

An Integrated Approach to Cervical Cancer Prevention Based on WHO's 90-70-90 Targets: A Rural Community-Based Study

Review began 10/02/2026

Review ended 10/14/2026

Published 10/25/2026

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DOI: 10.7759/cureus.118567

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Abstract

Background

Cervical cancer is one of the most commonly diagnosed cancers in women, mainly affecting women in low- and middle-income countries. The present study aimed to raise awareness about cervical cancer among rural populations in Haryana, India, and provide cervical cancer screening for women and vaccination for girls and young women.

Methodology

This community-based cross-sectional study included three distinct study populations targeted for different interventions, i.e., cervical cancer awareness, cervical cancer screening, and human papillomavirus (HPV) vaccination initiatives. Awareness was delivered through community health camps, interactive sessions, street plays (nukkad natak), and the distribution of pamphlets. Cervical cancer screening was conducted through HPV DNA detection using multiplex PCR. Furthermore, eligible girls and young women were provided with the CERVAVAC HPV vaccine (Serum Institute of India Pvt. Ltd., Pune, India).

Results

Awareness campaigns were conducted among the rural population of Haryana to provide knowledge about cervical cancer and its prevention. A total of 1,180 women aged over 18 years who attended the awareness campaigns (n = 1,000) and cervical cancer screening (n = 700) were briefly interviewed. Of these, 13.8% had heard of cervical cancer, 9.2% had poor knowledge about it, and 9% knew that the disease could be prevented. The HPV DNA positivity rate was 8.4% (59/700), with high-risk HPV genotypes (other than HPV-16 and HPV-18) being the most commonly detected, followed by HPV-18 (20%) and HPV-16 (10%), while 7% were co-infected with HPV-16 and HPV-18. A total of 102 individuals, comprising 17 (16.7%) girls aged 9-14 years and 85 (83.3%) girls/women aged 15-26 years, received HPV vaccination. Vaccine hesitancy was observed among the eligible population, with misinformation on social media cited as one of the reasons.

Conclusion

Our findings underscore the need for community-based cervical cancer awareness campaigns, strengthening health education from the school level, and providing access to HPV screening and vaccination facilities to improve cervical cancer prevention in rural settings.

Categories: Epidemiology/Public Health, Infectious Disease

Keywords: cervical cancer, hpv dna, hpv genotypes, hpv vaccine, human papillomavirus

Introduction

Cervical cancer is a major global health concern, ranking as the fourth most common cancer among women globally, with approximately 0.66 million new cases reported in 2022. The situation is even worse in low- and middle-income countries, where about 0.35 million women succumbed to the disease that year, with an alarming 94% of these fatalities occurring in those regions [1]. In South Asia, particularly India, cervical cancer is a significant concern, being the second most common cancer among women aged 15-44 years. In 2022, India reported an estimated 0.13 million new cases and approximately 0.08 million deaths due to cervical cancer [2-5].

Human papillomavirus (HPV) infection, primarily with oncogenic types HPV 16 and 18, is a common sexually transmitted infection strongly associated with cervical cancer. This relationship is well established,

How to cite this article

Sharma M, Sardar M, Jhamb T, et al. (October 25, 2026) An Integrated Approach to Cervical Cancer Prevention Based on WHO's 90-70-90 Targets: A Rural Community-Based Study. Cureus 18(10): e118567. DOI 10.7759/cureus.118567

with nearly 99% of cervical cancer cases attributed to persistent infection with high-risk HPV types [4,6]. Typically, most sexually active individuals will contract HPV at some point, often without exhibiting symptoms. The immune system usually clears the virus naturally within a year or two, leaving no lasting effects. However, persistent infection with certain high-risk HPV types can lead to precancerous changes, which may progress to cervical cancer if left untreated. Notably, cervical cancer typically takes 15–20 years to develop after HPV infection [6].

The WHO sets a target incidence rate of below 4 per 0.1 million women for cervical cancer elimination. This goal hinges on three key pillars: vaccination, screening, and treatment, each with specific targets. The WHO's 90–70–90 targets by 2030 include 90% HPV vaccination coverage for girls by age 15, 70% screening coverage for women at 35 and 45 years, and 90% treatment coverage for precancerous lesions and invasive cancer cases [7]. There are six licensed HPV vaccines (three bivalent, two quadrivalent, and one nonavalent vaccine) that are WHO-prequalified and globally marketed, effectively preventing HPV 16 and 18 infections. India licensed the first bivalent vaccine (Cervarix, GlaxoSmithKline Biologicals, Belgium) and quadrivalent vaccine (Gardasil, Merck Sharp & Dohme LLC, USA) in 2008 [4,5]. The nonavalent vaccine, protecting against HPV 16 and 18, also safeguards against high-risk types 31, 33, 45, 52, and 58, and was licensed in India in 2018 [5].

Despite being effective preventive measures, HPV vaccination and screening face implementation hurdles in low- and middle-income countries, including India. The large population poses a challenge in administering multiple HPV doses. Indian states, namely Delhi, Punjab, and Sikkim, initiated HPV vaccination programs for girls aged 9–13 years between 2016 and 2018. Furthermore, promising results were reported from pilot studies conducted across the country. Following this, in February 2024, India's Union Finance Minister announced a proposal for a phased nationwide HPV vaccination rollout for girls aged 9–14 years to combat cervical cancer [4]. Leveraging this momentum, our study aimed to raise awareness about cervical cancer among rural populations in Haryana, India, and provide screening (HPV DNA testing) for women, as well as vaccination for girls and women.

Materials And Methods

This community-based cross-sectional study was conducted between January and December 2025 in rural Haryana, India. Ethical approval for the study was obtained from the Institutional Ethics Committee prior to the commencement of the study (IEC/FMHS/F/23/12/24/10).

Study population

Inclusion Criteria

Three distinct study populations were targeted for different interventions, i.e., cervical cancer awareness, HPV screening, and vaccination initiatives, aiming to reach different demographic groups and maximize the impact of the interventions.

Group 1 - Cervical cancer awareness: Approximately 1,000 individuals from the general population, comprising women and men across rural Haryana, irrespective of gender and literacy levels, were targeted to raise awareness of cervical cancer.

Group 2 - Cervical cancer screening: A total of 700 women aged 30–65 years [8] were enrolled for HPV DNA testing, of whom 128 had previously attended the awareness campaigns. Five participants aged <30 years did not meet the age-based inclusion criteria; however, they were enrolled due to physician-observed symptoms suggestive of cervical cancer. Cervical swabs were collected by doctors and trained nurses and processed at the Molecular Laboratory. Prior to participation, informed consent was obtained from all participants, ensuring that they were aware of the objectives of the study. Demographic and clinical histories were obtained for all individuals using a predesigned proforma.

Group 3 - HPV vaccination: Using purposive sampling, 102 girls and women aged 9–26 years [9] were recruited for HPV vaccination. Prior to vaccination, informed consent was obtained, and details about the vaccine, including its benefits and risks, were provided to ensure that participants were fully informed.

Exclusion Criteria

Women over 65 years were excluded from HPV DNA screening, while girls under 9 years and women over 26 years were excluded from HPV vaccination. Additionally, the study excluded individuals with active HPV infections or pregnant women.

Study process

Cervical Cancer Awareness

Cervical cancer awareness was provided to the general population across rural Haryana, irrespective of gender and literacy levels. Participants were purposively selected through community announcements to ensure representation across age groups. Awareness interventions were delivered through 24 community health camps, featuring interactive sessions led by trained healthcare workers, street plays (*nukkad natak*), and the distribution of pamphlets covering risk factors, HPV vaccination, and screening for early detection. Eligible attendees were further encouraged to receive the HPV vaccine.

Cervical Cancer Screening

Sample collection: Cervical swabs were collected by gynaecologists and trained resident doctors using nylon-flocked swabs under aseptic conditions, following standard procedures. The swabs were inserted into viral transport medium (PK Viral Transport Kit, Pathkits Healthcare Pvt. Ltd., Gurgaon, India), transported to the Molecular Laboratory, and stored at -80°C until viral DNA extraction.

HPV screening and genotyping: Total nucleic acid was extracted from the collected cervical swabs in transport medium using the TRUPCR Tissue DNA Extraction Kit (3B BlackBio Dx Ltd., Bhopal, India) as per the manufacturer's instructions. The extracted DNA was subjected to real-time PCR using the TRUPCR HPV HR with 16 & 18 Differentiation Kit (3B BlackBio Dx Ltd., Bhopal, India) for the detection of 14 high-risk HPV types (16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59, 66, and 68), along with the differentiation of HPV 16 and 18 DNA. PCR reactions (30 µL) contained 10 µL of master mix, 10 µL of HPV HR with 16 & 18 primer-probe mix, and 10 µL of extracted DNA. Amplification was carried out using the 7500 FDX (Applied Biosystems, California, USA) with cycling conditions as follows: initial denaturation at 94°C for 10 min, 7 cycles of denaturation (94°C for 15 sec), annealing (62°C for 30 sec), and extension (72°C for 15 sec), followed by 38 cycles of denaturation (94°C for 15 sec), annealing (60°C for 30 sec), and extension (72°C for 15 sec). Results were interpreted using a cycle threshold (Ct) cut-off of 36.

Differentiation of high-risk HPV genotypes other than HPV-16 and HPV-18 was performed using the Human Papillomavirus High-Risk qPCR Panel (RUO) Kit (Bioeksan AR GE Teknolojileri A.S., Istanbul, Türkiye), which detects 14 high-risk HPV genotypes: 16, 18, 56, 58, 35, 51, 45, 39, 33, 52, 31, 59, 66, and 68. The kit contains four high-risk HPV oligo mixes. PCR reactions (20 µL) contained 10 µL of master mix, 5 µL of high-risk HPV oligo mix, and 5 µL of extracted DNA. Amplification cycling conditions were as follows: enzyme activation at 52°C for 3 min, pre-incubation at 95°C for 10 sec, 40 cycles of denaturation (95°C for 1 sec) and annealing and extension (55°C for 15 sec). Results were interpreted as “high positive” for Ct ≤22, “positive” for Ct >22 to ≤34, and “low positive” for Ct >34 to ≤40.

HPV Vaccination

CERVAVAC®, a quadrivalent HPV vaccine (serotypes 6, 11, 16, and 18) (Serum Institute of India Pvt. Ltd., Pune, India), was used for HPV vaccination [9]. The vaccination schedule was as follows: two doses (0.5 mL at 0 and 6 months) for girls aged 9–14 years and three doses (0.5 mL at 0, 2, and 6 months) for participants aged 15–26 years. The second dose was given at least one month after the first dose and the third dose at least three months after the second dose, with all doses administered within one year. The vaccine was administered intramuscularly in the deltoid region of the upper arm by nurses, as instructed by the manufacturer. Vaccination cards were maintained, and reminders were sent by project staff.

Statistical analysis

The data generated in the study were entered into Microsoft Excel 2021 (Microsoft Corp., Redmond, WA, USA). Categorical variables, including HPV DNA positivity, distribution of HPV genotypes, and HPV vaccination status, were expressed as frequencies and percentages. Associations between two categorical variables were evaluated using the χ^2 test [10]. A p-value of less than 0.05 was considered statistically significant.

Results

The study was divided into three components: cervical cancer awareness, cervical cancer screening, and vaccination campaigns, designed to target various demographics and enhance the effectiveness of the interventions.

Awareness about cervical cancer

The awareness campaigns were conducted among the rural population of Haryana and aimed to provide knowledge about cervical cancer, its risk factors, signs and symptoms, diagnostic methods, preventive measures, treatment, and the availability of HPV vaccines for its prevention through informational talks and the distribution of pamphlets. Additionally, as part of the awareness program, “nukkad natak” (street plays) on the theme of cervical cancer were performed. A total of 1,180 women aged >18 years who attended the awareness campaigns and cervical cancer screening were briefly interviewed to assess their awareness of cervical cancer. Only 13.8% (163/1,180) of the women had heard of cervical cancer, 9.2% (109/1,180) had poor knowledge about it, and 9% (105/1,180) knew that the disease could be prevented. Women attending

the awareness campaigns, along with their eligible female relatives and members of the surrounding community, were encouraged to undergo cervical cancer screening. Similarly, girls and women who were eligible for HPV vaccination were encouraged to receive the vaccine.

Screening for cervical cancer

A total of 700 women who attended the Department of Obstetrics and Gynaecology, either for screening following awareness programs organized during the study or as doctor-referred suspected cases, were included for HPV DNA testing. The eligible age range was 30-65 years; however, five women under 30 years of age with physician-observed symptoms suggestive of cervical cancer were also included, as shown in Table 1. A substantial proportion of the study participants (70%) belonged to the 30-40-year age group. In terms of educational status, more than two-thirds had attained secondary education or higher, while 5.5% had received no formal education. A small proportion of the participants (3.1%) had comorbid conditions (diabetes and hypothyroidism). Of the 700 participants, only four had previously undergone cervical cancer screening. Cervical swabs collected from the study participants were processed for HPV DNA detection, resulting in a positivity rate of 8.4% (n = 59). The majority of the cases were among patients in the 30-40-year age group. There was no statistically significant difference in HPV DNA positivity between participants with middle school education or lower (18/217) and those with secondary education or higher (41/483) (p = 0.9). All HPV DNA-positive participants were married except one, who was widowed. Three of the four individuals who had previously undergone cervical cancer screening were found to be positive for HPV DNA.

Variables	Categories	Study population (n = 700), n (%)	HPV DNA-positive (n = 59), n (%)
Age (years)*	<30	5 (0.7)	1 (1.7)
	30-40	484 (69.1)	44 (74.6)
	>40-50	145 (20.7)	7 (11.9)
	>50-60	50 (7.1)	5 (8.5)
	>60-65	16 (2.3)	2 (3.4)
Education level‡	No formal education	38 (5.4)	3 (5.1)
	Primary	85 (12.1)	10 (16.9)
	Middle school	94 (13.4)	5 (8.5)
	Secondary	149 (21.3)	12 (20.3)
	Senior secondary	164 (23.4)	23 (39.0)
	Graduate and above	170 (24.3)	6 (10.2)
Marital status	Married	696 (99.4)	58 (98.3)
	Unmarried	1 (0.1)	0 (0.0)
	Divorced	2 (0.3)	0 (0.0)
	Widowed	1 (0.1)	1 (1.7)
Comorbid conditions	Diabetes	14 (2.0)	1 (1.7)
	Hypothyroidism	8 (1.1)	0 (0.0)
Previous cervical cancer screening	Yes	4 (0.6)	3 (5.1)
	No	696 (99.4)	56 (94.9)

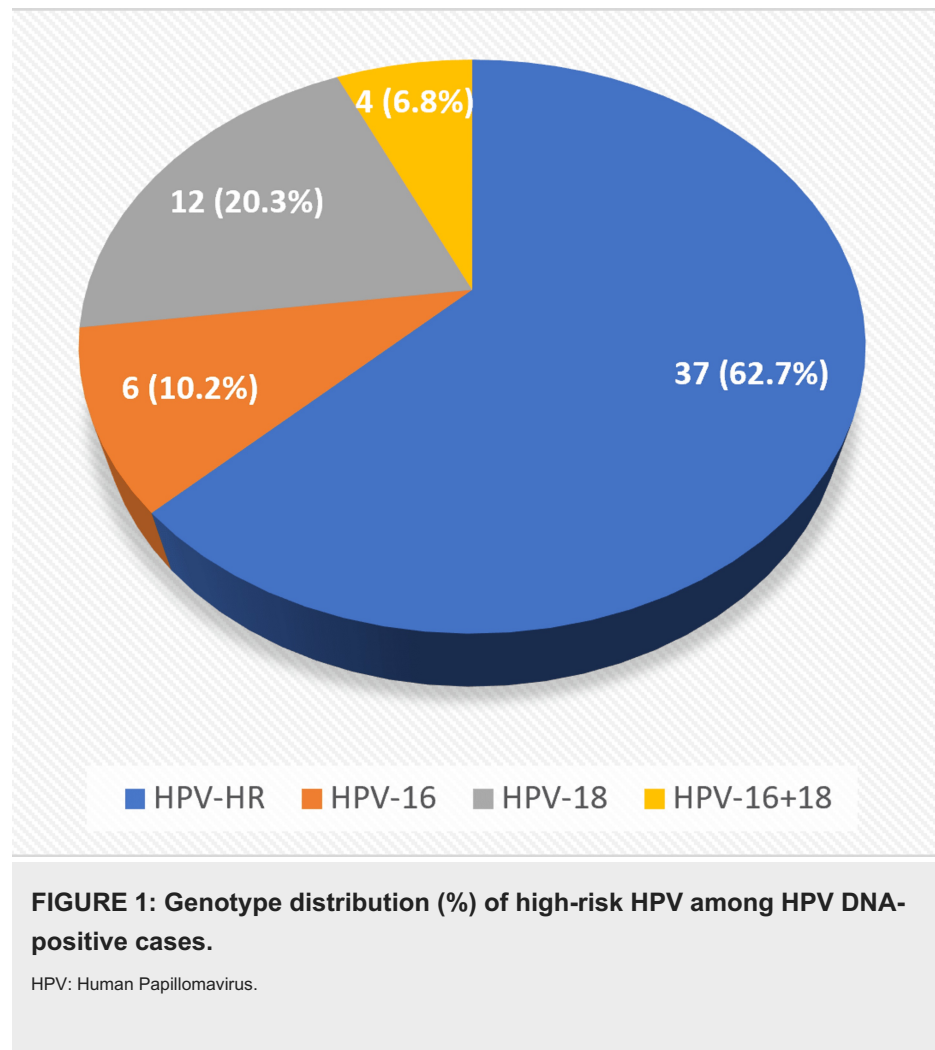
TABLE 1: Characteristics of study participants stratified by HPV DNA positivity.

*Five participants aged <30 years did not meet the age-based inclusion criteria; however, they were enrolled due to physician-observed symptoms suggestive of cervical cancer.

‡ Primary education = Classes 1-5; middle school = Classes 6-8; secondary education = Classes 9-10; senior secondary education = Classes 11-12.

HPV: Human Papillomavirus.

HPV genotype distribution was analysed using two HPV multiplex real-time PCR assays. Of the 59 participants who tested positive for HPV DNA, the most commonly detected genotype category was HPV-HR (62.7%, n = 37), followed by HPV-18 (20.3%, n = 12) and HPV-16 (10.2%, n = 6), while 6.8% (n = 4) were co-infected with both HPV-16 and HPV-18, as shown in Figure 1. Further differentiation of the HPV-HR genotypes revealed HPV-51 and HPV-52 as the most frequently detected genotypes, each accounting for seven (18.9%) cases. This was followed by HPV-35 in six (16.2%) cases, HPV-59 in five (13.5%) cases, and HPV-31 in four (10.9%) cases. Further genotyping using the second HPV multiplex real-time PCR assay detected co-infections in eight cases, comprising HPV-31 + HPV-66 (5/8), HPV-16 + HPV-31 (2/8), and HPV-18 + HPV-35 (1/8), as shown in Table 2. When HPV-HR genotype positivity was categorized based on the intensity of positivity (Ct), the majority of cases were classified as “positive” (26/37, 70.3%), followed by “high positive” (9/37, 24.3%) and “low positive” (2/37, 5.4%).



High-risk HPV genotypes	Total (n = 37), n (%)	Intensity of HPV-HR positivity, N (%)		
		High positive, n (%)	Positive, n (%)	Low positive, n (%)
HPV-31	4 (10.8)	0 (0.0)	4 (100.0)	0 (0.0)
HPV-35	6 (16.2)	4 (66.7)	2 (33.3)	0 (0.0)
HPV-51	7 (18.9)	0 (0.0)	6 (85.7)	1 (14.3)
HPV-52	7 (18.9)	2 (28.6)	4 (57.1)	1 (14.3)
HPV-59	5 (13.5)	0 (0.0)	5 (100.0)	0 (0.0)
HPV-16 + HPV-31	2 (5.4)	0 (0.0)	2 (100.0)	0 (0.0)
HPV-18 + HPV-35	1 (2.7)	1 (100.0)	0 (0.0)	0 (0.0)
HPV-31 + HPV-66	5 (13.5)	2 (40.0)	3 (60.0)	0 (0.0)

TABLE 2: Distribution of high-risk HPV genotypes other than HPV-16 and HPV-18.

HPV: Human papillomavirus; HPV-HR: High-risk human papillomavirus; n: Number of participants; %: Percentage.

Regardless of the HPV genotype, the majority of cases occurred in women aged 30–40 years (Table 3). A marginally higher number of women reported regular menstrual cycles (n = 28), while 24 had irregular cycles and seven were postmenopausal. Five of them had experienced abnormal pain or bleeding during or after intercourse. The majority (5/6) of HPV-16-positive cases had irregular menstrual cycles, with two reporting abnormal pain or bleeding during or after intercourse. Among HPV DNA-positive individuals, 22% used contraceptives, with condoms reported as the primary method. Abnormal vaginal discharge was reported by 21 (35.6%) individuals, including 12 with white discharge and nine with curdy discharge. Half of the participants who were HPV-16-positive or had HPV-16 and HPV-18 co-infection reported abnormal vaginal discharge. Additionally, 16 of them reported a foul or fishy odour associated with the discharge. More than half reported daily occurrence of the discharge. Along with abnormal discharge, associated symptoms such as pain, itching, or bleeding were reported by two-thirds of the individuals. Twelve individuals had a history of urinary tract infections, whereas none of the participants reported pelvic inflammatory disease, sexually transmitted infections (STIs), or HIV-positive status (data not shown in the table). Among the HPV DNA-positive cases, additional clinically significant abnormalities were identified. The high-risk HPV genotypes detected among cases with abnormal findings on per speculum (P/S) vaginal examination are presented in Table 4. Some of the hallmark P/S findings of cervical cancer, such as friability (easy bleeding on touch), foul-smelling discharge, and cervical erosions, were observed in a few cases.

Characteristics	Category	Total (n = 59), n (%)	Detection of high-risk HPV types, N (%)			
			HPV-16 (n = 6), n (%)	HPV-18 (n = 12), n (%)	HPV-16 and HPV-18 (n = 4), n (%)	HPV-HR (n = 37), n (%)
Age group (years)	<30	1 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)	1 (2.7)
	30-40	44 (74.6)	5 (83.3)	8 (66.7)	3 (75.0)	28 (75.7)
	>40-50	7 (11.9)	1 (16.7)	1 (8.3)	1 (25.0)	4 (10.8)
	>50-60	5 (8.5)	0 (0.0)	2 (16.7)	0 (0.0)	3 (8.1)
	>60-65	2 (3.4)	0 (0.0)	1 (8.3)	0 (0.0)	1 (2.7)
Menstrual cycle	Regular	28 (47.4)	1 (16.7)	5 (41.7)	2 (50.0)	20 (54.1)
	Irregular	24 (40.7)	5 (83.3)	4 (33.3)	2 (50.0)	13 (35.1)
	Attended menopause	7 (11.9)	0 (0.0)	3 (25.0)	0 (0.0)	4 (10.8)
Abnormal pain or bleeding during or after intercourse	Yes	5 (8.5)	2 (33.3)	1 (8.3)	0 (0.0)	2 (5.4)
	No	54 (91.5)	4 (66.7)	11 (91.7)	4 (100.0)	35 (94.6)
Use of contraception	Yes	13 (22.0)	2 (33.3)	3 (25.0)	0 (0.0)	8 (21.6)
	No	46 (78.0)	4 (66.7)	9 (75.0)	4 (100.0)	29 (78.4)
Abnormal vaginal discharge*	Present	21 (35.6)	3 (50.0)	4 (33.3)	2 (50.0)	12 (32.4)
Frequency	Daily	11 (52.4)	2 (66.7)	3 (75.0)	1 (50.0)	5 (41.7)
	Occasional	10 (47.6)	1 (33.3)	1 (25.0)	1 (50.0)	7 (58.3)
Colour	White	12 (57.1)	0 (0.0)	2 (50.0)	1 (50.0)	9 (75.0)
	Curdy	9 (42.9)	3 (100.0)	2 (50.0)	1 (50.0)	3 (25.0)
Foul or fishy odour	Present	16 (76.2)	2 (66.7)	3 (75.0)	2 (100.0)	9 (75.0)
Pain, itching, or bleeding	Yes	14 (66.7)	3 (100.0)	2 (50.0)	1 (50.0)	8 (66.7)
	No	7 (33.3)	0 (0.0)	2 (50.0)	1 (50.0)	4 (33.3)
History of UTI	Yes	12 (20.3)	0 (0.0)	2 (16.7)	0 (0.0)	10 (27.0)
	No	47 (79.7)	6 (100.0)	10 (83.3)	4 (100.0)	27 (73.0)

TABLE 3: Distribution of age groups and clinical presentations among HPV DNA-positive cases.

HPV: Human papillomavirus; HPV-HR: High-risk human papillomavirus.

*Calculated among participants with abnormal vaginal discharge.

Age (years) of the participant	High-risk HPV type detected	Findings on per speculum vaginal examination
37	HPV-16	Mid-hypertrophied cervix
40	HPV-52	Hypertrophied cervix with unhealthy appearance and bleeding on touch
29	HPV-16, HPV-18, and HPV-31	Mucosal discharge, cervical ectropion, and cervical erosion
33	HPV-31 and HPV-66	Abnormal vaginal bleeding
33	HPV-35	Cervical erosions
58	HPV-51	Circumoral erosions with fishy odour

TABLE 4: Distribution of high-risk HPV types according to age and clinically significant abnormal findings on per speculum vaginal examination.
HPV: Human papillomavirus.

HPV vaccination

A total of 102 individuals, comprising 17 (16.7%) girls aged 9-14 years (Group 1) and 85 (83.3%) girls/women aged 15-26 years (Group 2), received HPV vaccination. For the vaccine used in this study, i.e., CERVAVAC®, two doses were recommended for Group 1, while three doses were recommended for Group 2. In Group 1, all the girls completed the recommended two-dose HPV vaccination schedule, as shown in Table 5. In Group 2, 73 individuals completed the three-dose HPV vaccination schedule. Among the remaining 12 individuals, 10 discontinued after a single dose, and two discontinued after the second dose. Of the total vaccine recipients, five experienced mild adverse events after the first dose: two had mild fever, and three had swelling at the injection site. After the second dose, four experienced mild adverse events: two had fever, and two had swelling at the injection site. None required medication for the adverse events.

Age group	Recommended vaccination schedule	Completed vaccination schedule, n (%)	No. (%) of vaccinees who received	
			Incomplete vaccination schedule: 1 dose, n (%)	Incomplete vaccination schedule: 2 doses, n (%)
9-14 years (n = 17)	2 doses	17 (100.0)	0 (0.0)	NA
15-26 years (n = 85)	3 doses	73 (85.9)	10 (11.8)	2 (2.4)

TABLE 5: Vaccination status of participants who received the HPV vaccine.
HPV: Human papillomavirus; NA: Not applicable.

Discussion

Cervical cancer remains one of the leading cancers among Indian women, requiring improved awareness, prevention (through routine screening and vaccination), and access to care. Among the various factors that impede cervical cancer prevention and control in India, a lack of awareness is one of the major barriers [11]. To our knowledge, this is the first comprehensive study in Haryana aimed at reducing the burden of cervical cancer by integrating the WHO strategy of awareness, screening, and vaccination. In the present study, 13.8% of the surveyed women had heard of cervical cancer, while 9.2% had poor knowledge about it. This finding is similar to that of a study from rural Gujarat, which reported that 27% of participants (aged >18 years) had heard of cervical cancer [12]. In contrast, studies from different parts of the country reported much higher awareness of cervical cancer among surveyed women: 83% in Karnataka and 77.5% in Uttar Pradesh [13,14]. In our study, 9% of the women surveyed knew that cervical cancer is preventable, compared with 51% reported in a previous study [13]. The low level of knowledge about cervical cancer among the participants could be attributed to the fact that more than half of the study participants were illiterate or school dropouts. This is consistent with another study that identified similar educational status among participants as one of the significant predictors of poor knowledge about cervical cancer [13]. Thus, in India,

there is an urgent need for cervical cancer awareness programs at the school, college, and community levels to improve knowledge of its causes and prevention and eliminate common misconceptions and myths.

Early detection makes cervical cancer treatable; however, in India, delayed diagnosis leads to decreased survival rates and limited therapeutic options. The Ministry of Health and Family Welfare (MoHFW) launched visual inspection with acetic acid (VIA)-based cervical cancer screening every five years for women aged 30–65 years under the National Programme for Prevention and Control of Non-Communicable Diseases (NP-NCD) in 2016, acknowledging the role of early detection as key to reducing the burden of cervical cancer [4]. Following its implementation, according to the National Family Health Survey (NFHS)-5 (2019–2021) report, cervical cancer screening coverage among girls/women aged 15–49 years remained low, at 2% overall, comprising 2.2% in urban areas and 1.7% in rural areas [4,15]. Furthermore, the report revealed that cervical cancer screening was more common in urban than rural areas, and screening rates were higher in southern states (Tamil Nadu, Puducherry, and Andhra Pradesh) and northeastern India (Mizoram) compared with northern India, including Delhi and Haryana [15]. Gandhi R et al. from western India reported that only 9% of rural women who participated in their community-based study had undergone cervical cancer screening [12]. According to a national report, cervical cancer screening varied by religion, with Muslim women being slightly less likely than women of other religions to undergo cervical examination [15]. However, in the present study, such religion-based variation could not be assessed, as the study was conducted in Hindu-dominated areas.

In the present study, HPV DNA testing of the 700 participants revealed an overall positivity rate of 8.4% ($n = 59$) (positive for at least one HPV type), with multiple genotypes detected in 20.3% of the positive cases. This study highlights the higher detection of high-risk HPV genotypes other than HPV-16 and HPV-18 among the study participants (62.7%), followed by HPV-18 (20.3%) and HPV-16 (10%). Among the high-risk HPV types other than HPV-16 and HPV-18, HPV-51 and HPV-52 (12% each) were the most frequently detected, followed by HPV-35 (10%). Arumugam P et al. from the southeast coast of India reported a high HPV-16/18 positivity rate (51.3%) among healthy women attending a hospital, comprising HPV-16 (22%), HPV-18 (5%), and co-infection with both genotypes (25%) [16]. Nagaraja M et al. from southern India reported HPV-16 as the most frequently detected HPV genotype (85.3%), followed by HPV-18 (13.5%) and HPV-33 (11%). Unlike our study, the participants in their study were those with cervical disease [17]. A study by Senapati R et al. from eastern India evaluated the HPV genotype distribution among women with and without cervical carcinoma. As expected, the prevalence of HPV infection was higher among invasive cervical cancer cases (94%), followed by inflammatory smears (54%) and normal cytology (19%). Genotype distribution revealed HPV-16 as the most predominant type (87%), followed by HPV-18 (25%) and HPV-51 (3%). Furthermore, the study revealed that among HPV DNA-positive cases with normal cytology, HPV-16 was detected in seven cases and HPV-16 + HPV-18 in six cases [18]. It has been reported that after HPV exposure, approximately 70% of primary infections resolve within a year, while 91% resolve within two years. Furthermore, only 25% progress to cervical intraepithelial neoplasia and 1% to invasive cervical cancer [4]. Despite the fact that most HPV infections resolve spontaneously in the primary stage and few progress to cervical cancer, seroconversion does not always confer immunity. Additionally, HPV DNA positivity in young, healthy women may be transient and resolve spontaneously; thus, definitive conclusions are premature, and regular follow-up is recommended [5,16].

Cervical cancer is a preventable disease due to the availability of effective HPV vaccines. When girls are vaccinated, the HPV vaccine provides long-term protection against infections caused by high-risk HPV types frequently associated with cervical cancer. It prevents infection at the outset, thereby interrupting the pathway from HPV infection to cervical precancer and cancer [4]. In India, despite the announcement of a nationwide HPV vaccination rollout using India's indigenous HPV vaccine, i.e., Cervavac, for girls aged 9–14 years in 2024, vaccination had yet to be implemented by the end of 2025 [4,19]. Nevertheless, under the present study, a total of 102 eligible girls/women aged 9–26 years were vaccinated using the first indigenous HPV vaccine, i.e., Cervavac, between January and December 2025. As recommended by the manufacturer, 17 girls (aged 9–14 years) received the complete HPV vaccination schedule (two doses), whereas 73 girls/women aged 15–26 years received the complete schedule (three doses), and 12 received incomplete doses (one or two doses). According to a report from 2019–2021, HPV vaccine coverage was as low as 1% among girls aged 14 years in India [11,12]. A multisite study conducted across three diverse regions of India (Delhi-NCR, Karnataka, and Tripura) reported that awareness of HPV vaccination was remarkably low, with only 14 out of 146 (9.6%) participants being aware of it. The study included women from vulnerable populations, such as sex workers and women with HIV [20]. Another study from western India reported that 23% of rural women who participated in their community-based study had heard about the cervical cancer vaccine, and none of them had received HPV vaccination [12]. A nationwide HPV vaccination campaign was launched in India by Prime Minister Narendra Modi on 28 February 2026 from Ajmer, Rajasthan, targeting 14-year-old girls and marking a major step in the prevention of cervical cancer. The campaign offers a free, voluntary, single-dose HPV vaccine (Gardasil-4) at government health facilities, targeting a cohort of approximately 1.2 crore girls [21].

Limitations

Cervical cancer screening and HPV vaccination were offered free of cost to eligible rural girls/women in Haryana; however, due to a lack of awareness about the disease and existing sociocultural barriers, many

individuals did not avail themselves of the opportunity. Furthermore, the present study aimed to vaccinate 200 eligible girls and women; however, vaccine hesitancy among the eligible population was observed. The key reasons included misinformation on social media, including videos claiming adverse effects of HPV vaccination, and the prevailing misconception that the vaccine causes infertility later in life.

Conclusions

This study highlights poor baseline knowledge of cervical cancer and its vaccine among the study participants. Nearly all the women in the cervical cancer screening population had never undergone cervical cancer screening prior to this study. Furthermore, a significant proportion of eligible girls/women were reluctant to receive the HPV vaccine. These findings underscore the need for community-based cervical cancer awareness campaigns, strengthening health education at the school level, and providing access to HPV screening and vaccination facilities to improve cervical cancer prevention in rural settings.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee, Faculty of Medicine and Health Sciences, Shree Guru Gobind Singh Tricentenary University (SGT University) issued approval IEC/FMHS/F/23/12/24/10.

Animal subjects: All authors have confirmed that this study did not involve animal subjects or tissue.

Conflicts of interest: In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** This study was supported by Hella India Automotive Private Limited, Gurugram, Haryana, India under its Corporate Social Responsibility grant (Project ID. 48104113). **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

Acknowledgements

The authors would like to thank Mrs. Akshita (Research Assistant) and Ms. Ritika (Junior Research Fellow) of the Molecular Laboratory, FMHS, SGT University, for their tireless contributions to the execution of the project. The authors also acknowledge Mr. Sudhakar, Mr. Amit, and Mr. Naveen, laboratory technicians, for their contributions to sample processing. No AI tools were used to generate the research idea, objectives, or scientific content.

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