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Original Article

High-Risk and Low-Risk Human Papillomavirus (HPV) Virus Distribution in Symptomatic and Asymptomatic Population: a Cross-Sectional Study

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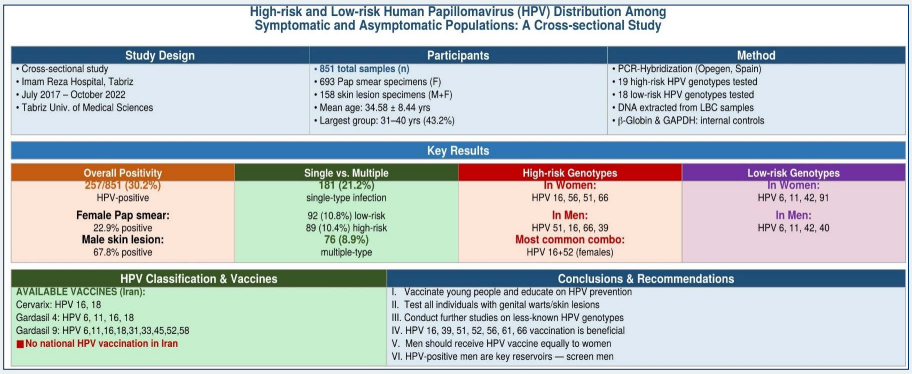

Abstract

Introduction: Human papillomavirus (HPV) infection is associated with both sexes' oropharyngeal and anogenital warts and malignancies. This virus has several genotypes, including high-risk and low-risk subtypes. Some genotypes are less known. This study investigated the prevalence of HPV genotypes, which could lead to the development of more effective vaccines and preventive strategies.

Methods: A total of 851 samples, including 693 swabs of Pap Smear and 158 skin lesions from genital warts were analyzed by polymerase chain reaction (PCR)-Hybridization method to determine 19 high-risk and 18 low-risk HPV genotypes.

Results: The participants' mean age was 34.58 ± 8.44, and most of them were between 31 to 40 years old. Totally, 257 participants (30.2%) tested positive for HPV; of these, 181 (21.2%) were positive for a single HPV subtype and 76 (8.9%) were infected by two or more HPV subtypes. The most frequent high-risk genotypes were HPV 16, 51, 56, and 66 in women and HPV 51, 16, 66, and 39 in men. Most frequent low-risk genotypes belonged to HPV 6, 11, 42, and 91. Moreover, HPV16 was the most prevalent high-risk HPV, especially when combined with genotype 52.

Conclusion: Due to the majority of HPV-positive results, men play a significant role. It is suggested that men and women should receive intensive education on prevention and vaccination, with an emphasis on younger generations. Research on HPV in men, accompanied by women's screening and routine vaccination in both genders, may be beneficial in reducing the consequences of this infection.

Introduction

Nowadays the prevalence of infection by human papillomavirus (HPV) is alarming, as, in most people, the infection evidence disappears without progressing in clinical signs and symptoms.[1,2] genital warts affect 1% of sexually active Americans and at least 15% of this group have a subclinical infection. In the United States 6.2 million new HPV cases in people aged 14 to 44 are estimated each year. Women aged 20 to 24 have the highest prevalence of HPV (44.8%) compared to women aged 14 to 19 (24.5%) and women aged 25 to 29 (27.4%).[3-5]

HPV subtypes can cause a variety of diseases with a spectrum of clinical manifestations. From low-risk benign lesions, to squamous intraepithelial lesions,

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invasive tumors and cervical malignancies.[6,7] Today, almost 200 subtypes of HPV have been identified, of which a considerable number can cause genital infections. Several HPV subtypes are responsible for genital warts, however, some HPV subtypes are highly pathogenic and leads to invasive cervical cancers and associated premalignant lesions.[2,7]

HPV is known as a leading risk factor for cervical malignancies.[7,8] Additionally, HPVs can cause anal cancer, malignant penile cancer, and approximately 20% of oropharyngeal carcinomas.[7,9] The initial isolation of HPV 16 and HPV 18 and their link with cervical cancer stimulated research and continued discoveries of novel HPV subtypes.[10]

HPV subtypes can cause various diseases, with each subtype displaying distinctive and particular disease characteristics and infection characteristics. Therefore, it is suggested that each HPV genotype be studied separately. The results of epidemiological studies need to be taken extremely seriously because there have not been many experimental investigations on the carcinogenicity of HPV types and the majority of most clinical studies have been focused on just HPV16 and HPV18 subtypes.[11,12]

Among the eight major carcinogenic HPV subtypes, six belong to the alpha-9 type (16, 31, 33, 35, 52, 58) and two (18, 45) belong to the alpha-7 type.[13,14] Additionally, some HPV subtypes are known to be less dangerous viruses because they typically cause genital warts and other benign conditions. Whereas the other HPV subtypes that are labeled as "probably or possibly carcinogenic" have limited evidence linking them to malignant cancers and require further investigation.[12,13]

Studies have shown that young women may be susceptible to HPV infection.[15] For example, HPV prevalence on the African continent is higher in women 30 years of age or younger.[16,17] In contrast to women, HPV infections in men are associated with lower mortality and fewer complications. Men who have HPV infection may develop genital warts in the penis and anorectal region cancer, as well as oropharyngeal cancer. The crucial topic is what part men can play in viral transmission, especially for men and women who have multiple sexual partners, because men often have asymptomatic HPV infections. An estimated 20% of males have HPV infection, and this number rises to 70% in some age groups, particularly those between 15 and 24.[18,19]

Vaccination is one of the most influential and cost-benefit methods of preventing HPV-related infections, lesions, diseases, and malignancies. The available vaccines are Cervarix, which prevents subtypes 18 and 16; Gardasil 4, which is effective against subtypes 16, 18, 11, and 6; and the Gardasil 9, which is effective against subtypes 6, 11, 16, 18, 31, 33, 45, 52, and 58.[20] The percentage of adults who have received an HPV vaccination grew from 56.1% in 2015 to 75.4% in 2020, a rise of 4.7% per year for men and 2.7% per year for women [21]. However, the distribution of HPV genotypes in females is essential because it may be used to assess the efficacy of existing vaccines. Various HPV vaccines, such as Cervarix, Gardasil 4 and Gardasil 9 are available in Iran. Unfortunately, HPV vaccination is not part of the national immunization program.The purpose of this study is to determine the distribution of the most dangerous subtypes of HPV in men and women using reputable pathology center data in Tabriz, northwest of Iran.

Material & Methods

Study Design and Patients

This cross-sectional study was conducted between July 2017 and October 2022 in the Imam Reza Hospital pathology department, Tabriz University of Medical Sciences. The study was approved by the Research Ethics Committee of Tabriz University of Medical Sciences (permission code: IR.TBZMED.REC. 1400.886). Written informed consent was obtained from patients. A total of 851 samples (693 Pap smears and 158 skin samples from anogenital warts) from symptomatic and asymptomatic participants were examined for HPV genotypes. Gynecologists, dermatologists, urologists, and other specialists referred patients to the laboratory. Therefore, patients suspected of HPV with defined clinical characteristics were included according to recommendations of gynecologists, dermatologists, urologists, and other specialists. The procedures were conducted the Helsinki Declaration—2013. The laboratory staff recorded each participant's demographic data (age and sex).

Molecular Investigations

DNA Extraction

DNA was extracted from LBC (Liquid base cytology) samples using the column-based technique of the DNA extraction kit (Favorgen Biotech, Taiwan). The sample was mixed with proteinase and lysing buffer and incubated at 56 °C for 10 minutes. Then, after mixing with absolute ethanol, it was placed on the kit columns. After washing with the washing solutions twice, a release buffer for DNA extraction was added, and the purified DNA was obtained. The purified DNA was stored at -20 °C for further molecular investigations.

PCR-Hybridization Method

The PCR-Hybridization method was applied to genotype 19 high-risk HPV isolates (16, 18, 26, 31, 33, 35, 39, 45, 51, 52, 53, 56, 58, 59, 66, 68, 69, 73, and 82) and 18 low-risk HPV isolates (6, 11, 40, 42, 43, 44, 54, 61, 62, 67, 70, 71, 72, 74, 81, 83, 84, and 91). For this purpose, a ready-to-use kit was prepared (Opegen, Operon, Spain). Briefly, the extracted DNA was inserted in two separate microtubes with primers for low-risk and high-risk genotypes to perform the hybridization method. Then, the PCR products were taken separately on strips for low-risk and high-risk genotypes, on which probes of different genotypes were placed to perform hybridization. In the stages of denaturation, hybridization, washing, and conjugation with streptavidin peroxidase, a picture

was taken on the strip. Finally, the identified genotypes appeared as blue stripes on the strips. Also, *β-Globin* and *GADPH* genes were selected as reaction controls.

Statistical Analysis

The SPSS version 24 (IBM Statistics, USA) was applied for statistical analysis. The qualitative variables of the study were analyzed through percentile rates. The *P* value < 0.05 was considered a statistically significant cut-off if needed.

Results

All 851 samples referred to the pathology department entered the survey. Samples included 764 specimens from females (693 pap smears and 71 skin lesions) and 87 skin lesion samples from males. Patients were divided into four groups based on their ages (< 31 years old: 290 (34.0%), 31-40 years old:368 (43.2%), 41-50 years old:159 (18.6%), and > 50 years old: 34(4.0%)) (Table 1).

The mean age was 34.58 ± 8.44 (37.77 ± 8.17 in the Pap smear group and 33.75 ± 9.53 in the skin lesion group). According to age groups, most patients were 31-40 years old (Table 1). A total of 257 (30.2%) participants tested positive for HPV genotypes (Table 2). Among them, 181 (21.2%) were positive for single-type HPV infection, 92 (10.8%) with low-risk single type, 89 (10.4%) with high-risk single type, and 76 (8.9%) for multiple-type HPV infection. Overall, as demonstrated in the Table 3, a high percentage of positive HPV (single and multiple) was detected among male skin lesion samples in all age groups compared to other samples.

The distribution of positive HPV according to age group was in the following order: 31-40 years:117 (32.0%), < 31 years old: 92 (31.7%), 41-50 years: 38 (23.8%), and > 50 years: 10 (29.4%) (Table 2).

HPV subtypes 16, 51, 56, and 66 were the most frequent high-risk genotypes, respectively. Meanwhile, 6, 11, 42, and 91 subtypes were the most low-risk genotypes, respectively. High-risk HPV 69 and low-risk HPVs 71, 72, 74, and 83 were not detected by the PCR-Hybridization method. High-risk HPV 45 and low-risk HPVs 40, 61, 70, and 81 were detected in skin lesion samples. As revealed in the figures, among females, HPV subtypes 16, 56, 51, and 66 in the high-risk group and subtypes 6, 11, 42, and 91 in the low-risk group are the most common genotypes compared to subtypes 51, 16, 66, and 39 in the high-risk group and subtypes 6, 11, 42, and 40 in the low-risk group among males (Figures 1 and 2). HPV subtype 16 is the most common genotype (16; 1.9%), accompanied by other high-risk genotypes, especially subtype 52 (5; 0.6%) among females (Table 4).

Discussion

HPV is a worldwide prevalent infection [2] with various subtypes ranging from low- to high-risk subtypes. Low-risk subtypes cause infections, genital warts, and skin lesions, whereas high-risk subtypes cause malignancies of the anogenital and oropharyngeal areas in both women and men.[6,7,9] *An important* prevention strategy currently is vaccination of *both women and men,*[19,21] Overall, 257 of 851(30.2%) male and female participants in this study had HPV infections.

The average prevalence of HPV worldwide is 11.7%, with wide variation among countries. The value obtained in this study is even higher than the HPV prevalence in China, which was reported to range from 9.9% to 27.5% among different cities.[22] The majority of positive HPV cases were found in women between the ages of 25 and 29 in a study on Chinese women.[23] In another study conducted in Xinjiang, China, the HPV prevalence was reported to be 14.02%.[24] In this study, 159 out of the total 693 women who had a Pap smear performed (22.9%) had positive HPV results, and 98 out of 158 (62%) men and women who provided skin lesion specimens had HPV-positive results. Of the 87 men with skin lesion specimens examined, 59 individuals (67.8%) had HPV-positive results. Compared to these results, the infection rate

Table 1. Demographic characteristics of patients

	All samples (n = 851)	Pap smear (n = 693)	Skin lesion (n = 158)	Only male cases (n = 87)
Sex (female: male)	764: 87	693: 0	71: 87	-
Age (mean ± SD[range])	34.58 ± 8.44[8-67]	37.77 ± 8.17[15-67]	33.75 ± 9.53[8-63]	36.01 ± 9.63[12-63]
Age < 31	290 (34.0%)	228 (32.9%)	62 (39.2%)	26 (29.9%)
Age 31-40	368 (43.2%)	309 (44.6%)	59 (37.3%)	37 (42.5%)
Age 41-50	159 (18.6%)	131 (18.9%)	28 (17.7%)	17 (19.5%)
Age > 50	34 (4.0%)	25 (3.6%)	9 (5.7%)	7 (8.0%)

SD: Standard Deviation

Table 2. Distribution of HPV in age groups

Positive HPV (% in age group)	All samples (n = 851)	Pap smear (n = 693)	Skin lesion (n = 158)	Only male cases (n = 87)
Positive HPV	257 (30.2%)	159 (22.9%)	98 (62.0%)	59 (67.8%)
Age < 31	92 (31.7%)	53 (23.2%)	39 (62.9%)	18 (69.2%)
Age 31-40	117 (32.0%)	80 (25.8%)	37 (62.7%)	24 (64.8%)
Age 41-50	38 (23.8%)	22 (16.8%)	16 (57.1%)	12 (70.6%)
Age > 50	10 (29.4%)	4 (16.0%)	6 (66.6%)	5 (71.4%)

Table 3. Single High-risk and Low-risk HPV infection

	All samples (n=851)	Pap smear (n=693)	Skin lesion (n=158)	Only male cases (n=87)
Single HPV infection	181 (21.2%)	103 (14.9%)	77 (48.7%)	44 (50.6%)
Low-risk HPV	92 (10.8%)	23 (3.3%)	68 (43.0%)	37 (42.5%)
6	58 (6.8%)	10 (1.4%)	48 (30.4%)	28 (32.2%)
11	19 (2.2%)	3 (0.4%)	16 (10.1%)	9 (10.3%)
42	8 (0.9%)	6 (0.8%)	2 (1.3%)	0 (0%)
44	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
61	2 (0.2%)	0 (0%)	2 (1.3%)	0 (0%)
67	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
84	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
91	2 (0.2%)	2 (0.2%)	0 (0%)	0 (0%)
High-risk HPV	89 (10.4%)	80 (11.5%)	9 (5.7%)	7 (8.0%)
16	23 (2.7%)	20 (2.9%)	3 (1.9%)	2 (2.3%)
18	4 (0.5%)	3 (0.4%)	1 (0.6)	1 (1.1%)
31	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
35	2 (0.2%)	2 (0.3%)	0 (0%)	0 (0%)
39	7 (0.8%)	5 (0.7%)	2 (1.3%)	2 (2.3%)
45	6 (0.7%)	6 (0.9%)	0 (0%)	0 (0%)
51	9 (1.0%)	7 (1.0%)	2 (1.3%)	2 (2.3%)
52	5 (0.6%)	5 (0.7%)	0 (0%)	0 (0%)
53	3 (0.3%)	3 (0.4%)	0 (0%)	0 (0%)
56	9 (1.0%)	8 (1.1%)	1 (0.6%)	0 (0%)
58	3 (0.3%)	3 (0.4%)	0 (0%)	0 (0%)
59	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
66	12 (1.4%)	12 (1.7%)	0 (0%)	0 (0%)
68	2 (0.2%)	2 (0.3%)	0 (0%)	0 (0%)
73	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
82	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)

Table 4. Multiple High-risk HPV infection including HPV16 subtype

	All samples (n=851)	Pap smear (n=693)	Skin lesion (n=158)	Only male cases (n=87)
Multiple high-risk HPV infection	76 (8.9%)	54 (7.8%)	21 (13.3%)	14 (16.1%)
16	16 (1.9%)	14 (2.0%)	2 (1.2%)	1 (1.1%)
16, 18	2 (0.2%)	2 (0.3%)	0 (0%)	0 (0%)
16, 26	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
16, 35	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
16, 51	2 (0.2%)	2 (0.3%)	0 (0%)	0 (0%)
16, 52	5 (0.6%)	5 (0.7%)	0 (0%)	0 (0%)
16, 56	1 (0.1%)	1 (0.1%)	0 (0%)	0 (0%)
16, 66	2 (0.2%)	2 (0.3%)	0 (0%)	0 (0%)
16, 68	3 (0.3%)	3 (0.4%)	0 (0%)	0 (0%)
16, 73	1 (0.1%)	0 (0%)	1 (0.6%)	1 (1.1%)

among young adult men in Africa was 37.2% in Botswana, 50% in Kenya, 77% in South Africa, 42.8% in Uganda, and 20.5% in Tanzania.[25] The prevalence of HPV was 61.2% in Yasouj, Iran.[26]

In the current study, the age group over 50 years had the lowest rate of HPV positivity, but in China, the age group of 30 to 39 years had the lowest infection rate.[27] In all age groups, the rate of positive HPV in skin lesion samples was higher than in Pap smear samples. The majority of positive HPV cases were found in women between the ages of 25 and 29 in a study on Chinese women [23], and among outpatient women less than 20 in a different study, the prevalence rate for positive HPV cases was 36.7% .[27]

According to this study, men are more likely than women to have HPV infections, which may be related to the asymptomatic nature of HPV infection in men. Men

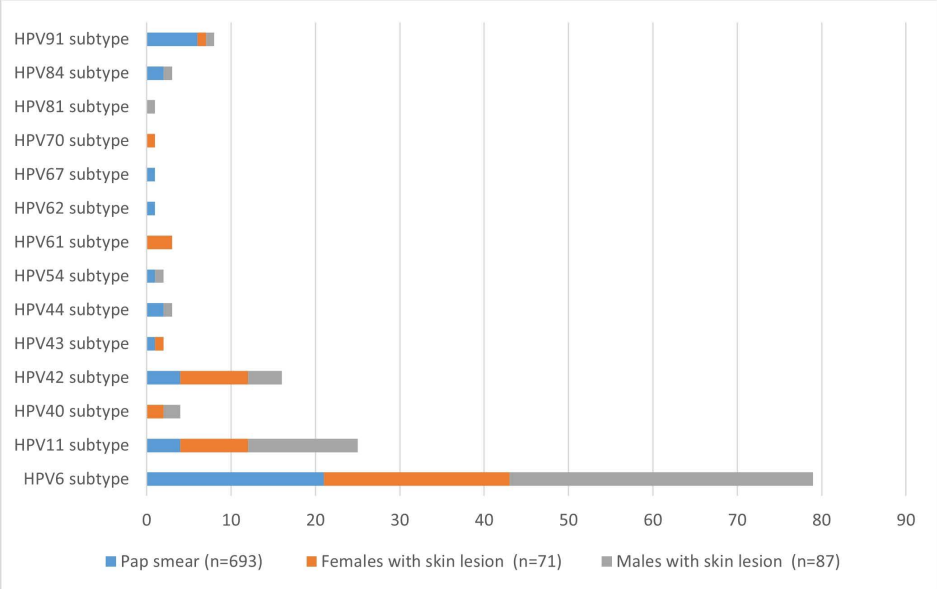

Figure 1. Prevalence of Low-risk HPV subtypes

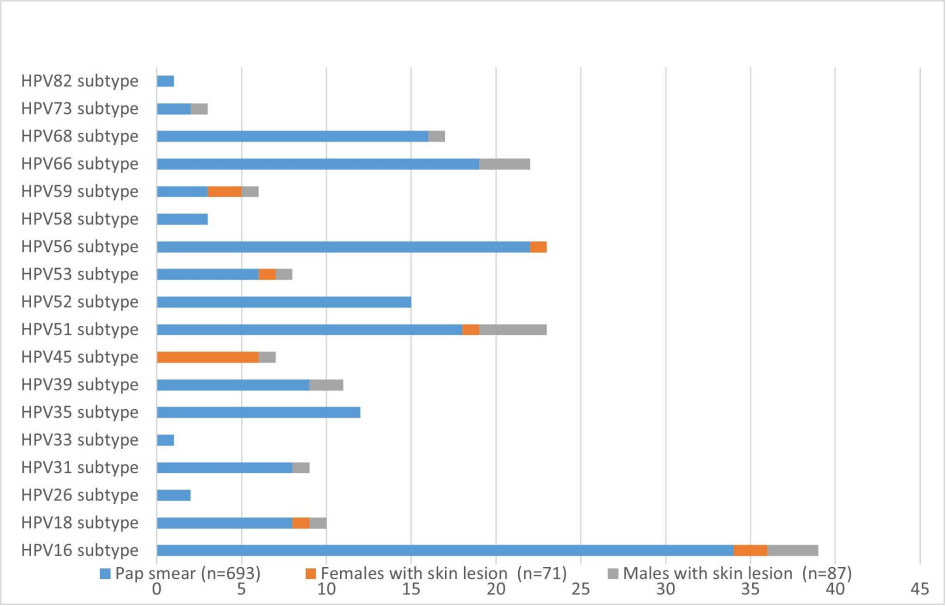

Figure 2. Prevalence of High-risk HPV subtypes

are also known reservoirs for the transmission of this virus, so the spread of HPV in men needs to be taken seriously.[18,28] In women, the most prevalent subtypes of high-risk HPV are genotypes 16, 51, 56, 66, while the most prevalent subtypes of low-risk HPV are 6,11,42, 91. In a study on Chinese women, the most prevalent genotypes in both single and multiple infections were (52,16, 58) subtypes. From 2011 to 2019, significant secular trends were observed in the prevalence of most HPV subtypes.[23] In east China in 2019, subtypes 16, 58,52,53 and 18 were found to be the most prevalent HPV subtypes among outpatient women [27], whereas in Beijing, China, subtypes 16,52, 58 were found to be the most frequently infected.[29] According to another survey in Boyer Ahmad, Iran, the most prevalent subtypes were 39, 66, 31, 18, and in contrast to the current study, the prevalence of subtype 16 was low.[26] In another study in Sanandaj, Iran, 56% of participants had an HPV infection.[30]

High-risk genotypes (16, 39, 51, 61) are the most prevalent in men. Among low-risk subtypes, 6, 11, 42, 40 are the most common. In a study in Mashhad, Iran, 56.9% of the males were HPV-positive, with genotype 66 being the most prevalent high-risk genotype and subtypes 6,11,42, 91 being the most pervasive low-risk HPVs.[28] The most prevalent subtype in females is HPV 16, and the combination of HPV 16 and 52 was the most pervasive multiple high-risk HPV infection. These findings corresponded with a study in China, which found that HPV subtypes are more prevalent when combined, as shown by the combination of the following types: 16 with 58, 52 with 58, 39 with 52, 16 with 52,.[27] In the current study, 181 participants out of 257 (70.42%) were infected with one subtype of the virus, while 76 participants out of these 257 (29.57%) were infected with multiple subtypes. These reports are similar to the results of a study in China, in which approximately 72.32% of the women were

infected with a single type of HPV. In comparison, only 27.68% of these women were infected with multiple HPV subtypes.[23] Another study in China revealed a similar ratio: 73.5% of women had a single type of HPV infection, while approximately 26.5% of these women were infected with multiple subtypes; it was discovered that 52, 16, 58, 53, 39 subtypes were the most prevalent HPV subtypes in the entire studied population.[22]

Evaluating the severity and frequency variation of high-risk subtypes in men and women is possible. The study may have some defects that we can alter in upcoming studies, such as: the unequal number of persons for each gender who participated in the research and the inability to assign additional people from the gender spectrum due to local government rules. Vaccine protection results and histories could be evaluated among the study participants. Even participant histories, particularly those of those who were HPV-positive at the time of their first sexual contact, might be collected.

Conclusion

Different HPV genotypes can result in malignancies, which can be lethal in both women and men. The importance of immunization, screening, prevention, and vaccination against this virus should be taken seriously because Iran does not have a structured and ongoing HPV vaccination program. In this situation, we need to focus on a few points; **I:** It is better to vaccinate young people and teach them how to prevent HPV infection. **II:** HPV infection should be checked for in all individuals who have genital warts and skin lesions. **III:** To create more effective vaccines, additional studies should be conducted to identify and deeply investigate a set of HPV genotypes for which complete information on carcinogenicity and lethality is not yet available. **IV:** According to this study's findings, vaccination and immunization against at least genotypes 16, 39, 51, 52, 56, 61, 66 are beneficial. **V:** Finally, men should receive the HPV vaccine just like females.

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Authors' Contribution

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Writing–review & editing: Haleh Farshi, Mahsa Nikanfar, Mortaza Raeisi, Amir Vahedi, Zahra Abdossamadi

Competing Interests

The authors have no conflict of interest to declare.

Ethical Approval

The ethics committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1400.886) approved the study, and the procedures were conducted in accordance with the Helsinki Declaration 2013.

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