-collected samples.

### *HPV Testing*

All samples were processed at the Reproductive Health Reference Center using the GeneXpert HPV assay. Data included HPV positivity and genotyping. Women with cervical lesions received appropriate management at specialized centers, while confirmed cervical cancer cases were referred to regional oncology facilities.

The GeneXpert assay was performed according to the manufacturer’s protocol. For each cervical specimen collected in ThinPrep-PreservCyt medium, 1 mL was transferred into the Xpert HPV cartridge and inserted into the GeneXpert® module. This real-time PCR assay detects 14 high-risk HPV genotypes within approximately one hour and provides partial genotyping for HPV16, HPV18/45, and a pooled group of high-risk types (31, 33, 35, 39, 51, 52, 56, 58, 59, 66, and 68).

### *Ethical Considerations*

The study was conducted in accordance with the Declaration of Helsinki. Ethical approval was granted by the Ethics Committee of Medical Research at the Faculty of Medicine and Pharmacy in Rabat, Morocco (Ref : 31-22). Written informed consent was obtained from all participants, who were informed of the study objectives, voluntary participation, and their right to withdraw at any time. All data were collected anonymously and managed with strict confidentiality.

### *Statistical Analysis*

Data were collected using structured questionnaires

on tablets and stored in a REDCap database. Univariate analyses (chi-square tests, Fisher's exact test, t-tests, ANOVA, and non-parametric equivalents) were conducted to identify factors associated with self-sampling preference. Statistical significance was set at  $p < 0.05$ .

## Results

### Sociodemographic Characteristics

A total of 997 women aged 30 or 40 years were enrolled. Most participants were urban residents (62.9%), married (89.0%), and housewives (81.4%) with low monthly incomes (58.8%). Educational attainment was limited, with 36.6% being illiterate and 34.4% having only primary education. Additionally, 77.0% had medical coverage, while 22.7% were uninsured (Table 1).

### Medical and Gynecological History

Comorbidities were reported by 10.7% of participants, and 26.8% presented gynecological symptoms suggestive of cervical pathology. Most women initiated sexual activity before age 21 (67.4%), with the highest proportion between ages 19 and 21 (29.6%). Contraceptive use was reported by 81.4% of participants. Nearly all women (95.6%) had a history of pregnancy, while 4.5% had never been pregnant (Table 2).

Table 1. Sociodemographic Characteristics of Study Participants (N=997)

	Variables	N	%
Age	30 year old bracket	458	46.0
	40 year old slice	539	54.0
Residence area	Urban	628	62.9
	Rural	369	37.1
Monthly household income (MAD)	<2000	575	57.7
	2000-5000	337	33.8
	5000-10000	63	6.3
	>10000	22	2.2
Education level	Illiterate	365	36.6
	Primary	342	34.4
	Secondary	226	22.6
	University	64	6.4
Profession	Housewife	812	81.4
	Civil servant	26	2.6
	Self-employed	50	5.1
	Casual employee	45	4.5
	Other	64	6.4
Marital status	Married	888	89.0
	Divorced	59	6.0
	Widowed	7	0.7
	Single	43	4.3
Medical coverage	Yes	768	77.0
	No	226	22.7
	Don't know	3	0.3

### Sampling Preferences

Among the 997 participants, 87.0% preferred clinician-collected sampling (867/997), and only 13.0% opted for self-sampling (4.8% chose unsupervised self-collection (48/997) and 8.2% selected supervised self-collection (82/997)). Face-to-face interviews with the 130 self-sampling participants revealed that 92.2% found the procedure easy or very easy. All participants reported feeling comfortable or very comfortable using the cytobrush, indicating high acceptability, and 100% stated they would recommend the test to family or friends (Table 3).

### Factors Associated with Self-Sampling

Bivariate analysis identified several factors significantly associated with the adoption of self-sampling (Table 4). Geographic location was a key determinant : women in Taroudant showed the highest preference (53.0%), compared to Inezgane-Aït Melloul (17.3%), Tangier (7.7%), and Béni Mellal (0.7%) ( $p < 0.001$ ). Age also played a significant role, with younger women (aged 30) being more likely to choose self-sampling than those aged 40 (18.1% vs. 8.7% ;  $p < 0.001$ ). Urban residence was strongly associated with self-sampling (19.6% vs. 1.9% among rural women ;  $p < 0.001$ ).

Socioeconomic status, measured through income and education, was also significantly associated with preference. Women with monthly household incomes above 5,000 MAD were more likely to select self-sampling than those earning less (31.8% vs. 12.1%;  $p < 0.001$ ). Similarly, literate women favored self-sampling over illiterate women (15.5% vs. 8.7% ;  $p = 0.002$ ). Age at first sexual intercourse was also relevant : women who initiated

Table 2. Medical and Gynecological History of Study Participants (n=997)

Variables		N	%
Presence of comorbidities	Yes	106	10.7
	No	891	89.3
Signs suggesting cervical pathology	Yes	266	26.8
	No	731	73.2
Age of first sexual intercourse	<15 years old	85	8.5
	16-18 years old	292	29.3
	19-21 years old	295	29.6
	22-24 years old	150	15.0
>25 years		175	17.6
Contraceptive use	Yes	812	81.4
	No	185	18.6
Pregnancy history	Yes	954	95.6
	No	43	4.4

Table 3. Distribution of Women by Sampling Preferences

Variables	N	%
Self-collection without supervision	48	4.8
Self-collection under supervision	82	8.2
Health professional sampling	867	87.0

Table 4. Associated Factors with the Use of Self-Sampling for Rapid Testing: Results of the Bivariate Analysis

Variables	Total	Self-sampling with or without supervision		Sample taken by a healthcare professional		p-value
		N	%	N	%	
Province of residence						
Béni Mellal	299	2	0.7	297	99.3	< 0.001
Inezgane -Ait Melloul	300	53	17.7	247	82.3	
Tangier	299	23	7.7	276	92.3	
Taroudant	99	52	52.5	47	47.5	
Age						
The 30 year old bracket	458	83	18.1	375	81.9	< 0.001
The 40 year old bracket	539	47	8.7	492	91.3	
Residence area						
Rural	369	6	1.6	363	98.4	< 0.001
Urban	628	124	19.7	504	80.4	
Monthly income						
< 5,000	899	109	12.1	790	87.9	< 0.001
≥ 5,000	66	21	31.8	45	68.3	
Education level						
Illiterate	365	31	8.5	334	91.5	0.002
Literate	632	99	15.7	533	84.3	
Occupation						
Housewife	812	99	12.2	713	87.8	0.150
Employee	185	31	16.8	154	83.2	
Marital status						
Unmarried	109	12	11.0	97	89.0	0.670
Married	888	117	13.2	771	86.8	
Pregnancy history						
No	44	7	15.9	37	84.1	0.600
Yes	953	123	13.0	830	87.0	
Age of first sexual intercourse						
<18 years old	375	37	9.9	338	90.1	0.019
>18 years old	618	93	15.0	525	85.0	

sexual activity after age 18 were more likely to choose self-sampling (15.0% vs. 9.9% ;  $p = 0.019$ ) (Table 4).

#### HPV Testing and Genotyping

Overall, 4.9% of samples tested positive for HPV using GeneXpert (49/997). HPV16 was the most prevalent

genotype (26.5% ; 13/49), followed by HPV18/45 (24.5% ; 12/49) and other high-risk HPV types (57.1% ; 28/49). Double infections occurred in 8.2% of positive cases (4/49) (Table 5).

No significant differences were observed in HPV DNA detection between clinician-collected and self-

Table 5. Association between the Sampling Method and HPV Testing and Genotyping Results

	N	HPV detection						p-value
		HPV positive cases		HPV negative cases		Invalid cases		
		N	%	N	%	N	%	
Professional sampling	867	41	4.7	820	94.6	6	0.7	0.146
Self-sampling	130	8	6.2	119	91.5	3	2.3	
	N	HPV genotyping						p-value
		HPV 16		HPV 18/46		Other oncogenic HPV genotypes		
		N	%	N	%	N	%	
Professional sampling	41	11	26.8	12	29.3	23	56.1	0.480
Self-sampling	8	2	25.0	0	-	5	62.5	

collected samples. HPV was detected in 4.73% of clinician-collected samples and 6.15% of self-collected samples, indicating comparable diagnostic performance. Invalid results occurred in 0.69% of clinician-collected samples (6/867) and 2.31% of self-collected samples (3/130).

Similarly, HPV genotyping showed no significant variation between sampling methods. HPV16 was detected in 26.8% of clinician-collected samples (11/41) and 25.0% of self-collected samples (2/8). Other high-risk types were identified in 56.1% (23/41) and 62.5% (5/8), respectively, while HPV18/45 was detected only in clinician-collected samples (Table 5).

In summary, although only 13 % of women opted for self-sampling, those who did reported very high satisfaction and ease of use. Self-sampling preference was significantly associated with urban residence, younger age, higher education, and higher income. Importantly, diagnostic performance was comparable across sampling approaches, with no significant differences in HPV detection or genotyping between self-collected and clinician-collected samples.

## Discussion

In alignment with WHO recommendations, Morocco is preparing to introduce HPV testing as the primary method for routine cervical cancer screening [4, 14]. Globally, the success of HPV-based screening is strongly linked to the large-scale adoption of self-sampling, particularly when its diagnostic accuracy is comparable to clinician-collected samples [20, 21]. The present study aimed to evaluate both the acceptability of self-sampling and the performance of HPV testing on self-collected specimens relative to clinician-collected samples.

Despite global progress, the adoption of self-sampling in this study remained notably low, with only 13% of participants opting for this method ; especially in rural settings. This contrasts sharply with findings from other settings, where acceptance rates have reached up to 80.5%, positioning self-sampling as an effective and practical alternative to clinician-based screening [21].

Importantly, the low uptake observed here does not reflect dissatisfaction with the method. Among women who selected self-sampling, all reported comfort and expressed willingness to recommend it. Instead, the preference for clinician-administered sampling (87%) appears to be influenced by strong trust in healthcare providers, limited confidence in self-collection, and cultural norms surrounding modesty, which may render internal procedures uncomfortable even in private environments. These findings suggest that the low adoption rate is driven by socioeconomic and cultural constraints rather than limitations in the self-sampling experience itself. Previous studies have similarly identified social inequalities, cultural barriers, and insufficient awareness as predictors of reluctance toward self-sampling [8, 22, 23].

Geographic location has indeed proven to be an important determinant of acceptability. Women living in urban settings showed the highest preference for

self-collection, whereas adoption was notably lower among rural populations overall, thereby highlighting persistent disparities in healthcare access, particularly in mountainous regions. These observations are consistent with previous research demonstrating that self-sampling uptake is strongly influenced by local contexts [24, 25] and that urban populations in low- and middle-income countries generally exhibit greater acceptance [26]. Higher literacy levels and improved access to health information in urban areas are frequently cited as contributing factors [27,28].

Age also played a significant role in shaping self-sampling behavior. Younger women (around age 30) were more likely to adopt the method than those in their 40s. In addition, women who initiated sexual activity after age 18 were more likely to engage in regular screening. This pattern is consistent with findings from other studies and may reflect greater exposure to health education and increased awareness of HPV-related risks among younger cohorts [21, 27, 29, 30].

Socioeconomic conditions are widely recognized as major determinants of preventive health behaviors. Women facing socioeconomic disadvantage are less likely to engage in routine screening, which may negatively impact long-term health outcomes [29, 31]. In this study, both income and educational level were key predictors of self-sampling acceptance. Women from higher-income households demonstrated greater acceptance, potentially due to increased financial security, reduced concern about the economic burden of disease, and greater familiarity with new health interventions [21, 27, 26]. Similarly, literate women were more likely to select self-sampling, emphasizing the role of awareness and understanding in shaping screening decisions [21, 28]. Together, these findings highlight the importance of age, education, income, geographic location, and health awareness as determinants of self-sampling uptake. Strengthening targeted educational strategies may therefore enhance community understanding of the benefits of HPV self-sampling and support its integration into national screening programs, ultimately helping to address the persistently low cervical cancer screening coverage.

Women who performed self-sampling in this study reported very high levels of satisfaction, describing the procedure as simple and comfortable, and indicating willingness to recommend it to others. These results are consistent with studies from high-income settings, including the United States, where Latin American women reported high acceptability due to convenience, confidentiality, and absence of discomfort [32]. Comparable findings have been documented in low- and middle-income countries such as Zambia, where self-sampling was favored for its non-invasive and practical nature [28, 33]. A recent systematic review focusing on Muslim women also identified cultural sensitivity, convenience, and accessibility as major contributors to acceptability [34]. These factors are particularly important in overcoming barriers such as embarrassment and confidentiality concerns [8, 33, 35]. Moreover, most women in this study expressed willingness to undergo regular screening if self-sampling were shown to be

as effective as clinician-collected methods, supporting evidence that empowering women through self-collection can significantly improve screening adherence, especially in settings with limited medical resources [11, 36, 37].

HPV DNA was detected in 4.9% of participants, with HPV16 being the most prevalent genotype (26.5% of positive cases). These findings are consistent with estimates from comparable low- and middle-income contexts [28, 34, 36]. The prevalence observed in this study is lower than previously reported in Morocco before 2016 [38], reflecting the impact of national sexually transmitted infection control programs and aligning with declining cervical cancer incidence reported in recent years [2, 39, 40]. Notably, no significant differences were observed in HPV detection or genotyping between self-collected and clinician-collected samples, supporting evidence from multiple studies demonstrating that self-sampling is a valid and reliable alternative to clinician-based collection [20, 21, 25, 41, 42].

However, the rate of invalid results was slightly higher among self-collected samples (2.31%) compared to clinician-collected samples (0.69%). This finding underscores the need for improved and standardized training to ensure proper sample collection and enhance diagnostic reliability [43].

This study offers valuable insights into the feasibility and acceptability of HPV self-sampling among Moroccan women, particularly within a low-resource context where traditional screening approaches encounter persistent challenges. The use of the GeneXpert HPV assay, a highly sensitive and specific diagnostic method, further strengthens the reliability of findings for both self-collected and clinician-collected samples.

Nonetheless, some limitations should be acknowledged. The primary limitation concerns the geographically restricted sampling across only four provinces. Although this constrains the generalizability of the findings to the broader Moroccan population, the selected sites were intentionally chosen to reflect substantial diversity, including high-density urban areas, a mountainous province (Taroudant), and rural or peri-urban settings with varying levels of healthcare access. This heterogeneity enabled the identification of pronounced socioeconomic and geographic disparities, generating regional evidence of considerable value for informing the design of a future national pilot program.

A second limitation is the absence of a cost-effectiveness evaluation of self-sampling, which is essential for assessing the long-term feasibility and integration of the approach within national screening strategies. However, the exceptionally high satisfaction rates (100% comfort and willingness to recommend) and the complete diagnostic comparability with clinician-collected samples (with no significant difference in HPV detection) provide strong qualitative and clinical justification for conducting a dedicated future economic study.

Finally, reliance on self-reported measures of satisfaction and comfort introduces the potential for social desirability bias. Nevertheless, the observation that 87% of participants still opted for clinician-administered sampling, despite receiving balanced information on both

options, suggests that decisions were largely guided by genuine initial preferences, thereby strengthening the credibility of the observed low adoption rate.

In conclusions, this study underscores the significant influence of socioeconomic factors on the acceptability of HPV self-sampling and highlights the need for continuous education, targeted interventions, and awareness initiatives to ensure its successful implementation. Such efforts are essential to facilitate HPV testing and strengthen cervical cancer prevention in alignment with Moroccan public health priorities. Moreover, high-risk HPV testing on self-collected cervicovaginal samples represents a reliable and accurate alternative to clinician-collected sampling and holds substantial potential for improving screening coverage, particularly among underscreened women.

## Author Contribution Statement

All authors Fatima Zahra Chellat, Nassiba Bahra, Youssef Chami, Rachid Bekkali, Maria Bennani, Zineb Gaizi, Nabil Tachfouti, Samira El Fakir, Anasse Ben Abdellah, Mohammed El Mzibri, and Mohamed Berraho contributed equally to all stages of the research project, including the study design, data collection, analysis, and manuscript writing. All authors have read and approved the final version of the manuscript.

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### Ethical Declaration

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board (Ethics Committee) of the Faculty of Medicine and Pharmacy in Rabat, Morocco (protocol code: 31-22; date of approval: 2022).

### Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

### Conflicts of Interest

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

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