

Gender situational analyses for HPV programs and coverage measurement in Liberia, Senegal, and Rwanda

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Abstract

Background

This paper examines how gender shapes both human papillomavirus vaccine (HPVV) program implementation and the measurement of vaccine coverage in Liberia, Rwanda, and Senegal. As part of the HPV IMPACT project, we conducted a multi-country gender situational analysis using a matrix approach that linked gender relations domains with implementation and measurement pathways relevant to HPV vaccination.

Methods

We synthesized peer-reviewed and grey literature, reviewed national survey and administrative data, and validated preliminary findings with stakeholders in Liberia and Rwanda. Across countries, gender influenced who was reached by vaccination programs, who was missed, and who was visible in coverage estimates.

Results

Key pathways included school attendance, household decision-making, access to trusted information, health system capacity, and gendered barriers to participation in surveys. Girls who were out of school, geographically remote, or had limited autonomy were more likely to be excluded from both vaccination delivery and measurement efforts.

Conclusions

These findings show that HPV coverage measurement is not gender-neutral. Survey design choices related to sampling frames, respondent selection, and data collection modes can reproduce or obscure inequities. Embedding gender analysis into coverage measurement is essential for generating more accurate estimates and guiding equitable cervical cancer prevention strategies.

Introduction

Cervical cancer remains a significant public health concern for women across Africa, particularly in sub-Saharan region where access to timely prevention, screening, and treatment services can be limited (1). A recent study found that cervical cancer is the most common cause of death among women in 21 of the 48 countries in sub-Saharan Africa (SSA) and close to 100% of all cases of cervical cancer are linked to human papillomavirus (HPV) (2). This impact is especially felt in underserved and rural communities (3). Contributing factors such as limited healthcare infrastructure, socio-economic barriers, and the presence of co-infections like HIV can further elevate risk (4–6). Addressing cervical cancer in these

contexts calls for equitable access to culturally appropriate health education, services, and support systems tailored to community needs.

HPV vaccination is a highly effective tool for preventing cervical cancer, particularly when administered before exposure during early adolescence (7, 8). Increasing coverage of the vaccine is critical to reducing the long-term burden of disease, especially in regions with limited access to screening and treatment services. However, significant gaps in coverage persist across many parts of SSA, often reflecting broader challenges related to health system capacity, geographic access, and social inequities (9, 10). Understanding where and why these gaps exist requires stronger data on HPV vaccine uptake and more consistent measurement practices. Improved coverage measurements can help identify underserved populations, support more equitable program delivery, and ensure that cervical cancer prevention efforts reach those most at risk.

The HPV IMPACT (Improving Methods for Measuring the Coverage and Equity of HPV Vaccination in Gavi Priority Countries) Project aimed to strengthen how HPV vaccine coverage is measured. The project focused on developing and testing optimal methods for conducting coverage surveys, generating household survey-based estimates, and evaluating alternative data collection approaches. A core focus on equity was integrated across all activities, with the goal of identifying who was being reached and who was left behind by HPV vaccination (HPVV) programs. This includes examining the characteristics of vaccinated and unvaccinated girls, as well as the social and behavioral factors that influence HPV vaccine uptake among adolescent girls and their caregivers.

Gender, the socially constructed norms, relations, and power dynamics that shape how people live in a given society, can affect HPVV coverage. For example, gender norms or beliefs about whether the HPVV causes infertility or encourages sexual promiscuity can affect whether a girl's caregiver allows her to get the HPV vaccine (11, 12). Alternatively, gender roles that keep girls out of school can affect their ability to access the vaccine when it is only offered within schools (13). Understanding gender-specific factors is essential for developing targeted tools that effectively measure and understand coverage, which can ultimately lead to more targeted interventions.

As part of HPV IMPACT, we conducted a multi-country gender-situational analysis to document potential gender equity concerns with HPVV coverage measurement. A gender situational analysis assesses how context-specific gender inequities influence the design, implementation, and effectiveness of programs, interventions, or policies, and generates recommendations to enhance gender responsiveness (14). A gender situational analysis can directly shape coverage measurements by, for example, revealing how gendered barriers affect who is included, who is missed, and who is able to respond, influencing sampling frames, consent processes, non-response, and reporting bias. This helps ensure coverage estimates are more accurate and interpretable by accounting for structural and social inequities. As such, this paper moves beyond sex-disaggregated data to interrogate the underlying gendered power dynamics that produce observed disparities in HPVV access and utilization (11, 15, 16).

The results of this analysis will better inform how survey methodologies can measure the gendered influences on vaccine uptake among adolescents, including marginalized populations considered hard to reach. We focus on Liberia, Rwanda, and Senegal, the three HPV IMPACT project countries, because they are currently Gavi-supported and have HPV vaccine programs (i.e., introduced HPV vaccine three or more years ago) that targeted girls before sexual debut. Each country faces unique sociocultural barriers, misinformation, and logistical hurdles affecting vaccine uptake. Cervical cancer is also a top health concern, ranking first or second for women in each country, driving the urgency of HPV programming.

Methods

Matrix approach

The situational analysis used a gender matrix analysis approach (17) focusing on two main areas of HPV coverage: program implementation and measurement of HPV estimates. Program implementation and measurement are critical for HPV coverage survey because how the vaccine is delivered determines who is reachable and visible to measurement, while measurement choices determine whether coverage estimates accurately reflect program performance and equity. Understanding both allows coverage surveys to correctly interpret gaps in uptake and to identify who is being missed due to delivery strategies, access barriers, or social and gendered dynamics.

We combined the approaches of Morgan et al (2016) and El-Kalaawy et al. (2021) to establish five key gender relations domains: access to resources, roles and practices, norms and beliefs, decision-making power or autonomy, and institutions, laws and policies (18, 19). We then mapped each domain to known pathways affecting vaccine uptake and cervical cancer screening, drawing on existing literature on vaccination programs. Additionally, these domains would allow us to examine how gender inequalities affect families' decision to vaccinate adolescent girls. Cervical cancer screening was included in this analysis as an important leverage point in the pathway to HPV. It is the most common cause of cancer deaths among women in 21 Sub-Saharan African countries, yet incidence is likely still underestimated due to lack of access to cervical cancer screening (2). As HPV is a highly effective means of cervical cancer prevention, improving screening access allows health systems to better estimate disease burden, connect women to health services, and advocate for vaccination in their contexts.

We arrived at six key domains for program implementation that would affect the vaccine uptake for adolescent girls and vaccine decision-making of their caretakers, and four measurement domains that would affect HPV coverage estimates (Table 1). The study team collectively defined the analysis questions comprising each topic domain to ensure alignment across countries. Each domain was also assessed for intersectional considerations particular to assessing gendered domains among hard-to-reach groups, such as location, marital status, and education. Lastly, gender-disaggregated data were included for relevant HPV factors such as vaccination rates by age, school enrollment, and access to technology.

Table 1
Definitions and descriptions of topic domains

	Topic Domain	Description of Topic
Program	Service delivery	What is the availability of the HPV vaccine in the country and what programs are in place to distribute those vaccines? How are the vaccines being marketed (i.e. who is being encouraged to vaccinate and why)? What policies are in place to encourage vaccination and how are those influenced by gender? What are the costs of implementing a national HPV program? How should HPV vaccines be distributed at a national level? This domain is important for understanding what service delivery looks like regardless of gender and helps interpret the gender analysis.
	Knowledge, awareness, attitudes	What information do girls have regarding HPV and vaccination, what are the trusted sources of that information, and how do gender norms impact how that information is perceived?
	Perceived risks	How does gender impact the perceived risk of both getting, and not getting, the HPV vaccine at an individual and community level? What is the current prevalence of HPV and/or cervical cancer? What do girls' sexual relationships look like at this age and what are the norms around them?
	Access to HPV vaccine/cancer screening	What infrastructure exists to support girls' vaccination? What is the cost of the vaccine, inclusive of travel, time, and social costs? What gender barriers exist towards self-efficacy in getting vaccinated for girls? What does access to other sexual health services look like? What other responsibilities do girls have that might prevent them from getting vaccinated?
	Patient/provider interactions / Provider training	What are girls' experiences with providers at health centers or other service delivery points? What norms exist among providers and communities about HPV vaccination for girls? What is the level of trust in the community of healthcare providers, and how is that influenced by gender? What type of providers have the most point of contact with the targeted population? How knowledgeable are these providers about the HPV vaccine? How knowledgeable are these providers about HPV disease burden and the importance of access and prevention?
	Decision to vaccinate	Who impacts decision-making for girls getting the HPV vaccine?
Measure	Sampling frame	Defining the population in need: What are the gender considerations to generate an accurate sampling frame that is representative of the population of adolescent girls in the country/region (example: capturing girls living in pastoral communities or high density urban areas, girls may be less likely to own mobile phones for phone based-surveys)
	Non-response	Accurate sampling: Once girls are selected for interview, how does gender affect non-response. (example: husband/parents will not allow her to consent, disability - unable to respond,

	cannot speak with male interviewers, is in confinement period after delivery, lives in rural/remote area with poor connectivity for phone surveys)
Reporting bias	Reporting bias: Once girls are speaking with a data collector what are the gender issues that could impact reporting bias (example: girls don't remember if got HPV, bias with caretaker response to interview for girls 10–14, domestic violence / abuse associated with getting HPV)
Unintended consequences / ethical considerations	What are the gender-related harms that women/girls may experience by participating (or not participating) in the surveys or other measurement activities?

Data search process

We searched existing data portals and published peer-reviewed and grey literature on HPV coverage in Liberia, Rwanda, and Senegal, including vaccine hesitancy and interventions to address it. We also explored literature on measurement in these settings to explore challenges reaching hard-to-reach girls, such as those out of school, living in remote regions, or married girls, with vaccine coverage surveys. A literature search was conducted in PubMed, Google Scholar, and Scopus to identify peer-reviewed studies on the implementation of the HPV campaign, focusing on facilitators and barriers to vaccine uptake. Review of the grey literature involved identifying data sources relevant to HPV, including government websites (e.g. Ministry of Health, Ministry of Education), non-governmental organizations (e.g. FHI360, Gavi, the Vaccine Alliance), and data repositories (e.g. Demographic and Health Surveys (DHS) or other national-level surveys).

Relevant findings were added to the gender analysis matrix at the intersection of the program or measurement topic and gender domain. Sex- and gender-disaggregated data were compared across countries using the most recent DHS per country available on StatCompiler. Relevant data and metrics included access to technology, education level, school enrollment, and sexual debut and behaviors.

Analysis

Evidence extracted through the literature and data search was systematically charted into the matrix at the intersection of program or measurement topic domains and gender relations domains, allowing the team to assess how gendered factors operated across delivery and measurement pathways. Within each cell of the matrix, findings were qualitatively analyzed to identify recurring patterns, contradictions, and gaps across countries, with attention to intersectional dimensions such as age, schooling status, marital status, geography, and socioeconomic position. Cross-country comparisons were then conducted to distinguish context-specific dynamics from shared gendered mechanisms shaping HPV vaccination uptake and coverage measurement. Throughout the analysis, the team met to discuss interpretive decisions and emerging themes, strengthening transparency and consistency across team

members. The final synthesis prioritized pathways with direct implications for HPV coverage estimation, highlighting how gendered power relations influence visibility, reach, and reporting in survey-based measurement.

Stakeholder validation

Findings from the search were presented at study inception meetings in Liberia and Rwanda (March–April 2025), both to validate the preliminary results and to identify gaps in the available evidence from the perspective of country partners. We did not have an opportunity to present at the Senegal meeting due to delays in the project launch in this setting. Stakeholders were invited to comment on the clarity, completeness, and contextual relevance of the synthesized findings, with particular attention to how they aligned with current programmatic realities and policy priorities. Stakeholders provided written feedback based on their professional experience, as well as links to non-published country reports and internal documents that were not captured in the database searches. These materials were reviewed for relevance and, where appropriate, used to supplement and contextualize the peer-reviewed evidence, with clear notation of their grey-literature status. The final report addressed stakeholders' comments and incorporated their feedback, and any resulting refinements to the interpretation of findings were documented to ensure transparency in how stakeholder engagement informed the review.

Results

Service Delivery Context

This section provides an overview of vaccination campaigns in each country, including coverage estimates and facilitators and barriers to implementation. These factors act as context for the following gender analysis, examined through topic domains.

In Liberia, the HPV effort began with a pilot program in 2016 and was integrated into the routine immunization schedule by 2019. The program primarily targets girls aged 9 to 14, aiming to immunize them before the onset of sexual activity, which commonly occurs at a young age in Liberia (20). The median age of first intercourse is 16.1 years for women 20–49 years of age and 18.4 years for men (20–59 years old). The median age at initiation is lower for girls with no education (15.8 years) than for girls with higher education (17.2 years), with inequalities by locality (15.8 in rural versus 16.4 in urban areas) and wealth (15.8 for girls from the poorest and 17.8 from the wealthiest households (21).

HPV delivery is provided through health facilities, school-based programs, and community outreach for out-of-school girls and HIV-positive girls needing additional doses (22). Despite these efforts, available estimates of vaccine coverage remain at 43% for the first dose and 30% for the second as of 2021, hindered by challenges such as community mistrust, misinformation, and logistical issues (23, 24).

In Rwanda, the HPV program achieved over 93% coverage among in-school girls for all three vaccine doses during the initial campaign. Due to the high rates of primary school attendance in Rwanda (89% of girls in urban areas and 93% in rural areas), the government employed a school-based vaccination campaign for all girls in grade six, with an initial catch-up campaign for girls in the second and third year of secondary school (25, 26). However, attendance drops precipitously between primary and secondary school, with only 53% of urban and 37% of rural girls attending regularly (26). This posed a barrier to HPV coverage for out-of-school girls, at 46%, 83%, and 85% for rounds one, two, and three (25, 26), respectively.

Out-of-school girls, or girls absent on the day of vaccination, were reached through direct contact by community health workers (CHWs) or were vaccinated at health centers. The vaccines were administered by health workers at schools or in communities, and in some cases, they were provided alongside other child health services when the HPV vaccination schedule coincided with such campaigns (27, 28). This limited the burden on health centers and encouraged greater participation among parents (27). However, challenges during the pilot phase included a lack of data, mobilization of funds, and workforce readiness, which were addressed through high-level leadership by the Rwandan First Lady and collaboration among various governmental ministries (29).

Senegal introduced the HPV vaccine into its national immunization program in 2018, using a routine delivery strategy. Before the national introduction, pilot and demonstration projects were conducted between 2014 and 2016 in two districts such as Dakar-Ouest and Méckhé to test delivery modalities, optimize logistics, and assess community acceptability (30). Senegal also took a school-based approach in its pilot, vaccinating 9- to 13-year-old girls to capitalize on the high primary school enrollment rate. However, due to vaccine shortages, the current program targets only 9-year-olds through its routine immunization platform and school-based programs. As the majority of the HPV doses were distributed in school-based programs, school staff were responsible for communicating HPV information and upcoming vaccination days. It was unclear if there were formal guidelines for the HPV consent process in school-based programs, but most schools adopted the “opt out” consent approach. However, this was not consistent with all educational institutions, as some private schools provided written consent forms (Casey et al. 2022).

Knowledge, attitudes, and awareness of HPV and HPV

Data on knowledge, attitudes, and awareness of HPV and HPV are critical for understanding how information environments and gender norms shape both vaccine uptake and the feasibility of accurate coverage measurement. Across the three countries, the available evidence highlights how misinformation, trust in information sources, and gendered communication pathways influence whether caregivers and girls understand the purpose of the vaccine, perceive it as acceptable, and engage with vaccination services.

In Liberia, the scarcity of country-specific data on HPV and HPV knowledge itself is an important finding, as it points to a measurement gap that limits the interpretation of low coverage rates. Reliance on regional evidence, such as widespread concerns about infertility, sexual promiscuity, and gendered decision-making norms, such as fathers/husbands should make decisions around vaccination of girls/women, suggests that vaccine-related knowledge is likely mediated through social and religious norms rather than formal health communication. A small study from Monrovia indicating low HPV knowledge but high vaccine acceptance underscores the distinction between awareness and willingness: limited biomedical understanding does not necessarily translate into refusal, but it does increase vulnerability to rumors and misinformation (31). This suggests that uptake may be highly sensitive to how information is framed and who delivers it, with implications for both program sustainability and caregiver reporting accuracy in surveys. (32), suggests that vaccine-related knowledge is likely mediated through social and religious norms rather than formal health communication. A small study from Monrovia indicating low HPV knowledge but high vaccine acceptance underscores the distinction between awareness and willingness: limited biomedical understanding does not necessarily translate into refusal, but it does increase vulnerability to rumors and misinformation (31). This suggests that uptake may be highly sensitive to how information is framed and who delivers it, with implications for both program sustainability and caregiver reporting accuracy in surveys.

In Rwanda, before their vaccination campaign in 2011, gaps in HPV knowledge and its link to cervical cancer (29), combined with strong gender norms around adolescent sexuality and stigma associated with pregnancy, shaped early interpretations of the vaccine's purpose. Confusion between HPV and contraception (29) illustrates how broader reproductive health narratives can spill over into vaccine perceptions, particularly when multiple health campaigns target similar populations. While there was some success in framing the vaccine as cervical cancer prevention, this led some women to wonder why it is only being offered to younger girls (25). A high level of trust in CHWs emerged as a central mechanism through which these misconceptions were addressed, with 91.8% of mothers getting their vaccine information from CHWs (33). This is particularly important given gendered disparities in access to mass media and mobile phones (47.9% of women compared to 61.6% of men own a mobile phone, though the rate is much lower in rural areas (26)), which limit the reach of alternative communication channels for women and girls. Together, these data show that awareness is not only about message content but also about who is reachable through dominant information systems - an issue that directly affects equity in both vaccination and coverage measurement.

In Senegal, widespread misinformation among healthcare workers, parents, and school personnel, exacerbated by a healthcare worker strike and broader mistrust following COVID-19, demonstrates how disruptions in the health system can undermine confidence in HPV messaging (34, 35). Rumors related to fertility, safety, and cancer causation illustrate how gendered fears about women's reproductive futures shape attitudes toward vaccination (30). At the same time, observed differences in HPV awareness by geography, where students in rural areas had 63% higher odds of having heard of HPV compared to those who lived in urban areas, highlight how targeted awareness campaigns can counter assumptions about urban advantage (36). This shows that knowledge can be unevenly distributed

across social groups and contexts, and that trusted messengers can either amplify or mitigate misinformation depending on institutional credibility and stability.

Taken together, these findings demonstrate that knowledge, attitudes, and awareness of HPV and HPVV are deeply embedded in gendered norms, trust relationships, and access to information. Such data points help explain variation in vaccine acceptance and coverage, but also signal where standard communication strategies, and by extension, survey instruments that assume uniform understanding, may fail to capture the realities shaping girls' vaccination experiences.

Access to cervical cancer screening and the HPVV

Understanding gendered barriers to cervical cancer screening and the HPVV are important because they illustrate how gender inequities shape both the perceived need for vaccination and the pathways through which girls and women engage with cervical cancer prevention more broadly. Although screening and vaccination are distinct interventions, patterns of access to screening provide critical context for understanding awareness, trust, and engagement with HPV-related services across the life course.

In Liberia, low levels of education among women and girls, particularly among rural populations and those from the poorest households, signal constrained access to health information and preventive services, including HPVV. Approximately 31% of women and girls aged 15–49 have no formal education; the proportion of women/girls with no education is 12.5% among younger women (15–24), 46.6% among rural women, and 54.3% for women from the poorest households (21). Education strongly influences both exposure to vaccination campaigns and the ability to navigate health systems. In Liberia, cervical cancer screening services have historically been sparse, though a WHO campaign was launched in 2021 to train healthcare workers on cervical and breast cancer detection. While the program was meant to reach 140,000 women of reproductive age, only 20 healthcare providers were trained in the protocol (37). This highlights weak preventive infrastructure, reinforcing the likelihood that HPV prevention is experienced as episodic rather than routine. Together, these data suggest that access barriers are not only geographic or financial, but also informational and institutional, shaping who benefits from HPV-related interventions.

In Rwanda, many find it challenging to access screening services. In one study, three-quarters of women in both urban and rural settings (76% and 78%, respectively) had never been screened for cervical cancer, even though the majority had made at least three visits to a health center in the last year for reasons other than prenatal care (38). This demonstrates that contact with the health system alone does not guarantee access to preventive services. The most common barriers to accessing health centers in Rwanda are low-quality care (e.g. long wait times, health care workers' attitudes), and transportation issues (e.g. cost, mode, and distance) (39). One of the most common reasons for seeking healthcare was child health, pointing to the importance women in Rwanda place on ensuring children receive necessary care (Niyonsenga et al. 2021). Women's prioritization of child health over their own preventive care reflects gendered norms around caregiving responsibilities, which may indirectly support high

uptake of childhood and adolescent vaccinations while leaving women's own preventive needs unmet. Such prioritization presents an opportunity for increasing HPVV among adolescent girls and highlights the important role that HPVV plays in preventing cervical cancer.

In Senegal, extremely low screening coverage highlights stark inequities in access to cervical cancer prevention. It is estimated that only 6.9% of women aged 18 to 69 years old have ever had a cervical cancer screening, and the percentage is lower among women residing in rural areas, as well as those over 40 years of age (1.9%) (40). Efforts have been made to expand screening and treatment services, but they have not yet been nationally scaled and accessible to eligible women (41). The concentration of screening services in urban areas illustrates how geographic and infrastructural barriers intersect with gender and age to exclude large segments of the population. This shows the importance of HPV vaccination in contexts where downstream preventive and treatment services are largely unavailable.

Taken together, the data highlight that access to HPV-related preventive services is highly uneven and closely linked to education, geography, and health system capacity. These access constraints provide essential context for understanding perceptions of HPV risk, engagement with vaccination programs, and broader inequities in cervical cancer prevention.

Health system supply side factors

Health systems supply side factors capture how workforce availability, training, service organization, and system capacity shape the delivery and consistency of HPVV programs. These structural conditions influence whether accurate information is provided, services are reliably available, and vaccination efforts are sustained over time, particularly for adolescent girls who depend on institutional platforms such as schools and primary health facilities.

In Liberia, the severe shortage of healthcare workers, with only 11 core health workers per 10,000 population, which is significantly below the WHO recommended benchmark (44.5 per 10,000) (42), provides critical context for understanding limitations in HPVV delivery and oversight. Workforce constraints are likely to affect providers' ability to conduct outreach, deliver consistent messaging, and follow up with girls who miss scheduled vaccination opportunities.

In Senegal, frequent turnover among healthcare workers emerged as a key supply-side challenge, necessitating repeated HPVV training for both new and existing staff (43). Evidence that staff absences and shortages delayed vaccine delivery highlights how instability in the health workforce can disrupt program continuity (Union for International Cancer Control (UICC) n.d.). The additional workload associated with HPVV delivery reported by healthcare workers, particularly when layered onto existing responsibilities, led to overburden. This illustrates how system strain may compromise timely service provision.

In Rwanda, the organization and composition of the health workforce provide insight into how supply-side structures support HPVV delivery. The distribution of healthcare roles is gendered, with 82% of

doctors being male (44) While nurses, who comprise the majority of the workforce and are predominantly women, play a central role in service provision (44), a robust community health worker system extends the reach of vaccination efforts beyond formal facilities (Williams P. Rwanda's Community Health Worker Program n.d.). The availability of CHWs at the community level (three CHWs (one female maternal healthcare worker, and one male/female pair focused on comprehensive services) per 50–150 households (45)) helps mitigate facility-based constraints and supports follow-up for out-of-school girls. By 2018, the community health programme had grown to four CHWs per village, with a polyvalent model -all the CHWs covering all the services- that significantly broadened the scope of health services delivered at the community level (46).

A further gender divide exists in patient/provider interactions. Within healthcare settings, studies have shown that men are favored in healthcare decision-making and that women and men who seek SRH together are prioritized (47). One study focusing on provider-patient dynamics for maternal health services showed that 25% of providers, including doctors and nurses, believed men should have more power than women in their families (47). Additionally, poor quality health services and negative interactions with providers are two of the main reasons women do not seek care for cervical cancer (38)

Across settings, limitations in workforce availability, training, stability, and service organization provide insight into the variation in HPV coverage. These structural conditions shape the consistency of vaccine delivery, the reliability of information provided to caregivers and girls, and the ability of programs to reach populations who are already marginalized by geography, poverty, or schooling status.

Decision-making

As HPV vaccination for adolescent girls typically requires caregiver consent, household power dynamics are a critical determinant of uptake. Understanding who holds decision-making authority and under what conditions decisions are made highlights how gender norms translate into vaccination outcomes.

In Rwanda, evidence that male heads of household commonly hold primary authority over healthcare decisions highlights structural constraints on women's autonomy. Only two-thirds of women, for example, make all their own decisions about their healthcare (26). However, for the rollout of the HPV in schools, caregiver permission for vaccine administration was most often provided by mothers, as they were more likely to be available to accompany their daughter to school to give consent (25). This reflects how program design can temporarily shift decision-making power by aligning consent processes with women's caregiving roles. The campaign used a voluntary opt-out approach, meaning that vaccines were given to all girls unless the girl or their parent explicitly said they did not want the vaccine (25), illustrating how institutional arrangements can mediate gendered power relations. However, adolescent girls in Rwanda do not often go against their parents' decisions, as there is a strong culture of obedience which is a common practice (48).

In West African contexts, including Senegal, evidence shows that men may be more accepting of vaccination for daughters, likely due to concerns about promiscuity and family shame (32, 36). As

women are more likely to make health decisions for their children, women's hesitancy to vaccinate their daughters can lead to lower HPV rates. However, in Senegal, fathers' education level was associated with a lower likelihood of vaccination despite a higher likelihood of having heard of HPV (36), suggesting that knowledge does not uniformly translate into acceptance.

In Liberia, 2019–2020 DHS data show lower participation in health decision-making among younger women aged 15–19 (63% compared to 78% nationally) and unemployed women (68% versus 81% for employed), underscoring how age and economic dependence constrain autonomy (21). There were minimal differences by household wealth and urban/rural locality (21). These patterns suggest that adolescent girls' access to the vaccine is shaped by caregivers who may themselves have limited decision-making power, shaping both consent and follow-through.

The findings demonstrate that decisions about HPV vaccination are embedded in household power relations and gender norms, with authority and responsibility often distributed across multiple actors. Understanding these decision-making dynamics is essential for interpreting consent processes and observed patterns of vaccine uptake.

Gender-based violence, harmful practices, and HIV

Data on violence, HIV, and other mediating factors highlight structural and gendered risks that shape both vulnerability to HPV infection and engagement with preventive services. These factors provide critical context for understanding inequities in HPV exposure and vaccine effectiveness.

In Liberia, several mediating factors impact HPV coverage. A significant concern is the prevalence of female genital cutting (FGC), which is associated with increased risk of HPV infection. In 2020, 38% of women reported they had been circumcised. Of these, 25% reported FGC before the age of 5 and 44% reported before the age of 10. Sexual violence is also a contributing factor to HPV exposure, which in Liberia has a lifetime prevalence of 9%, while 3% of women experienced sexual violence before the age of 15 (21).

In Liberia and Senegal, there is a high prevalence of FGC among women and girls, particularly among rural and socioeconomically disadvantaged populations (49, 50). In Liberia in 2020, 38% of women reported they had been circumcised. Of these, 25% reported FGM before the age of 5 and 44% reported before the age of 10 (49). While in Senegal, the prevalence is at 20,1% and approximately 2 million girls under 5 years of age have undergone FGM (ANSD & ICF, 2023). The practice is common despite being outlawed since 1999 (50). Girls residing in rural areas, mothers with no education, and from the poorest socio-economic quintile had the highest prevalence of FGM (51). Understanding FGM rates is important due to its association with increased risk of HPV infection; such data illustrates how gendered practices can increase biological susceptibility to HPV while also shaping interactions with health services.

Evidence of sexual violence, especially among young girls, underscores additional pathways of HPV exposure that occur outside individual agency. Liberia has a lifetime prevalence of sexual violence of 9%, while 3% of women experienced sexual violence before the age of 15 (21). In Senegal, the 2017 DHS

found 30% of women aged 15–49 had experienced sexual violence in their lives, while in Rwanda this rate was 12.4% in 2020 (52). These data illustrate how HPV risk is patterned by gendered harm, reinforcing the need for preventive strategies that account for structural violence.

In Rwanda, lower vaccine effectiveness and coverage among women with fewer years of education and among women living with HIV highlight intersections between health status, social position, and HPV prevention (47). HIV positive women's lower likelihood of being vaccinated, potentially due to school exclusion or prior exposure, illustrates how existing health inequities shape both biological outcomes and program reach (47).

Evidence on gender-based violence, harmful practices, and HIV illustrates how structural and social vulnerabilities intersect with HPV risk and prevention. These mediating factors are important for understanding differential exposure, vaccine effectiveness, and inequities in who ultimately benefits from HPV vaccination programs.

Discussion

This multi-country gender situational analysis demonstrates that HPV vaccine coverage, and the way it is measured, is fundamentally shaped by gendered social systems rather than individual knowledge or attitudes alone. Across Liberia, Rwanda, and Senegal, gender operates through households, schools, and health systems to influence who can be reached by vaccination programs, who is visible to measurement efforts, and how vaccination status is reported. Together, these findings reinforce that HPV coverage measurement is not gender-neutral, and that failure to account for gendered pathways risks systematically obscuring inequities in both program reach and data quality.

The gap between eligibility, reach, and measurability as a core equity problem

One of the most consistent themes across countries is that being eligible for HPV vaccination does not guarantee being reachable by programs or visible in coverage data. School-based delivery platforms remain central to HPV strategies, yet access to schooling is shaped by gendered and intersecting inequities related to poverty, geography, education, and social norms. Out-of-school girls, girls absent on vaccination days, and girls living in remote or pastoral settings emerged repeatedly as populations at risk of being missed - not only by service delivery, but also by subsequent measurement efforts that rely on school rosters or institution-based sampling frames.

Measurement approaches that depend on phone-based surveys introduce additional layers of exclusion. Gender gaps in mobile phone ownership, access, and control may skew samples toward households with greater connectivity and autonomy, thereby biasing estimates upward if girls with more constrained access are systematically excluded. These findings underscore that sampling frames are not neutral

technical instruments, but socially patterned constructs that reflect who is easiest to count rather than who most needs to be reached.

Health system capacity shapes gender equity outcomes, even when programs exist

Although HPV vaccination programs were in place in all three countries, the findings show that health system capacity strongly conditions whether these programs result in equitable outcomes. Gender inequities are not shaped by demand-side factors alone; they are reinforced or mitigated by how health systems are staffed, trained, resourced, and organized. Even where policies exist, weaknesses in frontline service delivery can disproportionately disadvantage girls who already face social or structural barriers.

Across settings, workforce shortages, turnover, and uneven training constrained the consistency and quality of HPV delivery. Overburdened providers often lack time for outreach, follow-up, and tailored communication – functions that are particularly important for reaching out-of-school girls, girls in remote areas, or those requiring additional consent processes. When systems are stretched, outreach and flexibility are among the first capacities lost, amplifying inequities for girls whose access depends on additional effort or accommodation.

CHWs and nurses played a critical role in sustaining vaccination efforts and countering misinformation, especially where access to mass media was limited. High levels of trust in CHWs in Rwanda, for example, helped mitigate misinformation despite limited access to mass media. This highlights that investments in community-based and frontline health workers function as gender equity strategies, extending reach beyond schools and facilities.

Demand- and supply-side factors are deeply intertwined. Girls' ability to benefit from HPV vaccination, and to be visible in coverage data, depends on health systems' capacity to deliver vaccines consistently, communicate clearly, and use platforms aligned with girls' lived realities. Health system strengthening should therefore be understood as a necessary condition for gender-equitable HPV vaccination.

Measurement choices can reproduce or obscure gender inequities

The findings show that survey design decisions are not neutral; they determine which girls and caregivers are visible in coverage data and whose experiences inform HPV estimates. Choices related to sampling frames, respondent selection, interviewer assignment, modes of data collection, social identifiers, and privacy protocols shape who is counted and how vaccination pathways are represented.

Caregiver and adolescent reporting introduce different, non-random biases. Caregiver reports may reflect social desirability, incomplete knowledge, or normative framing of girls' health decisions, while adolescent self-reports can be constrained by recall limitations, deference to authority, and fear of repercussions in contexts with limited privacy. Non-response is similarly patterned, often driven by

gendered gatekeeping by caregivers or heads of household and by privacy constraints that disproportionately exclude girls with lower autonomy. In addition, technology-based survey approaches risk systematic exclusion, as gendered gaps in phone access, control, and connectivity can bias samples toward more connected and less marginalized households.

Together, these dynamics demonstrate that measurement itself can reproduce gender inequities if not explicitly addressed. HPV coverage surveys should include variables that allow analysts to assess differential reach and exclusion, including schooling status (in-school versus out-of-school and absenteeism), marital status, HIV status, age–grade alignment, and the platform through which vaccination was delivered (school, health facility, or community outreach). These measures enable equity-oriented stratification and help interpret coverage differences across areas with varying delivery strategies and educational access. Integrating gender constructs, such as decision-making power, autonomy, access to resources, and experience of violence, into survey instruments and analytic strategies allows coverage measurement to better distinguish whether observed gaps reflect program access barriers, household power dynamics, gender norms, or methodological exclusions.

Beyond questionnaire items, sampling protocols themselves require intentional adaptation. Strategies such as purposive oversampling of out-of-school girls and girls in remote areas, or the use of complementary community-based lists, may be necessary to capture populations systematically missed by standard frames. Conducting household surveys during holidays captures vaccination status for both in and out-of-school girls, ensuring both are reached. Treating these groups as marginal rather than integral to coverage measurement risks reproducing the very inequities that HPV programs aim to address. Ethical safeguards should be embedded into survey procedures, including privacy checks before modules that may be sensitive, careful interviewer training, and limiting questions to the minimum required to capture gendered pathways relevant to coverage and equity.

How this work informed HPV IMPACT tool design

As part of HPV IMPACT, we incorporated many of the suggestions outlined above. For example, we connected gender theory on decision-making and agency to our instruments, including questions on decision-making power and autonomy specific to HPV, to better understand the drivers of decision-making. For adolescents, we embedded an agency scale that measures both freedom of movement and freedom of voice.

We ensured the inclusion of key sociodemographic stratifiers, including region, rural/urban locality, household wealth, school attendance, and absenteeism. To compare perceptions of wealth, we integrated a validated scale for adolescents and context-driven asset indexes for caregivers. This will allow us to understand differences in how adolescents and caregivers report wealth – informing equity measures for future coverage measurement tools.

These changes will allow HPV-IMPACT to identify missed populations and clarify whether observed differences reflect program access barriers, information gaps, household power dynamics, or

measurement limitations.

Limitations

This work is subject to several limitations. First, we were unable to validate findings with stakeholders in Senegal due to project timing and delays in the project launch in that setting, which may have limited our ability to confirm the contextual accuracy of the synthesized evidence and to identify additional unpublished program documents. Second, the analysis relied primarily on published peer-reviewed literature, grey literature, and publicly available data portals; as a result, important implementation details (e.g., consent procedures, microplanning practices, and school–health facility coordination) may be incompletely documented, outdated, or unevenly reported across countries, contributing to differential depth of evidence by setting and topic. Third, because available sources often emphasize women and caregivers rather than adolescents themselves, the perspectives of girls—particularly out-of-school girls and other marginalized groups—may be underrepresented. Further, intersectional dynamics (e.g., disability status, migration, or pastoralist livelihoods) could not always be examined with the same specificity across settings.

Conclusion

This gender situational analysis highlights that HPV vaccine uptake and the accuracy of HPV coverage measurement is shaped by gendered norms, household decision-making, schooling pathways, and health-system structures across Liberia, Rwanda, and Senegal. Across settings, girls most likely to be missed by vaccination delivery (e.g., out-of-school girls, girls in remote areas, or girls with constrained autonomy) are also most likely to be undercounted or misclassified in standard coverage measurement approaches, reinforcing inequities through both program reach and data quality. These findings underscore that coverage surveys cannot be gender-neutral. Choices about sampling frames, respondent selection, interview modality, and privacy protections can reproduce or obscure gendered exclusions. Integrating gender- and equity-relevant variables such as schooling status and absenteeism, marital status, delivery platform, and measures of agency and decision-making and adopting intentional strategies to reach marginalized adolescents can improve the interpretability and fairness of coverage estimates. Ultimately, embedding gender analysis into HPV coverage measurement design is essential to identifying who is left behind and to guiding more equitable cervical cancer prevention strategies.

Declarations

Ethics, Consent to Participate, Consent to Publish: Not applicable. This work was informed by a document review and did not include human subjects.

Competing interests: Authors declare no competing interests

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Author contributions: AK and RM conceptualized the study and built the organizing matrix. KH, HK, and EH extracted data from documents and completed the matrix and analysis. AN, NAF, and MP organized stakeholder meetings and supported stakeholder consultations; they also reviewed and added data to the matrices. AK, HK, and KH produced the original draft. JO ensured alignment with overall project goals and objectives. All authors reviewed the final draft, provided robust feedback, and approved the submission.

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